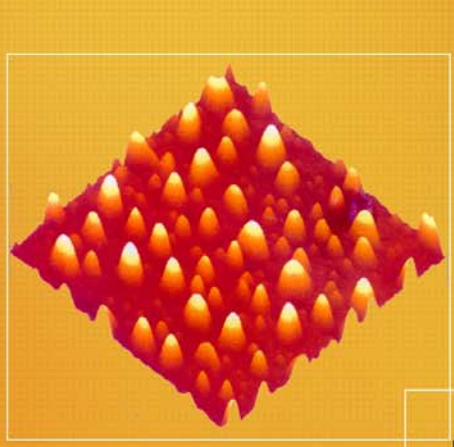
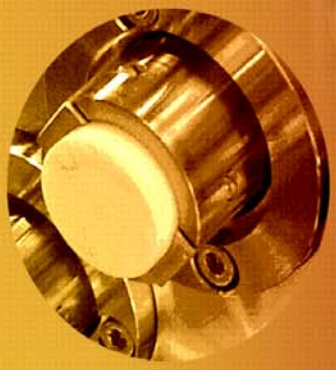
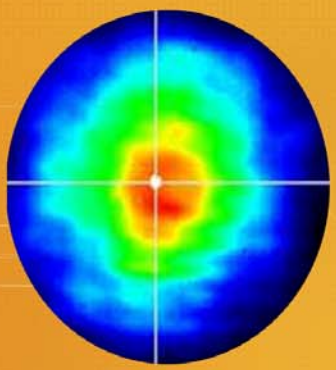
DAE-BRNS 4th National Symposium on Pulsed Laser Deposition of Thin Films and Nanostructured Materials

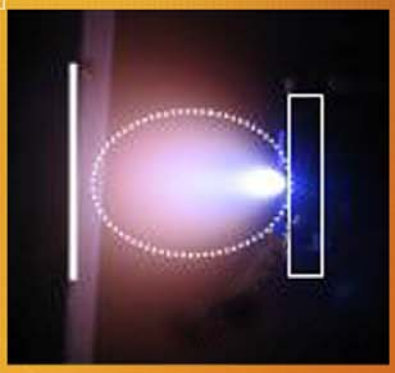
PLD 2007

October 3-5, 2007
Rajkot, Gujarat-360005









Abstract Book-cum-Souvenir

Contents

FROM THE CONVENER....

Dear Invitees, Participants, Colleagues and Friends,

It gives me immense pleasure to welcome you all at the DAE BRNS 4th National Symposium on Pulsed Laser Deposition of Thin Films and Nanostructured Materials, PLD 2007 for short. Since its inception in 2001 biennial PLD meets have provided a forum for intense professional interactions amongst scientists, students and suppliers of the Indian PLD community. Countless ideas have been discussed, collaborations have been planned and executed, suggestions have been mooted and contemplated and an enormous amount of scientific knowledge has been disseminated and absorbed through these meetings. At PLD meets researchers from national laboratories and universities come closer to share their respective strengths and do away with their respective lacunae. We are indeed indebted to DAE – BRNS for their continued support to hold these meetings and hence to fulfill the purpose of these meetings.

Albeit in a small way, PLD 2007 is witnessing something special that for sure is a reason for all of us to feel upbeat. Not only that we have registered a quantitative increase in the number of abstracts submitted, we notice a qualitative improvement of the research being presented in the papers. Not only that we have delegates from all the important institutes of the country, for the first time, we have a sizable participation of highly acclaimed scientists from Germany and China. These are harbingers of an upward contribution that Indian scientists are vying to make and enhancing integration of our research with the global science. Individually our forward moving steps may still be small but collectively we can proceed at a gallop. This is the goal we will strive to achieve together.

As you can see from the planned proceedings of PLD 2007, the sequences of presentations are so elaborate that it will make your cup of time overflow. But I believe you will welcome this. By the time we wind up this meet, although we all will be extremely tired but will also be extremely happy to get soaked with new knowledge, new ideas and something significant to take home. I wish you all a very successful and enchanting participation in PLD 2007.

Lalit M. Kukreja
August 20, 2007

FROM THE SCIENTIFIC PROGRAM COMMITTEE…

We take this opportunity to welcome you all to the PLD-2007 symposium. It is a great pleasure to share with you the feeling of overwhelming response of abstract submissions in this symposium. We have received about 85 abstract for PLD 2007 from most of the active groups from Indian Laboratories and some foreign participants from China and Germany. The number of total submitted abstracts in PLD 2007 is significantly higher than the total number of abstract received in previous PLD symposia e.g., in 28 in PLD-2005, 26 in PLD-2003 which and 19 in PLD-2001. The scientific standard of the contributed abstract has also improved significantly over the years. This year we received abstracts for thesis presentations also and included it in scientific program. The scientific programs will run all the three days and every day there will be different sessions of presentations such as invited tutorial talks (ITT), Invited review talks (IRT), Invited Paper talks (IPT), Oral presentations (OPT), thesis presentations (THP) and poster presentations (PSP).We have included a special session for corporate presentations on the last day of the symposium. In this session discussions about scientific products pertinent to the scope of the symposium will be carried out. An arrangement to display the product catalogues and handouts etc from the corporate sector have been made at the venue for all the three days.

We thank Prof. L. M. Kukreja, Symposium Convener for his constant guidance and suggestions for preparing this compendium of abstracts. We would also like to thank our colleague Mr. Amit K. Das of RRCAT, Indore for his help in designing the cover pages of the abstract book. Thanks are also due to Dr. B. N. Singh of RRCAT, Indore and Mr. R. Bankar of Pune University, Pune for their help during preparation of the abstract book.

We wish you all a very fruitful participation in PLD 2007 and happy back home.

Pankaj Misra
Secretary

Kiran P. Adhi
Convener

Scientific Program Committee
PLD-2007

October 2, 2007 (Tuesday)
20:00 hrs onwards: *Welcome Dinner and Registration at Hotel Rangoli Park, Rajkot*

Scientific Program

Venue: Resort Chouki Dhani, Rajkot

October 3, 2007 (Wednesday)											
Time	8:30-9:30	9:30-10:30	10:30-11:00	11:00-13:00	13:00-14:00	14:00-15:00	15:00-15:30	15:30-16:30	16:30-17:30	17:30-18:30	19:00-21:00
Sessions	Break Fast & Registration	Inauguration of the symposium	High Tea	IRT1 IRT2 IRT3 IRT4	Lunch	ITT1	OPT1 OPT2	Tea + PSP1	IPT1 IPT2	THP1 THP2	Cultural Program and Dinner

October 4, 2007 (Thursday)											
Time	8:30-9:00	9:00 – 11:00	11:00-11:30	11:30-13:00	13:00-14:00	14:00-15:00	15:00-15:30	15:30-16:30	16:30-17:30	17:30-18:30	19:00-21:00
Sessions	Break Fast & Registration	IRT5 IRT6 IRT7 IRT8	TEA	IRT9 IRT10 IRT11	Lunch	ITT2	OPT3 OPT4	Tea + PSP2	IPT3 IPT4	THP3 THP4	Dinner

October 5, 2007 (Friday)											
Time	8:30-9:00	9:00 – 11:00	11:00-11:30	11:30-13:00	13:00-14:00	14:00-15:00	15:00-15:30	15:30-16:00	16:00-17:30	17:30-19:00	19:00-21:00
Sessions	Break fast	IRT12 IRT13 IRT14 IRT15	TEA	IRT16 IPT5 IPT6	Lunch	ITT3	OPT5 OPT6	TEA	THP5 IPT7 OPT7 OPT8	CPT1 CPT2 CPT3 CPT4 CPT5	Closing and Dinner

ITT: Invited Tutorial Talk; IRT: Invited Review Talk; IPT: Invited Paper Talk; OPT: Oral Presentation; THP: Theses Presentation; PSP: Poster Presentation
CPT: Corporate Presentation
Time durations: ITTs: 60 min; IRTs: 30 min; IPTs: 30 min; OPT: 15 min; THPs: 30 min; CPTs: 15 min

Invited Tutorial Talks (ITT)

S. No.	Code No.	Title	Speaker	Address	Co-authors
1	ITT1	Optical Properties of Semiconductors at the fundamental absorption edge	Claus Klingshirn	Institut für Angewandte Physik Universität Karlsruhe Karlsruhe Germany *Claus.Klingshirn@physik.uni-karlsruhe.de*	J. Fallert, H. Zhou, and H. Kalt
2	ITT2	Field Emission From Nanomaterials - A Tutorial	D. S. Joag	Centre for Advanced Studies in Condensed Matter Physics and Material Science Department of Physics Pune University Pune 411 007 *dsj@physics.unipune.ernet.in*	
3	ITT3	Pulsed Laser Growth of Nanostructured Materials: Some Recent Experiments	L. M. Kukreja	Thin Film Laboratory, RRCAT, Indore – 452 013 *kukreja@cat.ernet.in*	

Invited Review Talks (IRT)

S. No.	Code No.	Title	Speaker	Address	Co-authors
4	IRT 1	Research on p-type ZnO	Z. Z. Ye	State Key Laboratory of Silicon Materials, Zhejiang University, Hangzhou, 310027, E-mail: *yezz@zju.edu.cn*	Y. F. Lu, Y. J. Zeng, J. G. Lu, L. P. Zhu
5	IRT 2	Electrical, Optical And Magnetic Properties Of Oxide Based Nanostructures	M. S. Ramachandra Rao	Department of Physics, Indian Institute of Technology, Madras, Chennai *msrrao@iitm.ac.in*	
6	IRT 3	Temperature-dependent photoluminescence from $ZnO/Zn_{0.85}Mg_{0.15}O$ quantum well grown on Si(111) substrates	L.P. Zhu	State Key Lab of Silicon Materials, Department of Materials Science and Engineering, Zhejiang University, Hangzhou, 310027, People's Republic of China *zlp1@zjuem.zju.edu.cn*	X.Q. Gu, H.P. He, F. Huang, M.X. Qiu, Z.Z. Ye, Y.Z. Zhang, B.H. Zhao
7	IRT 4	Electron doped manganites: Reality or illusion?	Pratap Raychaudhuri	Department of Condensed Matter Physics and Materials Science,TIFR,, Homi Bhabha Rd., Colaba, Mumbai-400005	

				pratap@tifr.res.in	
8	IRT 5	Multiferroic behavior of modified $BiFeO_3$ thin films grown by PLD: A Review	V. R. Palkar	Electrical Engineering, Indian Institute of Technology Bombay, Mumbai 400 076, India palkar@ee.iitb.ac.in	
9	IRT 6	Nanostructured Thin Films of Titania Prepared by Pulsed Laser Ablation: Process and Properties	P. Kuppusami	Physical Metallurgy Division Indira Gandhi Centre for Atomic Research Kalpkkam-603 102, Tamilnadu *pk@igcar.ernet.in*	S. Murugesan and E. Mohandas
10	IRT 7	Combinatorial Pulsed Laser Abltation for Parallel Synthesis and High Throughput Characterization of Functional Inorganic materials	Utpal S. Joshi	Department of Physics, School of Sciences, Gujarat University, Ahmedabad–380009 usjoshi@gmail.com	
11	IRT 8	Single Step Single Shot Lithography Techniques via Selective laser ablation	Alika Khare	Department of Physics Indian Institute of Technology Guwahati, Guwahati 781039 alika@iitg.ernet.in	
12	ITR 9	Pulsed laser deposition of amorphous oxides for transparent electronics	M.K. Jayaraj	Optoelectronic Devices Laboratory, Department of Physics, Cochin University of Science and Technology, Kochi 682 022 mkj@cusat.ac.in	K.J. Saji
13	IRT 10	Preparation of Luminescent Nanostructures by Pulsed Laser Ablation	V.P.Mahadevan Pillai	Department of Optoelectronics, University of Kerala, Kariavattom, Kerala, India vpmpillai9@rediffmail.com	
14	IRT 11	Studies on manganite based Thin films and Heterostructures grown by PLD	D. G. Kuberkar	Department of Physics, Saurashtra University Rajkot- 360 005 Gujarat dgkcmr@rediffmail.com	
15	IRT 12	Laser ablation of Zn/ZnO Core-Shell Nanoparticles: Effect of SDS Concentration	R. K. Soni	Laser Spectroscopy Laboratory, Physics Department Indian Institute of Technology, Delhi, New Delhi-110016 ravisoni@physics.iitd.ac.in	First author: Geetika Bajaj

16	IRT 13	Characterization of pulsed laser deposited Fe_3O_4 thin films on different substrates	D. M. Phase	UGC-DAE Consortium for Scientific Research, University Campus, Indore-452017, India. dmphase@csr.ernet.in	
17	IRT 14	Application of pulsed laser deposited thin films of ZnO as varistors and InN as field emitters	K. P. Adhi	*Center for Advanced Studies in Material Science and Condensed Matter Physics. DST unit on Nanoscience, Department of Physics, University of Pune, Pune – 411 007, India* kpa@physics.unipune.ernet.in	
18	IRT 15	Effect of swift heavy ion irradiation on the surface morphology of highly c-axis oriented LSMO thin films grown by pulsed laser deposition.	S. I. Patil	Department of Physics, University of Pune, Pune 411 007 ***patil@physics.unipune.ernet.in***	M. S. Sahasrabudhe, Deepak N. Bankar, A. G. Banpurkar and K. P. Adhi
19	IRT 16	Tailoring the electrical and magnetic properties of $LaFe_{1-x}Ni_xO_3$ thin films by swift heavy ion irradiation	Ravi Kumar	Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi-110067 *ranade@iuac.ernet.in*	

Invited Paper Talks: (IPT)

S. No.	Code No.	Title	Speaker	Address	Co-authors
20	IPT1	Study of device characteristics on Pulsed Laser Deposited manganite-semiconductor heterostructures	S.N. Kale	Fergusson College Pune 411 004, India snkale@vsnl.com	J. Mona, H. Mamgain, R.R. Rawat, V. Ganesan, R.J. Choudhary, D.M. Phase
21	IPT2	Pulsed Laser Deposition of $La_{1.5}Dy_{0.5}CaBa_2Cu_5O_z$ Superconducting Thin Films	S. Rayaprol	UGC-DAE CSR-Mumbai centre, R-5 Shed, BARC, Trombay, Mumbai rayaprol@gmail.com sudhindra@csr.ernet.in	K. R. Mavani, D. G. Kuberkar, N. A. Shah, J. John, R. Pinto
22	IPT3	Basic Photoluminescence Processes at different Temperatures in ZnO / (0001) Sapphire Thin Films Grown by Pulsed	P. Misra	Laser Program, Raja Ramanna Centre for Advanced Technology, Indore– 452 013 (M.P.)	T. K. Sharma and L. M. Kukreja

		Laser Deposition		*pmisra@cat.ernet.in*	
23	IPT4	Synthesis and properties of pulsed laser deposited Fe doped MoO_{3-d} thin films	R. J. Choudhary	UGC-DAE Consortium for Scientific Research, University Campus, Indore-452017, India. *ram@csr.ernet.in*	Ram Prakash, D. M. Phase and Ravi Kumar
24	IPT5	UV Excimer lasers for smart materials and nanostructures	B. Fechner	Coherent GmbH, Hans-Böckler-Str. 12, D-37079 Göttingen, Germany *burkhard.fechner@coherent.com*	R. Pätzel, R. Delmdahl
25	IPT6	Precise photonic engines for UV pulsed laser deposition	R. Delmdahl	Coherent GmbH, Hans-Böckler-Str. 12, D-37079 Göttingen, Germany *ralph.delmdahl@coherent.com*	J. Sieber, B. Fechner
26	IPT7	Research and Development in Pulsed Laser Deposition: A Scientometric Perspective	G. Surwase	Scientific Information Resource Division, Knowledge Management Group Bhabha Atomic Research Centre, Mumbai-400 085 (India) *bskademani@yahoo.co.in; bsk@barc.gov.in*	B.S. Kademani and Vijai Kumar

Oral presentations: (OPT)

S. No.	Code No.	Title	Speaker	Address	Co-authors
27	OPT1	**Large Room Temperature Magnetization of Pulsed Laser Deposited Cobalt Ferrite Thin Film**	Subasa C. Sahoo	Department of physics,Indian Institute of Technology Bombay Powai, Mumbai – 400076 *ramani@iitb.ac.in*	M. Bohra, N.Venkataramani, Shiva Prasad, D. S. Misra and R. Krishnan
28	OPT2	Photoluminescence of ZnO nanowires grown by thermal evaporation on pulsed laser deposited ZnO buffer layer	A. Mohanta	Department of Physics and Centre for Laser Technology, Indian Institute of Technology Kanpur-208016 *antary@iitk.ac.in*	A. P. Singh, Vandna S., and R. K. Thareja
29	OPT3	Nanostructured Growth of AlN Thin Films by Pulsed Laser Deposition	Gaurav Shukla	Department of Physics Indian Institute of Technology Guwahati, Guwahati 781039 *alika@iitg.ernet.in*	Alika Khare
30	OPT4	Resistivity of thin films of $YBa_2Cu_3O_{7-\delta}$ and	L.S.Vaidhyanat-han	Materials Science Division, Indira Gandhi Centre for	D.K. Baisnab, M.P.

		Multilayers of YBCO/Ga_2O_3		Atomic Research, Kalpakkaam lsv@igcar.ernet.in	Janawadkar and Y. Hariharan
31	OPT5	Morphological and physical property changes in ZnO thin films grown by PLD due to Mg doping	Shubra Singh	Department of Physics and Materials Science Research Centre IIT Madras, Chennai-36, India shubra@physics.iitm.ac.in	M. S. Ramachandra Rao
32	OPT6	Characteristics of pulsed laser deposited $Zn_{1-x}Ni_xO$/ZnO bi-layer thin films	Subhash Thota	Materials Science Programme, Indian Institute of Technology Kanpur, Kanpur-208016 jk@iitk.ac	Pankaj Misra, Lalit M Kukreja and Jitendra Kumar
33	OPT7	Structural and Optical Characterization of UV-transparent β-Ga_2O_3	V. Sridharan	Material Science Division, Indira Gandhi Centre for Atomic Research, Kalpakkam 603102. varadu@igcar.gov.in	L.S. Vaidhyanathan , V. Srihari, G. Raghavan, S. T. Sundari, M. Kamruddin , M. Premila, H.K. Sahu, B. K. Panigrahi, V.S. Sastry and C.S. Sundar
34	OPT8	The low temperature electrical transport in $La_{0.7}Ca_{0.3}MnO_3$	P.R. Sagdeo	UGC-DAE Consortium for scientific research, University campus Khandwa road indore 452017, M.P. INDIA sagdeo@csr.ernet.in	R.J. Choudhary and D.M. Phase

Thesis Presentations: (THP)

S. No.	Code No.	Title	Speaker	Address	Co-authors
35	THP1	Oxygen Reduction Kinetics and Transport Properties of $(Ba,Sr)(Co,Fe)O_{3-delta}$ Solid Oxide Fuel Cell Cathode Materials	Lei Wang	Max Planck Institute for Solid State Research, Heisenbergstrasse 1, D-70569 Stuttgart, Germany lei.wang@fkf.mpg.de	Rotraut Merkle[1], Frank S. Baumann[1], Jürgen Fleig[2], and Joachim Maier[1]
36	THP2	Study on p-type ZnO thin films and ZnO homojunction LED	Y. Lu	State Key Laboratory of Silicon Materials, Zhejiang University, Hangzhou, 310027, People's Republic of China sailinglu27@gmail.com	Z. Z. Ye, Y. J. Zeng, L. P. Zhu
37	THP3	Magnetoresistive and	Jaysukh H	Department of Physics,	

		Transport Properties of Pulsed Laser Deposited Manganite Thin Films and Heterostructure.	Markna	Saurashtra University, Rajkot-360 005 INDIA *jaysukh28@rediffmail.com*	
38	THP4	Pulsed Laser Deposited Thin Films of ZnO, GaN, AlN, ZnO/GaN WBSC: Structural, Micro-structural, Optical & Electrical Characterization	Suhas Madhav Jejurikar	Center for Advanced Studies in Materials Science and Condensed Matter Physics, Department of Physics, University of Pune, Pune 411 007, India. *suhas@physics.unipune.ernet.in*	Dr. K. P. Adhi, Co-guide: Dr. A. V. Limaye
39	THP5	Synthesis and characterization of LaB_6 thin films on tungsten, rhenium and silicon substrates and their investigations as Field Emitters	D. J. Late	Center for Advanced Studies in Material Science and Condensed Matter Physics, Department of Physics, University of Pune, Pune - 411007, India *dsj@physics.unipune.ernet.in*	

Poster Presentations: (PSP)

		PSP 1 *(October 3, 2007)*			
S. No.	Code No.	Title	Speaker	Address	Co-authors
40	PSP1.1	Effect of oxygen pressure on the photoluminescence of Gd_2O_3 :Eu^{3+} films grown by PLD	Geo Rajan	Department of Optoelectronics, University of Kerala, Kariavattom, Thiruvananthapuram-695 581, India *gopchandran@yahoo.com*	Nissamudeen K. M, Sasi B and K.G.Gopchandran
41	PSP1.2	A comparative study of nanostructures Co thin films deposited on different substrates by pulsed laser deposition	A. Sharma	University Grant Commission- Department of Atomic Energy Consortium for Scientific Research, University Campus, Khandwa Road, Indore-452 017, India. *anupamsharma2003@yahoo.co.in*	S. Tripathi, R. Brajpuriya, Ram Prakash, R. J. Chaudhari, D. M. Phase and T. Shripathi
42	PSP1.3	Raman Study of oriented thin films of $PrMnO_3$ deposited on different	Aditi Dubey	UGC-DAE Consortium for Scientific Research, University Campus, Khandwa	V. G. Sathe

		substrates		Road, Indore – 452 017 *aditidubey@csr.ernet.in*	
43	PSP1.4	Application of pulsed laser deposited ZnO thin films as a solar blind detector	Alka V. Deshmukh	Center for Advanced Studies in Materials Science and Condensed Matter Physics, Department of Physics, University of Pune, Pune 411 007, India. *alka_d@physics.unipune.ernet.in*	S. M. Jejurikar, K. P. Adhi and S. I. Patil
44	PSP1.5	DC-Discharge Assisted Pulsed Laser Growth of Ultra-thin Silicon-Oxinitride Films	B. N. Singh	Thin Film Lab., Raja Ramanna Centre for Advanced Technology, Indore 452 013 *bnsingh@cat.ernet.in*	P. Misra, A. K. Das, R. Kumar, Binsu J Kailath, M. Mishra, D.M. Phase, A. DasGupta, N. DasGupta and L. M. Kukreja
45	PSP1.6	Unique nanostructures in pulsed laser ablated NiO thin films	B. Sasi	Department of Optoelectronics, University of Kerala, Thiruvananthapuram-695 581, India *thazhavasasi@sancharnet.in*	K.M. Nissamudeen and K. G. Gopchnadran
46	PSP1.7	Influence of Ti^{2+} doping on the structural and optical properties of WO_3 thin films prepared by pulsed laser ablation technique.	Lethy K.J	Department of Optoelectronics, University of Kerala, Kariavattom, Kerala, India *vpmpillai9@rediffmail.com*	Beena D, Bahna.A.H V.P.Mahadevan Pillai
47	PSP1.8	Effect of Substrate on Pulsed Laser Deposition of InN Thin Film	Gaurav Shukla	Department of Physics Indian Institute of Technology Guwahati, Guwahati 781039 *alika@iitg.ernet.in*	Alika Khare
48	PSP1.9	Synthesis and Optical Properties of Cr_2O_3 Films Prepared by Pulsed Laser Ablation	G. Balakrishnan	Physical Metallurgy Division, Indira Gandhi Centre for Atomic Research, Kalpakkam-603 102, Tamil nadu *pk@igcar.ernet.in*	P. Kuppusami, T.N. Sairam, E. Mohandas and D. Sastikumar
49	PSP1.10	Synthesis and Characterization of $La_{0.7}Ba_{0.3}MnO_3$-SnO_2 bilayer using Pulsed Laser Deposition Technique	J. Mona	Fergusson College, Fergusson College Road, Pune 411004 *snkale@vsnl.com*	Ram Prakash, R. Rawat, R.J. Choudhary, D.M. Phase, S.N. Kale

50	PSP1.11	Semiconductor Nano-pattern formation through laser induced diffusion	U. Das	Dept of Physics, Tezpur University, Napaam, Tezpur – 784028, India upam2005@gail.com	A.Choudhury
51	PSP1.12	Growth of n-Zinc Oxide on various substrates using pulsed laser deposition and its photo conducting properties	G. Naresh Kumar	Loyola institute of frontier energy (LIFE), Physics Department, Loyola college, Chennai 600 034, India *naresh_matsci@yahoo.co.in*	V.Immanuel, Francis P. Xavier
52	PSP1.13	Characterisation of pulsed laser deposited PZT and PLZT thin films on oxide pervoskite electrodes	R.Reshmi	Optoelectronics Device Laboratory, Department Of Physics, Cochin University of Science and Technology, Kochi-*682022, India* mkj@cusat.ac.in	M.K.Jayaraj, M.T.Sebastian
53	PSP1.14	Effect of Structural Disorder on Electronic Transport in $La_{0.5}Pr_{0.2}R_{0.3}MnO_3$ (R = Sr, Ba) Manganite Thin Films	P.S. Solanki	Department of Physics, Saurashtra University, Rajkot – 360 005 dgkcmr@rediffmail.com	R.R. Doshi, J.H. Markna, C.M. Thaker, N.A. Shah and D.G. Kuberkar K.R. Mavani, D.S. Rana and S.K. Malik P. Misra, B.N. Singh and L.M. Kukreja
54	PSP1.15	Improvement in field sensitivity of La-based manganite multilayered structure	P.S. Vachhani	Department of Physics, Saurashtra University, Rajkot – 360 005, India dgkcmr@rediffmail.com	J.H. Markna, J.A. Bhalodia and D.G. Kuberkar P. Misra, B.N. Singh and L.M. Kukreja V. Ganesan and R. Rawat
55	PSP1.16	Synthesis and Characterization of $PrCoO_3$ thin films grown by Pulsed Laser Deposition	Ram Prakash	UGC-DAE Consortium for Scientific Research, Indore (M.P.) 452017, India. ramprakash@csr.ernet.in	R. J. Choudhary, D. M. Phase
56	PSP1.17	Effect of laser energy on the structural and optical properties of non-reactive pulsed laser ablated tantalum oxide thin films	Renju R Krishnan	Department of Optoelectronics, University of Kerala, Kariyavattom, Trivandrum-695581, Kerala, INDIA ypmpillai9@rediffmail.com	V.P.M. Pillai
57	PSP1.18	Room temperature luminescence from low temperature grown ZnMgO/ZnO Quantum wells using pulsed laser deposition.	R.S. Ajimsha	Optoelectronics Devices Laboratory, Department of Physics, Cochin University of Science and Technology, Cochin-22. *mkj@cusat.ac.in*	M.K.Jayaraj P Misra, L.M. Kukreja
58	PSP1.19	Novel feature of quantum transport through finite	Santanu K. Maiti	[1]Theoretical Condensed Matter Physics, Saha Institute	

		width mesoscopic ring		of Nuclear Physics, 1/AF, Bidhannagar, Kolkata-700 064, India	
59	PSP1.20	Structural, Optical and Electrical Properties of Co and Ga codoped ZnO Thin Films Prepared by Pulsed Laser Deposition	M. Subramanian	Crystal Growth Centre, Anna University, Chennai – 600 025 ***subu_mjs@yahoo.co.in***	G. Mohan Kumar, P. Misra. Amit K Das, B. N. Singh, S. Venkatraj, S. Vijayalakshmi, R. Jayavel and L.M. Kukreja
		PSP2 *(October 4, 2007)*			
60	PSP2.1	Structural, Optical and Electrical Properties of $Zn_{1-(x+y)}Mn_xGa_yO$ THIN FILMS Prepared by Pulsed Laser Deposition	M. Subramanian	Crystal Growth Centre, Anna University, Chennai – 600 025 ***subu_mjs@yahoo.co.in***	P. Ilanchezhiyan, P. Misra. A. K Das, B. N. Singh, S. Venkatraj, S. Vijayalakshmi, R. Jayavel and L.M. Kukreja
61	PSP2.2	Effect of doping and substrate temperature on the structural and optical properties of reactive pulsed laser ablated Aluminium Oxide doped Tantalum Oxide thin films	Renju R Krishnan	Department of Optoelectronics, University of Kerala, Kariavattom, Trivandrum-695581, Kerala, INDIA. *vpmpillai9@rediffmail.com*	V.P.M. Pillai
62	PSP2.3	Optimizing the doping concentration in a single experiment by using Combinatorial Laser Molecular Beam Epitaxy (CLMBE)	Utpal S. Joshi	Department of Physics, School of Sciences, Gujarat University, Ahmedabad – 380 009, India *usjoshi@gmail com*	Kenji Itaka, Yuji Matsumoto, Masatomo Sumiya and Hideomi Koinuma
63	PSP2.4	Superparamagnetism in epitaxial thin films of Fe, Cr, Co, Mn and V doped p-type NiO	U. V. Chhaya	Physics Department, St. Xavier's College, Ahmedabad-380 009, India *usjoshi@gmail com*	P.S. Raval, P.A. Joshi, S. Trivedi, K. Itaka, Y.Matsumoto, H. Koinuma and U.S. Joshi
64	PSP2.5	Structural and Optical properties of GdO doped ZnO Thin Films by Pulsed Laser Deposition Technique.	R.Vinodkumar	Department of Optoelectronics, University of Kerala, Thiruvananthapuram, Kerala, India – 695581. *vpmpillai9@rediffmail.com*	D.Beena, Geo Rajan, Jayasree R.S. and V.P.Mahadeva n Pillai
65	PSP2.6	Structural, Morphological and Optical studies of Potassium Lithium Niobate thin films prepared under ambient conditions of substrate temperature	V. Jayasree	Department of Optoelectronics, University of Kerala, Kariavattom, Trivandrum, Kerala, 695 581 India *nayarvu@sancharnet.in*	R Vinod Kumar, R Ratheesh, V. P Mahadevan Pillai & V. U Nayar

66	PSP2.7	Studies on effect of europium concentration on the photoemission of laser ablated Y_2O_3:Eu based nano-phosphors.	K.M. Nissamudeen	Department of Optoelectronics, University of Kerala, Kariavattom, Thiruvananthapuram ***gopchandran@yahoo.com***	R Krishnan, Geo Rajan and K.G. Gopchandran
67	PSP2.8	Studies on Si Doped ZnO Thin Films Grown by Sequential Pulsed Laser Deposition	A.K. Das	Thin Film Laboratory, Raja Ramanna Centre for Advanced Technology, Indore 452 013 *amitdas@cat.ernet.in*	B. N. Singh, P. Misra and L. M. Kukreja
68	PSP2.9	Textured CeO_2 thin films on amorphous substrate by PLD at room temperature	T. K. Chaudhuri	Dr. K C Patel Research and Development Centre Education Campus – Changa, Changa (Petlad), Anand Gujarat 388 421, INDIA *tkchaudhuri@gmail.com*	R N Bhattacharya
69	PSP2.10	Synthesis of II-VI Oxide Semiconductor Nanocrystals by Pulsed Laser Ablation in Liquid Media	S. C. Singh	Laser and Spectroscopy Laboratory, Department of Physics, University of Allahabad, Allahabad-211002 *Spectra2@rediffmail.com*	R.K. Swarnkar and R. Gopal
70	PSP2.11	Studies on CoZnO thin films grown by Pulsed Laser Deposition	Satyapal S. Rathore	Dept. of Applied Physics, Birla Institute of Technology, Mesra – 835215 and Thin Film Laboratory, Raja Ramanna Centre for Advanced Technology, Indore 452 013 *satyapal03@gmail.com*	A.K.Das, B.N. Singh, P.Misra, L.M.Kukreja
71	PSP2.12	Laser assisted growth of Eu^{3+} doped $Ba_{0.7}Sr_{0.3}TiO_3$ thin film for optoelectronic and ferroelectric application	R.Reshmi	Optoelectronics Device Laboratory, Department Of Physics, Cochin University of Science and Technology, Kochi-682022, India *mkj@cusat.ac.in*	M.K.Jayaraj, M.T.Sebastian
72	PSP2.13	Comparative studies of irradiation induced modifications in Fe_3O_4 thin films on MgO and Si substrates grown by pulsed laser ablation	Shailja Tiwari	UGC-DAE Consortium for Scientific Research, Indore-452 017, INDIA email: *shailja@csr.ernet.in*	Ram Prakash, R. J. Choudhary and D. M. Phase Ravi Kumar
73	PSP2.14	Synthesis and Characterization of SnO_2 Thin Films by PLD for Sensor Applications	K. Prabakar	Materials Science Division, Indira Gandhi Centre for Atomic Research, Kalpakkam – 603102,Tamil Nad *kpr@igcar.gov.in*	R. Krishnan, B. Yasodhaadevi, Ashok S. Chauhan, S. Tripura Sundari, S. Dash and J. Jayapandian

74	PSP2.15	Structural and electrical characterization of pulsed laser deposited Ga doped ZnO thin films on Si(100)	S.D. Shinde	Center for Advanced Studies in Materials Science and Condensed Matter Physics, Department of Physics, University of Pune, Pune 411 007, India. *shashi@physics.unipune.ernet.in*	S.M. Jejurikar and K.P. Adhi
75	PSP2.16	Thickness dependent multiferroic properties of $Bi_{0.7}Dy_{0.3}FeO_3$ polycrystalline thin films grown by pulse laser deposition technique	Prashanthi K	Electrical Engineering, Indian In of Technology Bombay, Mumba 076, India ***shanthi@ee.iitb.ac.in***	S. P. Dattagupta, R. Pinto and V. R. Palkar
76	PSP2.17	Electroresistive and Magnetoresistive effects in electron doped manganite $La_{0.7}Ce_{0.3}MnO_3$ thin films	Kavita Bajaj	Department of Condensed Matter Physics and Materials Sciences, TIFR, Homi Bhabha Rd., Colaba, Mumbai 400005, India. and Department of Physics, Mumbai University, Mumbai 400098, India. *bajajkp@rediffmail.com* *johnj@tifr.res.in*	John Jesudasan, Vivas Bagwe, Pratap Raychaudhuri
77	PSP2.18	Size dependent study of $CuFe_2O_4$ nanoparticles	Archana Rai	Department of Physics, Indian Institute of Technology, Powai, Mumbai-400 076 *archana3@iitb.ac.in*	M. Banerjee
78	PSP2.19	A theoretical approach to the effect of particle size on the luminescence intensity in nanocrystals	Anamika Awadhwal	Department of Post Graduate Studies and Research in Physics and Electronics Rani Durgavati University, Jabalpur-482001	B.P. Chandra
79	PSP2.20	Third Order Non-Linear Optical Properties of Eurhodin Dye Doped Ppolymer Film	Rekha R.K	Centre for Laser Technology, Department of Physics, Anna University, Chennai-600 025 *rekhasri71@yahoo.com*	A. Ramalingam , G. Vinitha
80	PSP2.21	Nonlinear characterization and optical limiting of organic dye doped polymer	G.Vinitha	Centre for Laser Technology, Department of Physics,Anna University, Chennai-25, India. *svini2005@yahoo.co.in*	R.K REKHA., A. RAMALINGAM
81	PSP2.22	Studies on the Fluorescence emission from nano silver / silver oxide thin films for optical read write	A. Subrahmanyam	Department of Physics, Indian Institute of Technology Madras, Chennai-600036, India	N.Ravichandra Raju

		memory applications		ravichandra@physics.iitm.ac.in	

Corporate Talks: (CPT)

S. No.	Code No.	Company	Speaker	Address
82	CPT1	Oerlikon leybold Vacuum	S. Inamdar	EL-22, J-Block, MIDC Bhosari, Pune-411 026 Shrikant.inamdar@oerlikon.com www.oerlikon.com
83	CPT2.	Laser Science	L. Kumar	Laser Science Services Pvt. Ltd. A-454, MIDC, TTC Industrial Area, Mahape, Navi Mumbai – 400 701 laser_science@vsnl.com
84	CPT3	Specialise Instruments Pvt. Ltd.	P. Deshpande	Specialise Instrument Marketing Co. 18th Fort-view, Scheme No. 6, Road No.1, Sion (East), Mumbai 400 022, India specmo@vsnl.in
85	CPT4	Excel Instruments	S. P. Pai	Excell Instruments A/15 Guru Nanak Compound Opp. Hindustan Lever, Chakala Road Andheri (East) Mumbai 400 099 sppai@tifr.res.in
86	CPT5	Laser Spectra Services India Pvt. Ltd.	N.R.P.Kumar	Laser Spectra Services India Pvt. Ltd., 80/10, I Floor, Raj Towers, M. S. Ramiah Main Road, Mathikere, BANGALORE-560 054. lss@bgl.vsnl.net.in

ITT1

Optical Properties of Semiconductors at the fundamental absorption edge

Claus Klingshirn, J. Fallert, H. Zhou, and H. Kalt

Institut für Angewandte Physik
Universität Karlsruhe
76128 Karlsruhe, Germany
email: Claus.Klingshirn@physik.uni-karlsruhe.de

In this tutorial talk we review the optical properties of direct gap semiconductors and semiconductor quantum structures close to the fundamental absorption edge, using essentially ZnO as model substance.

In a first part we start with the band structure, i.e. the one particle states, proceed to the electron-hole pair states i.e. the excitons and end this section with the mixed state of excitons and photons, the exciton polaritons.

The second part will be devoted to the properties of and processes in a dense exciton or generally electron-hole pair system reaching the electron-hole plasma at the highest densities.

Frequently, these processes allow stimulated emission and we spend the third part on this aspect.

ITT2

Field Emission From Nanomaterials - A Tutorial

DILIP S. JOAG

Centre for Advanced Studies in Condensed Matter Physics and Material Science
University of Pune : Department of Physics
dsj@physics.unipune.ernet.in

Field electron emission phenomenon is known for more than a century and is the best example of quantum mechanical tunneling process. Since the invention of the field emission microscope, it has been an important tool in the study of surface adsorption phenomena, work function measurements, diffusion kinetics etc. The specimen in the field emission microscope is required to be in the form of a sharp needle in order to create electric field of the order of $10^6 - 10^7$ V/cm necessary for measurable emission current. Technologically, the phenomenon is important for its potential application as a high brightness electron source.

In the era of nanomaterials, there has been renewed interest and an upsurge in the study of field emission. This is due to the advantage of the size and shape of nanocrystallites of various materials. These nanometeric materials become eligible candidates for `low onset voltage' field emitters. Several such materials have been investigated worldover for their potential applications in field emission based devices such as flat panel displays.

This tutorial is aimed at giving the basic background required for the study of field emission from nanomaterials. Various case studies will be presented illustrating the suitability of these materials in the development of field emission cathodes and devices. Work from the author's laboratory on pulsed laser deposited nanometric films of ZnO and LaB_6 will also be presented elucidating the scope of the studies.

ITT3

Pulsed Laser Growth of Nanostructured Materials: Some Recent Experiments

L. M. Kukreja

Thin Film Laboratory, Raja Ramanna Centre for Advanced Technology,

Indore – 452 013

Email: kukreja@cat.ernet.in

In this tutorial talk results of our two ongoing experiments will be discussed. One experiment is on the behavior of sub-monolayer gold nano-islands grown on (0001) Sapphire substrates by Pulsed Laser Deposition (PLD). The other experiment is about a variant of PLD to grow ultra-thin high k-dielectric layer of SiO_2 and silicon oxy-nitride for MOS technology.

Nanometer size gold depositions on oxide substrates have recently come under scrutiny since the experimental observation of their large catalytic activity. Using high resolution Atomic Force Microscopy (AFM) we observed in normal ambient atmosphere the slow morphological dynamics of apparently sessile gold nano-islands grown on (0001) Sapphire substrates by Pulsed Laser Deposition (PLD) at room temperature with an equivalent average thickness of about 0.55 Å, i.e. one fourth of the monolayer. Within approximately one day, a transient wavy surface structure developed with rms roughness of about 0.6 nm and a two-fold symmetry. After about 6 days under ambient conditions this structure completely transformed into a de-wetted phase of spherical gold beads with average diameter of ~20 nm and a broad size distribution. Each bead was found to be surrounded by a concentric layer, which could be seen as corona in the AFM images. This concentric shell layer appears to be mainly the condensed moisture from atmosphere since by dehydration of the sample in vacuum using molecular sieves the corona layer completely vanished. While the shape and size distributions of the as-prepared Au nano-islands are attributed to the specific deposition technique of PLD with its large fraction of high energy particles arriving at the substrate, the de-wetting and bead formation under ambient conditions are probably mainly due to the condensation of atmospheric moisture modifying the surface interactions. These observations are expected to have significant implications for our understanding on the wetting characteristics of gold on oxide substrates in sub-monolayer regime.

In another experiment a novel technique for the growth of ultra-thin SiO2 at room temperature using a pulsed laser has been demonstrated. It is observed that, after an initial high growth rate, the oxide thickness reduces with time and the quality of the oxide improves. The results of our experiments show that this technique can be used to grow high quality ultra-thin SiO2 films with excellent control suitable for ULSI of MOSFETs. However there are certain unsettled issues. It is still not very clear that why does the thickness of the dielectric layer decrease with time of laser irradiation. One of the hypotheses is that while the laser irradiation facilitates the oxidation, it also etches the surface through photo-sputtering, thermal evaporation or both. This proposal of photo-sputtering is supported by the directional exfoliation observed at the surface of the lasers oxidized Si wafer. Recently we have also extended the scope of the laser induced oxidation process by incorporating a DC discharge assisted supply of atomic / reactive nitrogen during the growth process. This has enabled us to grow silicon oxy-nitride layers structurally integrated with the Si wafer. The oxy-nitride has shown superior dielectric characteristics. We could also succeed in getting effective dielectric thickness in the sub-nanometer regime using this methodology. The detailed results of these experiments will be discussed.

IRT1

Research on p-type ZnO

Z. Z. Ye*, Y. F. Lu, Y. J. Zeng, J. G. Lu, L. P. Zhu
State Key Laboratory of Silicon Materials, Zhejiang University, Hangzhou, 310027
People's Republic of China
**E-mail: yezz@zju.edu.cn*

Research activitites on ZnO have increased over the past few years. It is known that lack of high quality p-type ZnO has been a bottle neck in developing ZnO optoelectronic devices since ZnO is naturally n type. In this study, we report on our research p-type ZnO. P-type ZnO is grown by different methods using different dopant sources. The specific doping mechanism is investigated at the same time.

For the first time, a nitrogen substituting – hydrogen passivating method is used to increase the solubility of nitrogen in ZnO. Nitrogen atoms that are passivated by hydrogen are introduced into the crystal lattice. Then the N-H bonds are broken and the N dopants are activated. Using this nonequivalent way, p-type ZnO is realized by magnetron sputtering method.

P-type ZnO with high crystalline quality and good electrical property is also realized firstly by using donor-acceptor codoping method. Al-N and In-N codpoed p-type ZnO thin films are grown by magnetron sputtering. The codoped donors, such as Al, In, are found to increase the concentration of N in ZnO evidently. And the codoped ZnO based p-n homo-junctions show good rectifying property.

In addition to codping method, Li mono-acceptor is introduced into ZnO successfully and the best condition window for growth of Li doped p-type ZnO is investigated. It is found that there exist two acceptor levels for Li in ZnO. And to control the relative proportion of the two acceptor levels is of essential importance for realizing p-type transformation.

Besides donor-acceptor codoping, a Li-N dual acceptor codoping method is prompted to increase the hole concentration in ZnO. More importantly, the stability of the p-type conduction is improved largely. The energy level of Li-N dual acceptor and the codoping mechanism of Li-N dual acceptor are investigated.

The success in growth of P, Sb doped p-type ZnO confirmed the theoretical large-size-mismatched doping mechanism.

Furthermore, normally undoped p-type ZnO is obtained using plasma-assisted MOCVD. The oxygen concentration in ZnO is enhanced obviously by using radio frequency plasma, which is an important reason for p-type conduction.

Finally, room-temperature electroluminescence is observed in ZnO homojunction using nitrogen as the acceptor dopant, which is a great progress towards the application of ZnO based light emitting diods.

IRT2

ELECTRICAL, OPTICAL AND MAGNETIC PROPERTIES OF OXIDE BASED NANOSTRUCTURES

M.S.Ramachandra Rao
Department of Physics and Materials Science Research Centre
Nano Functional Materials Technology Centre (NFMTC)
Indian Institute of Technology (IIT) Madras, Chennai – 600036, INDIA.
msrrao@iitm.ac.in; www.physics.iitm.ac.in/~msrrao

The properties of nanoscale elecronics will be controlled by novel engineered nanomaterials. I will give a brief review of our research activity in different fields namely, multiferroics, magnetic oxides ($CoFe_2O_4$, Fe_3O_4 etc.) and transparent conducting oxides.

I will devote the rest of the time on ZnO Fe_3O_4. ZnO is a unique material that offers about a dozen different application possibilities. The physics of doping in ZnO is intriguing. We found that Ni doping in ZnO drastically reduces the electrical resistivity of ZnO which is due to the 3d orbital splitting contributing to the increase in conduction [1]. We observe that small amounts of transition metal ion doping has a marked influence on the morphology of ZnO leading to interesting changes in optical properties. We also observed changes in the non-linear characteristics upon UV irradiation in ZnO heterostructures grown by PLD. Light emission in ZnO is a defect driven phenomenon. ZnO nanostructures prepared in different gas environments lead to interesting photoluminescence and microstructural changes. We have succeeded in preparing ZnO encapsulated Fe_3O_4 nanoparticles (5-8 nm core diameter) which show promising trends suitable for device applications. PLD grown Fe_3O_4 films on glass show high degree of orientation and yield good MR. Nanostructured fabrication of ZnO has many futuristic technological applications (blue and white LEDs, UV emitters/detectors and gas sensors).

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IRT3

Temperature-dependent photoluminescence from ZnO/$Zn_{0.85}Mg_{0.15}O$ quantum well grown on Si(111) substrates

L. P. Zhu, X.Q. Gu, H.P. He, F. Huang, M.X. Qiu, Z.Z. Ye, Y.Z. Zhang, B.H. Zhao

State Key Laboratory of Silicon Materials, Zhejiang University, Hangzhou, 310027
People's Republic of China
Electronic address: zlp1@zjuem.zju.edu.cn

A set of ten-period ZnO/Zn0.85Mg0.15O multiple quantum wells with well thickness varying from 2.5 to 5 nm has been grown on Si_111_ substrates by pulsed laser deposition. A periodic structure with sharp interfaces was observed by cross-sectional transmission electron microscopy. The room-temperature photoluminescence resulting from the well regions exhibits a significant blue shift with respect to the ZnO single layer. The well layer thickness dependence of the emission energy from the well regions was investigated and compared with a simple theoretical model. The results suggest that the quantum confinement effects in the quantum wells can be observed up to room temperature

IRT4

Electron doped manganites: Reality or illusion?

Pratap Raychaudhuri
Department of Condensed Matter Physics and Materials Science,TIFR,, Homi Bhabha Rd., Colaba, Mumbai-400005
pratap@tifr.res.in

Electron doped manganites are a new addition in the family of doped rare-earth manganites showing colossal magneto-resistance. In these materials Mn is beleived to exist in a mixture of Mn3+ and Mn2+ valence states. However, despite decade long of research controversies regarding the valence state of Mn in these compounds still persist. In this talk I will review the recent progress in the field of electron doped manganites grown through pulsed laser deposition. I will highlight some of the distinct properties of these materials which might make them important from an application perspective.

IRT5

Multiferroic behavior of modified $BiFeO_3$ thin films grown by PLD: A Review

V. R. Palkar
Electrical Engineering, Indian Institute of Technology Bombay, Mumbai 400 076, India
palkar@ee.iitb.ac.in

Multiferroics are materials that exhibit ferroelectric and magnetic ordering simultaneously in the same phase in certain range of temperature. Moreover, there is coupling between two order parameters. As a result spontaneous magnetization can be switched by applying an electric field and spontaneous electric polarization can be switched by a magnetic field. Hence multiferroics are likely to offer a whole range of novel applications. Apart from their application potential, multiferroics are rich in physics and in recent years the basic science aspects too have attracted a great deal of attention. The primary experimental efforts continue to be focused on attempts to find novel systems with ferromagnetic and ferroelectric properties at room temperature with significant coupling (ME) coefficient which is a primary requirement for bringing these materials in device applications. Moreover, there are very few systems to date that satisfy the requirements. It is therefore a subject of front line research all over the world. $BiFeO_3$ is one of the known multiferroic system showing antiferromagnetic and ferroelectric properties at room temperature. There are continued efforts to enhance magnetic and ferroelectric properties of $BiFeO_3$ system through different possible ways. Controlling film growth conditions so as to bring strain on the lattice during film growth has been tried apart from trying substitutions at Bi or Fe site. In my talk I will try to review the work done in this direction with more emphasis on the study carried out by us on thin films of $BiFeO_3$ and related systems. The advantage of using PLD technique is discussed. The presence of magnetic and ferroelectric domains in same spatial area of few microns obtained by using multimode scanning probe microscopy will be shown.

IRT6

Nanostructured Thin Films of Titania Prepared by Pulsed Laser Ablation: Process and Properties

P. Kuppusami, S. Murugesan and E. Mohandas
Physical Metallurgy Division
Indira Gandhi Centre for Atomic Research, Kalpkkam-603 102, Tamilnadu
E mail : pk@igcar.ernet.in

Titania (TiO_2) has generated a considerable interest due to their unique physical and chemical properties such as large band gap, high refractive index and dielectric constant. Thin films of titanium oxides are widely used in photovoltaic devices, photocatalysts or dielectric thin film capacitors and in filters. TiO_2 has mainly three types of crystallographic structures: anatase (tetragonal), rutile (tetragonal) and brookite (orthorhombic). Anatase is metastable and is only synthesized at relatively low temperature. Brookite is formed only in extreme conditions. The anatase to rutile transformation is irreversible and, generally , occurs at temperatures higher than about 700^oC. Interestingly, the anatase phase exhibits better photocatalytic activity compared with rutile or brookite phases. Pulsed laser deposition has been applied to synthesize TiO_2 films because control of gas atmospheres for a good quality of films is relatively easier than in other deposition techniques. In this work, we present a simple fabrication procedure to synthesize nanostructured thin films of rutile and anatase phases of chromia doped and undoped titania.

The investigation studies the influence of laser energy, oxygen addition and substrate temperature on the film growth of both anatase and rutile thin films from a sintered rutile target of an undoped TiO_2 and 2 mol% chromia doped TiO_2 by pulsed laser ablation technique. X-ray diffraction analysis of the films indicated that the films are single phasic and nano crystalline. Titania films deposited in at a base pressure of $5x10^{-5}$ mbar and at 673 K are rutile with particle sizes in the range 5-10 nm, whereas the films formed at the oxygen partial pressure of 0.04-0.1 mbar are anatase with particle sizes in the range 10-24 nm. In contrast, chromia doped titania films show mixed phases of anatase and rutile at 673 K, while pure anatase films form at 873 K.

The influence of the microstructural state of the films on the optical and thermal properties is also discussed.

IRT7

Combinatorial Pulsed Laser Abltation for Parallel Synthesis and High Throughput Characterization of Functional Inorganic materials

Utpal S. Joshi
Department of Physics, School of Sciences, Gujarat University, Ahmedabad–380009
e-mail : usjoshi@gmail.com

Pulsed laser deposition (PLD) is one of the most powerful techniques for the epitaxail quality thin film growth for variety of functional materials. Conventional 'one by one' synthesis approach using the PLD has been a major rate limiting step in the systematic exploration of increasingly complex materials in nano regime for the demanding new technologies. Derived from the new concepts of 'combinatorial chemistry', recently introduced continuous composition spread technique based on the non-uniformity of the deposition rate typically observed in pulsed laser deposition (PLD) is applied to the parallel growth of large number of functional oxides and related materials for the growth of opto-electronic and variety of semiconductor nano-structures and their devices. In this talk, the concepts of inorganic combinatorial chemistry, particularly applied to the modern PLD technique and high throughput characterization tools, for rapid optimization of growth parameters, will be discussed. Results of some case studies of COMBI-PLD applied to (a) transparent and semiconducting oxides (TCO), (b) novel diluted magnetic semiconductor (DMS) nano-structured films and (c) organic field effect devices (OFET), will be presented.

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IRT8

Single Step Single Shot Lithography Techniques via Selective laser ablation

Alika Khare
Department of Physics
Indian Institute of Technology Guwahati, Guwahati 781039
Email: alika@iitg.ernet.in

The scope of the pulsed laser ablation is tremendous in processing any material. One can engineer the materials with the desired properties and desired surface morphology. The selective laser ablation can be used as a powerful technique of single step single shot laser lithography. In the present talk, the focus is on following two schemes of single shot lithography technique for writing the complete periodic structures of dimensions of the order of wavelength and below using Selective laser ablation without using any mask .

1. Selective ablation of thin films via high power laser Interferometry: This technique is based on modifying the surface morphology to the order of tens of nanometer sizes via selective ablation of material by laser. This technique is very general and is applicable to any kind of materials. In this technique, thin films of metal, semiconductors, polymers or any other complex material is ablated selectively by illuminating it with interference pattern formed by high power laser. This results into the ablation of materials in the region of maximum intensity (bright fring) leaving the area of minimum intensity (dark fringe) unaffected. Width and periodicity of the ablated region depends on the laser intensity distribution with in the bright fringe and wavelength of laser respectively. By using the two interferometers in tandem, one can generate desired two-dimensional tiny arrays of the materials[1]. This technique is a single step with the advantage of having on line control on the configuration of the nano structures simply by modifying the interference pattern. With this technique one write more than 2000 spot/mm^2 in a single shot without using any mask[2].

2. Manipulation of atomic trajectories via dipole force: Manipulation of atomic trajectories in presence of near resonant optical field is coming up because of its potential application towards direct deposition of neutral atoms on to a substrate resulting feature size of sub -100nm. This atomic lithography technique offers the advantage of creating the two and three-dimensional complex structure without using any mask. An atom in an off resonance radiation field having gradient in intensity distribution experiences the dipole force. This dipole force can modify the trajectories of atoms and with the care full choice of the parameters; it can lead to the focusing of the atomic beam by an order of magnitude down to 10^3. Thus the dipole force acts as an atomic lens. If a two dimensional periodic arrays of slow moving atomic beam is subjected to such atomic lens it will compress the complete arrays of atomic beam in the transverse direction, to yield a pattern having periodicity and spot sizes much less than the wavelength of the laser. The periodic arrays of slow moving atomic beams can be generated via selective laser ablation technique[4,5]. These arrays of atomic beams are allowed to interact with the counter propagating TEM_{oo} mode of off resonance laser. Because of the gradient in intensity of TEM_{oo} mode, the dipole force is experienced by the atoms and result into the focusing of parallel arrays of beams, which can be deposited on to the suitable substrate[4].

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IRT9

Pulsed laser deposition of amorphous oxides for transparent electronics

M.K. Jayaraj and K.J. Saji
Optoelectronic Devices Laboratory, Department of Physics,
Cochin University of Science and Technology, Kochi – 682 022, India
E-mail: mkj@cusat.ac.in

Transparent and electrically conductive materials are rapidly growing in technological applications in optoelectronic devices like solar cells, liquid crystal displays, energy efficient windows and 'invisible electronic circuits'. Crystalline materials like tin doped indium oxide (ITO), aluminium doped zinc oxide (ZnO:Al) and antimony doped tin oxide (SnO_2:Sb) are presently being used for such applications. Amorphous transparent conductors are much attractive because of uniformity of device characteristics and low processing temperature and can be grown on plastic substrates. The bottom of the conduction band in oxide semiconductors with cation electronic configuration $(n-l)d^{10}ns^0$ (with $n \geq 4$) is primarily composed of spatially spread metal *ns* orbital (*n* is the principal quantum number). Isotropic shape of metal *ns* orbitals allows direct overlap among neighbouring orbitals and they are insensitive to the intrinsic structural randomness of amorphous materials. Hence degenerate band conduction and large mobility are possible in amorphous oxide semiconductors containing post transition metal cations. This contrasts to low mobility covalent bonded amorphous materials where carrier transport is controlled by hopping between localized tail states.

In this paper we describe the growth and characterization of transparent conducting zinc tin oxide thin films at room temperature and their use as channel layer in thin film transistors (TFTs). Zinc tin oxide films have the advantages of both ZnO (higher transparency and more stability in activated hydrogen environments than ITO and SnO_2) and SnO_2 (high stability in acidic, basic solutions and in oxidizing environments at higher temperatures). TFTs using transparent oxide semiconductors as the channel layer have several merits compared with conventional Si-TFTs such as the insensitivity of device performance to visible light illumination and efficient use of backlight in LCDs or emitted light in OLEDs etc. In addition, oxide TFTs have potential advantages over covalent semiconductor-based TFTs in terms of their high voltage, temperature, and radiation tolerances.

Zinc tin oxide thin films are deposited on glass substrates at room temperature (RT) by pulsed laser deposition (PLD) from a ceramic zinc tin oxide target with a KrF excimer laser (248 nm wavelength, 10 Hz repetition frequency). Laser ablation was carried out at a laser energy density of ~ 35 mJ cm^{-2} $pulse^{-1}$. By varying oxygen pressure from 0 to 9 Pa during deposition, the carrier concentration can be controlled in the range 10^{12} cm^{-3} to 10^{19} cm^{-3}.

Amorphous nature of the films was confirmed by glancing angle x-ray diffraction analysis. Optical and electrical properties of the films were studied for various Zn/Sn ratio in the film and also the dependence of oxygen partial pressure during the deposition. Thin film transistors were fabricated on silicon substrates using amorphous zinc tin oxide as channel layer. Typical n-channel enhancement mode operation is achieved in these devices with field effect mobility 0.015 cm^2 V^{-1} s^{-1} and on-off ratio 10^5.

Acknowledgment

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IRT10

Preparation of Luminescent Nanostructures by Pulsed Laser Ablation

V.P. Mahadevan Pillai
Department of Optoelectronics, University of Kerala, Kariavattom, Trivandrum, Kerala 695 581
*E mail : vpmpillai9@rediffmail.com

Pulsed laser deposition technique is a simple and efficient method for the preparation of nanostructured films. In PLD, one can control size distribution and shape of nanocrystals by varying the parameters like target to substrate distance, laser fluence, background gas pressure, substrate temperature etc and thus it emerges as an effective tool for the growth of quantum structures with high chemical purity and controlled stochiometry. This paper is a review report on the preparation of nanostructures of technologically important materials like Si, SiC, WO_3, ZnO, Ta_2O_5, In_2O_3, ITO, KLN and $BaWO_4$ using PLD under various conditions in our laboratory. Effect of dopants, laser energy, deposition time, substrate temperature, post deposition annealing, nature of substrate, substrate to target distance and back ground gas pressure etc. on the structural and optical properties of these materials are investigated. XRD, SEM, EDX, AFM, TEM, XPS, UV-visible spectra, Photoluminescence spectra, FTIR spectra, Raman spectra, and open aperture Z scan technique are used for the characterization of the films. Silicon quantum dots of average size 1 nm were synthesized by off-axis pulsed laser deposition. TEM analysis reveals that the mean size of silicon nanoparticles has a direct dependence on the off-axis height of the substrate from the axis of the plume. The synthesized films exhibit PL peak in the UV-Visible region. The PL emission peak and intensity are dependent on the nature of the substrate used. The observed luminescence in Si films does not originate from localized states in gap but from extended states. The growth of SnO_2 doped Si nanorings with minimum outer diameter of 20 nm and average thickness of 5nm have been achieved on sapphire substrate by pulsed laser deposition. The atomic force microscopy and Transmission electron microscopy displays several interesting self-assembling forms of polycrystalline as well as amorphous forms of silicon nanorings. Tungsten oxide thin films are prepared using reactive pulsed laser ablation technique and the structural, optical and morphological properties of deposited films are systematically studied by changing the ambient oxygen pressure (pO_2). Structural dependence of Tungsten oxide films on ambient oxygen pressure is discussed using Grazing Incidence X-ray diffraction (GIXRD) and Micro-Raman spectra. The section analysis using Atomic Force Microscopy exposed the smooth surface features of the films. The blue shift in optical band gap with increase in ambient oxygen pressure is expounded in terms of electronic band structure of tungsten oxide. The influence of oxygen pressure on optical constants like extinction coefficient, band edge sharpness, refractive index and optical band gap are also investigated. The structural morphological and optical characterization of indium oxide films deposited on fused silica substrates (quartz) at the ambient temperature and post annealed in the temperature range 473 –973 K were investigated using XRD, SEM, AFM, UV-Visible spectra. The lattice constants, grain size, microstrain and dislocation density of the films are calculated and correlated with annealing temperature. Indium tin oxide (ITO) films deposited in a reactive oxygen atmosphere on glass substrate at different substrate temperatures (T_s) ranging from 300 K to 573 K are characterized using GIXRD, AFM and UV-visible spectroscopy to study the effect of substrate temperature on the structural and optical properties of films. The XRD patterns suggest that the films deposited at room temperature are amorphous in nature and the crystalline nature of the films increases with increase in substrate temperature. The thickness of the film decreases with increase in substrate temperature. The AFM data show that substrate temperature plays a dominant role on the surface morphology of the films. UV-Visible spectra show that all the deposited ITO films prepared by PLD exhibit a direct allowed transition. The XRD analysis of $BaWO_4$ thin films were prepared on quartz substrate revealed that on annealing, the films show crystalline nature as well as attains a more stable homogeneous structure of monoclinic phase from a co-existed phase of tetragonal scheelite and monoclinic BaWO4 phase.This was well supported by the SEM, AFM and optical studies. Thin films of tantalum oxide are deposited on glass substrates as a

function of laser fluence (laser energy from 45 to 65 mJ in steps of 5 mJ) . Bandgap energy was found to decrease with the increase in laser energy. SEM and TEM (transmission electron microscopy) studies show the formation of tantalum oxide nanotubes of diameter less than 50 nm and length greater than 3000 nm in the energy range 50-55 mJ. KLN thin films are prepared using pulsed laser deposition technique for the first time with stoichiometric ceramic target in a non reactive atmosphere. The AFM images revealed a four fold symmetric grain growth. As on annealing the grain size is found to be decreasing. The surface roughness is also found to be decreasing due to annealing. SiC thin films (undoped and doped with SnO_2 at 1 at.%, 5 at.% and 10 at.% concentrations) are prepared using pulsed laser deposition on quartz substrates kept at room temperature. SEM and TEM analysis show the formation SiC nanorods of length more than 1 micron and diameter ~20nm in the 10% SnO2 doped SiC films. Zinc oxide (ZnO) films were prepared by pulsed laser ablation, on an optically flat fused silica (quartz) substrate for different deposition timeviz.10, 15 and 20 minutes. The influence of annealing temperatures, ranging from 573 to 773 K, on the structural and optical properties of ZnO films deposited at different ablation time was investigated systematically using X-ray diffraction (XRD), Energy Dispersive X-ray Analysis (EDX), Scanning electron microscopy (SEM), Atomic force microscopy (AFM), Raman spectra, UV-VIS Spectroscopy and Photoluminescence spectroscopy (PL). All these annealed films show a polycrystalline hexagonal wurtzite structure. Effect of CdO doping is also studied.

IRT11

Studies on manganite based Thin films and Heterostructures grown by PLD

D. G. Kuberkar
Department of Physics, Saurashtra University, Rajkot- 360 005
dgkcmr@rediffmail.com

The practical applicability of the manganite materials is a topic of great interest, such as manganite based thin films, multilayers and p-n junction devices. Owing to high sensitivity of the electronic and magnetic properties of doped manganites to external magnetic field, electric field or irradiation, these materials exhibit several interesting characteristics.

We have investigated the structural, microstructural and magnetotransport properties of Pr doped $La_{0.5}Ba_{0.3}MnO_3$ (LBMO) manganite thin films with optimum Pr concentration of $(La_{0.5}Pr_{0.2})Ba_{0.3}MnO_3$ (LPBMO) and studied the thickness dependent effects of swift Heavy Ion (SHI) irradiation on the electronic transport of these films. It is shown that, effect of irradiation on the transport properties increases with increasing film thickness. In addition, we have shown that, the $(La_{0.5}Pr_{0.2})Sr_{0.3}MnO_3$ (LPSMO) manganite thin films exhibit the half metallicity in a broad range of temperature (up to 200K) , a behavior useful for spin injector devices.

we have also studied the effect of non-magnetic spin scattering in $(La_{0.5}Pr_{0.2})Sr_{0.3}MnO_3/Al_2O_3/(La_{0.5}Pr_{0.2})Sr_{0.3}MnO_3$ heterostructure, grown by the PLD technique. A large MR ~77 % is observed at T_{IM} (~220K) in this heterostructure, possibility due to the magnetic field induced spin fluctuations in the scattering barrier of Al_2O_3, controlled by external applied field.

Recently we have investigated properties of manganite based $La_{0.5}Pr_{0.2}Sr_{0.3}MnO_3$ [5] / $La_{0.5}Pr_{0.2}Ba_{0.3}MnO_3$ [4] / STO multilayered structure grown by PLD technique. It is observed that a large Field Coefficient of Resistance (FCR) ~ 35% along with an appreciably large MR ~ 56% is exhibited by this heterostructure at RT.

IRT12

Laser ablation of Zn/ZnO Core-Shell Nanoparticles: Effect of SDS Concentration

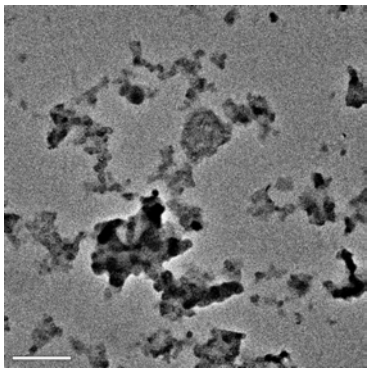
Geetika Bajaj and R.K.Soni[1]

Laser Spectroscopy Laboratory, Physics Department
Indian Institute of Technology, Delhi, New Delhi-110016
[1]Email: ravisoni@physics.iitd.ac.in

Pulsed laser ablation in liquid (PLAL) has gained considerable popularity in recent years for the growth of metal and semiconductor nanoparticles [1-2]. It involves ablating the target material in liquid media that confines the plasma plume formed when the high-energy laser beam interacts with the material. Laser induced reactive quenching can lead to the formation of the metal and metal oxide nanoparticles. The size control can be achieved by varying laser parameters and liquid media. The advantage of this method over the conventional chemical methods is that it is a single step process and nanoparticles produced are of high purity and defect free.

We have used Zn in the powder form to enhance the interaction with the laser in order to improve the nanoparticle yield. A suspension of 20 mg Zn (99.9%) dust in 15 ml of deionised water and aqueous solution of Sodium dodecyl sulfate (SDS) with concentrations 0.1 M, 0.05 M, 0.01 M and 0.0067 M was used as target material. The target, kept in a glass vessel, irradiated for 45 minutes with the second harmonic (532 nm) of a pulsed Nd: YAG laser operating at 10 Hz with a 5 ns pulse width and the beam was focused to maximize the laser interaction with the Zn powder particles for high nanoparticle yield. The maximum pulse energy used was 17mJ. The concentrations of SDS were chosen both above and below the CMC (0.008M) to investigate the effect of micelle formation on the fabrication of the nanoparticles. No visible change was observed in the solutions after the ablation.

Figure 1 shows the TEM image of Zn/ZnO sample prepared in aqueous solution with 0.1M SDS concentrations. Optical absorption spectra of the colloidal solution in deionised water and in SDS is shown in Fig. 2.. There are three distinct features in the spectra at around 242 nm, 270 nm and 350 nm which can be attributed to Zn nanoparticles, surface plasmon resonance (SPR) from Zn and ZnO excitonic absorption, respectively. These peaks exhibit marked variation in their relative strength with variation in SDS concentration. High SDS concentration corresponds to high relative amount of Zn nanoparticles existing as the core in the core/shell nanostructures, whereas low SDS concentration leads to large ZnO shell thickness. This can be understood as laser ablation of the target induces local zinc plasma above the target, which results in the formation of Zn clusters during extinguishment of the zinc plasma plume, and subsequent aqueous oxidation can lead to the formation of ZnO nanoparticles. However, SDS can depress such oxidation because of its surface capping on the particles and can lead to the formation of Zn/ZnO core/shell nanoparticles. Thus varying amounts of components Zn and ZnO can thus evolve with varying SDS concentration in solution.



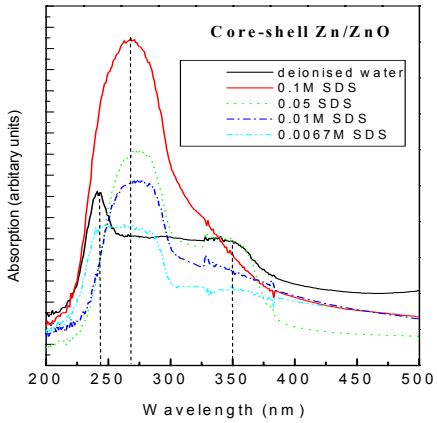


Fig.1 TEM image of Zn/ZnO prepared in aqueous solution Fig. 2 Room temperature optical absorption spectra from Zn/ZnO core-shell nanostructures

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IRT13

Characterization of pulsed laser deposited Fe_3O_4 thin films on different substrates.

D.M.Phase
UGC-DAE Consortium for DAE facilities
Khandwa Road, University Campus, Indore-452 017

Magnetite (Fe_3O_4) is a well known half metallic ferromagnetic material and enjoys the ability to inject 100 % spin polarized electrons. The Curie temperature of Fe_3O_4 is 858K, which is very high as compared to other half metallic ferromagnetic materials. These properties make the Fe_3O_4 a potential candidate for spintronic devices. Magnetite has a cubic inverse spinel structure and it consists of Fe^{2+} and Fe^{3+} ions. At room temperature the electrons continuously hop between Fe^{2+} and Fe^{3+} ions at B sites leading to metallic nature of the system. At 120K hopping is frozen and consequently resistivity is increased by two orders of magnitude as the temperature is lowered. This transition is termed as Verwey transition. Though the precise origin of Verwey transition is still under review, works is progressing in the direction of further harnessing the important features of magnetite for superior technological relevancies. In this scenario it is essential to study the properties of Fe_3O_4 in thin film form since for any application thin films finally hold the key. There are several reports[1-3] available on thin film growth of Fe_3O_4 by various techniques. From these studies it is evident that the electrical or magnetization property of Fe_3O_4 thin films immensely depend on the method of preparation, substrate used, nature of defects and the defect density. In this talk we present a review of our recent research work[4-6] on the growth and characterization of Fe_3O_4 thin films on different substrates. Some of the issues, which will be addressed, are Raman scattering across Verwey transition, substrate independent oriented growth and modifications in structural and electrical properties due to swift heavy ion irradiation.

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IRT14

Application of pulsed laser deposited thin films of ZnO as varistors and InN as field emitters

K. P. Adhi*
Center for Advanced Studies in Material Science and Condensed Matter Physics.
DST unit on Nanoscience,
Department of Physics, University of Pune,
Pune –411 007, India
*Corresponding authors e-mail: kpa@physics.unipune.ernet.in

We discuss the application of pulsed laser deposited ZnO thin films as varistors and InN thin films as field emitters. Abstract of the work in this context is as given below;

Pulsed laser deposition technique was used to grow thin films of ZnO on Si (100) substrate held at different temperatures (T_s) ranging from 100 to 600 °C. All the as-deposited or the pristine (P) films show a preferential *c*-axis orientation. Current-voltage (I-V) characteristics of the P films show Ohmic behavior for all the samples. These films were subjected to annealing at 800 °C in air ambient for 4 hours. Interestingly, these annealed films (A) show nonlinear variation of current with applied voltage, very similar to the one observed in doped ZnO varistors [1]. Attempt is made, using X-ray photoelectron spectroscopy (XPS), to comprehend the drastic difference in I-V characteristics of the P and A films. The O1s and the $Zn2P_{3/2}$ spectra reveal the chemical environments in the P and A films. The spectra recorded for A films is significantly different from that of the P films. It is found that annealing results in the formation of $Zn(OH)_x$ barrier in the ZnO films. The nonlinear behavior, in case of the annealed films, is attributed to the tunneling of electrons through the aforesaid barrier during inter grain electron transport [2]. The nonlinearity in I-V characteristics of A films suggests the use of PLD-grown thin films subjected to annealing as thin-film varistors in electronic industry.

DC plasma assisted pulsed laser deposition technique was used to grow thin films of InN on c-cut Al_2O_3 substrates. X-ray diffraction (XRD) studies revealed the single phase, polycrystalline nature of the InN thin films with wurtzite structure. The root mean square (rms) surface roughness, as seen by atomic force microscopy (AFM), was estimated to be ~ 35 nm. The surface morphology showed hexagonal features having sharp edges and protrusions. Using the diode configuration, the field emission characteristics of InN/Al_2O_3 were investigated in ultra high vacuum (1×10^{-8} Torr). The turn-on field, required to draw an emission current density of $10\mu A/cm^2$, was observed to be ~3.5 V/μm. The maximum emission current density obtained was $230\mu A/cm^2$ when the applied electric field strength was ~ 4 V/μm. The Fowler–Nordheim (FN) plot obtained from the current–voltage characteristic was found to be linear in accordance with the quantum mechanical tunneling phenomenon. The field enhancement factor β, estimated from the slope of the FN plot was 21,167 cm^{-1}[3]. To the best of our knowledge this is the first report of field emission studies of InN/Al_2O_3 with such high values of β. The study indicates strongly that InN nanostructured thin films can be used successfully in integrated field emitting devices.

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IRT15

Effect of swift heavy ion irradiation on the surface morphology of highly c-axis oriented LSMO thin films grown by pulsed laser deposition.

S. I. Patil, M. S. Sahasrabudhe, Deepak N. Bankar, A. G. Banpurkar and K. P. Adhi
Department of Physics, University of Pune, Pune 411 007, India
Ravi Kumar
Inter-University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi 110 067, India
E-mail:patil@physics.unipune.ernet.in

In perovskite manganite of the form $R_{1-x}A_xMnO_3$ the spin, lattice, charge and orbital degrees of freedom are coupled to one another. Since interaction energies are also of the same order of magnitude, their properties are extremely sensitive to small changes in the material parameters thereby leading to very rich phase diagram. To study the role of heavy ion irradiation on the thin films of manganites, highly c-axis oriented LSMO thin films were grown on $LaAlO_3$ (100) (LAO) substrates by the pulsed laser deposition (PLD) technique. The well-characterized films were implanted and irradiated with different ions, with varying energies and dose values. Influence of irradiation on the structural, electrical, magnetic and magnetoresistance properties were studied.

A detailed investigation of the surface morphology of the pristine and swift heavy ion (SHI) irradiated $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) thin film using atomic force microscope (AFM) is presented. The films were annealed at 800 °C for 12 hours in air (pristine films) and subsequently irradiated with SHI of oxygen and silver. The incident fluence was varied from 1×10^{12} to 1×10^{14} ions/cm^2 and 1×10^{11} to 1×10^{12} ions/cm^2 for oxygen and silver ions respectively. X-ray diffraction (XRD) studies reveal that the irradiated films are strained. From the AFM images, various details pertaining to the surface morphology show drastic modifications, which is dependent on the nature of ions and the incident fluence. However, the surface is found to remain self-affine. The difference in the modifications of surface morphology for both the ions will be discussed in detail.

The future work in this context on the strontium doped manganite system is ongoing and will also be discussed in detail.

IRT16

Tailoring the electrical and magnetic properties of $LaFe_{1-x}Ni_xO_3$ thin films by swift heavy ion irradiation

Ravi Kumar
Inter University Accelerator Centre, Aruna Asaf Ali Marg, New Delhi-110067
ranade@iuac.ernet.in

We have investigated the effect of 190MeV Ag ion irradiation on the structural, electrical and magnetic properties of the pulsed laser deposited thin films of $LaFe_{0.5}Ni_{0.5}O_3$. It is observed that following the irradiation, the lattice of the composition relaxes with enhanced *c*-axis orientation. Consequently the resistivity of the composition, which shows semiconducting trend, decreases with irradiation possibly due to the enhanced hybridization between the transition metal 3d and oxygen 2p orbitals. The pristine sample shows the activated variable range hopping behavior through out the studied temperature range, though the irradiated samples deviate from this behavior at lower temperatures. The pristine as well as the irradiated films exhibit room temperature ferromagnetic behavior and the magnetization increases with the irradiation fluence, almost doubled as compared to that of the pristine value.

IPT1

Study of device characteristics on Pulsed Laser Deposited Manganite-semiconductor Heterostructures

S.N. Kale[1], J. Mona[1], Hitesh Mamgain[2], R.R. Rawat[3], V. Ganesan[3], R.J. Choudhary[3], D.M. Phase[3]
[1] Fergusson College, Pune 411 004, India
[2] Nanonics Imaging Limited, Jerusalem., Israel
[3]UGC-DAE Consortium for Scientific Research, Indore 452 017, India
Email for correspondence: snkale@vsnl.com

There have been numerous reports on study of manganite systems juxtaposed with either another manganite system or with a semiconductor to yield interesting p-n junctions which can have potential applications in the area of spintronics.[1-4] In this context, we report on study of morphology, optical contrast and transport characteristics of two different manganite-semiconductor thin film systems, namely, $La_{0.7}Ba_{0.3}MnO_3$ (LBMO) bilayered with SnO_2 and $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) bilayered with SnO_2 on Si (001) substrate, synthesized using Pulsed Laser Deposition system. X-ray Diffraction studies reveal that while LBMO exhibits oriented growth, LSMO grow in a polycrystalline manner on polycrystalline SnO_2. Atomic Force Microscopy shows interesting pyramidal structures of both manganite systems of size ~ 2 μm x 1 μm x 200 nm. On the other hand, SnO_2 grows in the form of close packed cylindrical clusters of ~ 200 nm radius. Near-Field Optical Microscopy (NSOM) study using 532 nm laser reveal that optical NSOM output intensity in manganites (both LBMO and LSMO) is four times less than SnO_2 signal. Transport characterizations of LBMO:SnO_2 system exhibits non-linear current-voltage characteristics at 300 K which becomes linear at 60 K. On the other hand, LSMO:SnO_2 system show non-linear current-voltage characteristics at both at 300K and 60K. The results have been interpreted in terms of lattice matching and strain in both the systems. The work will essentially project the systems as a promising candidate in non-conventional device category.

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IPT2

Pulsed Laser Deposition of $La_{1.5}Dy_{0.5}CaBa_2Cu_5O_z$ Superconducting Thin Films

Sudhindra Rayaprol[1], K. R. Mavani[2, 3], D. G. Kuberkar[2], N. A. Shah[2], J. John[4] and R. Pinto[4, 5]

[1]*UGC-DAE CSR-Mumbai centre, R-5 Shed, BARC, Trombay, Mumbai*
[2]*Department of Physics, Saurashtra University, Rajkot*
[3]*Institute of Laser Engineering, Osaka University, Osaka Japan*
[4]*DCMP&MS, Tata Institute of Fundamental Research, Colaba, Mumbai*
[5]*Indian Institute of Technology – Bombay, Powai, Mumbai*

The La and Ca substituted, tetragonal superconductors have enhanced corrosion resistance compared to *RE*-123 type orthorhombic superconductors. These tetragonal superconductors have a stable oxygen stoichiometry and structure with lesser aging effect in the atmosphere compared to the orthorhombic *RE*-123 superconductors. This property of tetragonal superconductors, particularly La-Ca substituted systems, is desirable for possible thin film applications.

A single-phase target of polycrystalline $La_{1.5}Dy_{0.5}CaBa_2Cu_5O_z$ (La-2125) was used for the deposition of thin films using Pulsed Laser Deposition technique. A KrF excimer laser (λ = 248 nm) with pulse repetition rate of 10 Hz, energy density of 0.9 J/cm^2 on the target, the substrate-target distance of 4.5 cm distance was used to deposit the La-2125 thin films (~2000 Å) on single crystal $LaAlO_3$ (*001*) substrates held at temperature of 820°C. The O_2 partial pressure in the chamber was maintained at 500 mTorr during the deposition.

The XRD patterns showed that the thin films were pure phase (La-2125) and *c*-axis oriented on single crystal $LaAlO_3$ (*001*) substrates. The resistance was measured as a function of temperature for determining the T_c of the thin films. The films showed the onset of superconducting transition at ~79 K and the T_c ~ 75 K, which is close to the T_c (~78 K) of single-phase bulk La-2125 compound.

Recent irradiation studies on the La-2125 thin films using Ag and O beams have shown that the columnar defects created by the ion beams of certain fluence (ions/cm^2) have desirable effect on the critical current density, i.e., up to certain fluence J_c increases with increasing fluence. The typical J_c for pristine and irradiated thin film of La-2125 composition is of the order of 10^6 A/cm^2. The irradiation results in two or three fold increase in the J_c value.

In this presentation, we will highlight the results of ERDA experiments and effect of ion-beam irradiation on the modification of superconducting properties of La-2125 thin films.

IPT3

Basic Photoluminescence Processes at different Temperatures in ZnO / (0001) Sapphire Thin Films Grown by Pulsed Laser Deposition

P. Misra*, T. K. Sharma and L. M. Kukreja
Laser Program, Raja Ramanna Centre for Advanced Technology, Indore– 452 013
*Corresponding author email: pmisra@cat.ernet.in

Photoluminescence (PL) transitions associated with free (F_X) and bound (B_X) excitons and their corresponding phonon replicas in ZnO thin film have been studied in the range of 10 to 300K. As shown in Fig.1 the low temperature PL spectra were dominated by recombination of donor bound excitons and their phonon replicas (B'_X & B''_X) while with increasing temperature, free exciton PL and the associated LO phonon replicas (F'_X & F''_X) increased in intensity at the expense of their bound counterparts. The B_X peak with line width of ~6 meV at 10K exhibited thermal activation energy of ~ 17 meV, consistent with the exciton-defect binding energy. The F_X and B_X peak positions were found to converge with increasing temperature, which was attributed to the transformation of B_X into the shallower donor bound exciton complexes at consecutive lower energy states with increasing

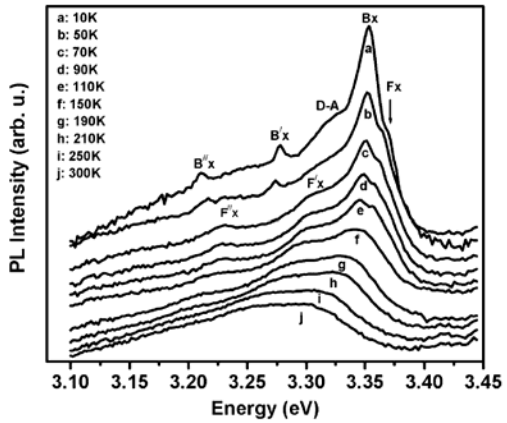

Figure 1. Photoluminescence spectra of ZnO thin film taken at different temperatures in the range of 10-300K

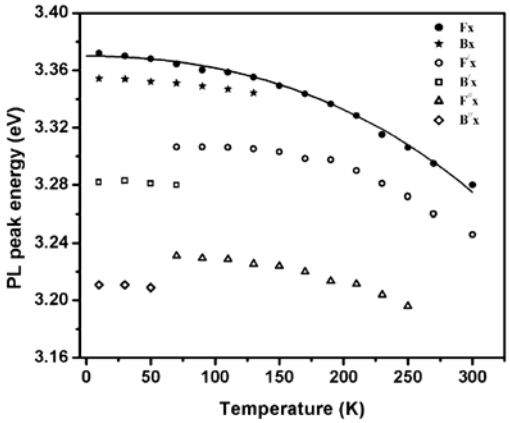

Figure 2. Temperature dependence of energy positions of F_X, B_X, F'_X, B'_X, F''_X and B''_X peaks.

temperature. The energy separation between F_X peak and its corresponding 1-LO phonon replica showed stronger dependence on temperature that of 2-LO phonon replica as shown in Figure 2. However their bound counterparts did not exhibit this behavior. The observed temperature dependence of the energy separation between the free exciton and its' LO phonon replicas are explained by considering the contribution of kinetic energy of free excitons

IPT4

Synthesis and properties of pulsed laser deposited Fe doped MoO_{3-d} thin films

R. J. Choudhary[1], Ram Prakash[1], D. M. Phase[1] and Ravi Kumar[2]
[1]UGC-DAE Consortium for Scientific Research, University Campus, Indore-452017, India.
[2]Inter University Accelerator Center, N. Delhi-110067, India.
Email:ram@csr.ernet.in

Over the last few years there has been insurgence in the research field of spintronics, wherein the spin controlled electrical, optical and magnetic properties are desired. It is commonly believed that if the two degrees of freedom of a carrier, namely charge and spin, can be coupled together so that there is a coalition of electrical and magnetic properties, the emerging device would possess unparallel opportunities of applications. One way to realize this arrangement is to dope some magnetic impurity in a semiconducting material and hope that it harnesses the ferromagnetic property alongwith the semiconducting property. The new system of magnetic impurity doped semiconductor system has been branded as diluted magnetic semiconductors. Molybdenum oxide (MoO_3) is a wide band gap (2.85 eV) n-type semiconductor having orthorhombic unit cell with the space group of Pnma. For the last several years, molybdenum oxide has attracted attentions because of their potential applications in electrochromism, photochromism, gas sensing devices, optically switchable coatings, catalysis etc. The demonstration of such a wide range applications is due to the non-stoicheometric nature of molybdenum oxide and to the occurrence of several different allotropes and phases of molybdenum oxide (such as MoO_3, MoO_2, β-MoO_3, Mo_4O_{11}, etc.). The dependence of electrical property on oxygen concentration is such that MoO_3 is optically transparent and electrically insulating in nature while MoO_2 is metallic. This provides a window to optimize oxygen concentration between these two members of molybdenum oxide in a way to achieve transparent conducting semiconductor with desired band gap. Besides the above-mentioned attracting physical and optical applications, if another degree of dimensionality in terms of magnetic property could be induced in the system by doping some magnetic impurity, the resulting device will grant a boost to the existing MoO_3 based technology. Though the room temperature ferromagnetism in transition metal elements doped in other oxides system has been realized, there have been controversies regarding the cause of origin of ferromagnetism in the system. We report the growth of molybdenum oxide and iron doped (2 and 5 at. %) molybdenum oxide thin films on c-plane of sapphire substrate using pulsed laser deposition in oxygen ambient. The structure was characterized using x-ray diffraction, x-ray photoelectron spectroscopy (XPS). The electrical resistivity and magnetization behavior were investigated using four point probe resistivity and vibration sample magnetometer respectively. XRD results show that the films are oriented in (100) direction and have monoclinic structure based on MoO_2 phase. We do not observe any impurity phase of iron oxide in iron doped films in their XRD patterns. The resistivity data show a minima at 101 K for undoped which is shifted to 57 K for 5% Fe doping. The Fe doped samples show ferromagnetic behavior at room temperature. X ray photo spectroscopy data reveal that Fe is in +2 valence state, excluding the possibility of formation of Fe clusters.

IPT5

UV excimer lasers for smart materials and nanostructures

B. Fechner, R. Pätzel, R. Delmdahl
Coherent GmbH, Hans-Böckler-Str. 12, D-37079 Göttingen, Germany
E-mail: burkhard.fechner@coherent.com

Abstract

From medicine through consumer electronics, device manufacturers face market pressure to increase miniaturization while increasing device functionality and hence complexity. As a result, many industries are turning to laser micromachining as a manufacturing solution to meet these needs. Excimer lasers have already proven particularly well-suited to these micromachining applications. Ongoing progress in material research and processing industry is fueled to a large extent by the technique of pulsed laser deposition (PLD). With this powerful and versatile approach, multi-component target materials can be ablated and deposited onto a substrate to form stoichiometric layers which exhibit the desired properties. Monitoring of growth parameters such as thickness and surface roughness is frequently in-situ monitored via electron diffraction or other diagnostic tools.
Both quality and longevity of the microstructures acting e.g. as sensors, actuators, bioreactors or information transmitters strongly depend on the degree of accuracy achieved in the manufacturing process.

1. Introduction

Pulsed Laser Deposition (PLD) as a physical vapour deposition technique for coating development and material screening opens up nearly unlimited pathways to functional coatings by means of rapid protocoating. Prerequisites for a successful rapid protocoating are well-conceived ablation systems and lasers enabling efficient, development of thin film coatings for medical device manufacturing, mechanical engineering, microsystems technology or optics on a short timescale. In the PLD technique a high pulse energy laser beam, preferably the rectangular profile of a short wavelength excimer laser at 248 or 193 nm, is demagnified on the target material which is to be deposited. Due to the short wavelength of the pulsed excimer light (20ns) and the resulting small penetration depth, the absorption takes place selectively in a limited volume near the surface leading to fast heating and explosive evaporation[1]. This non–thermal equilibration mechanism is the basis for depositing multi-component substrate materials controlling stoichiometry and crystal properties during thin film growth.
The high energy photons of the excimer laser allow virtually all target materials to be deposited such as oxides, nitrides, and carbides for isolators, metals, complex ceramics, and polymers for semiconductors. The flexibility in view of the employed materials which can be varied during the deposition process allowing straightforward tayloring of multicoatings has rendered PLD an established and productive technology for coating and material development[2].

2. Pulsed Laser Deposition

2.1 Ablation source

Uniform pulse energy, at both low repetition rates and in burst operation, is among the most critical laser output parameters for PLD. A constant, uniform pulse energy produces consistent

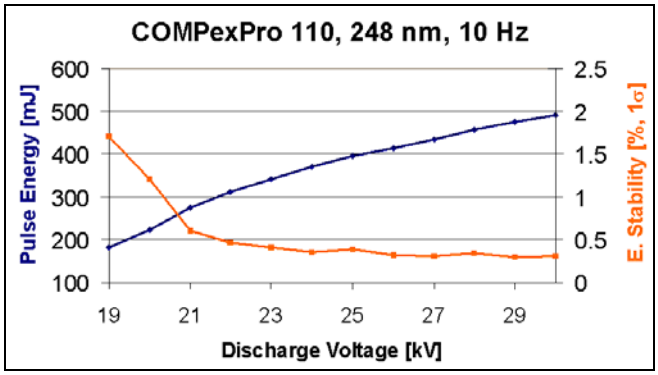

Fig.1 Pulse energy and energy stability of COMPexPro as a function of operation voltage at 248 nm and 10Hz.

deposition parameters, resulting in homogeneous films and a repeatable process. High laser pulse energy provides several benefits for PLD. First, it enhances the deposition rate of target materials. Depending on laser pulse energy several microns per minute are achievable. Next, it enables a larger area on the target to be ablated at a given fluence. This area enlargement increases the deposition rate and reduces the plume angle, resulting in higher deposition efficiency. Finally, higher photon energies as provided by excimer lasers at wavelengths of 193 nm and 157 nm provide an even larger process window, allowing consistent, successful material ablation well above the ablation threshold also for transparent polymers and hard target samples[3]. Even compact excimer lasers provide high pulse energies between 200mJ and 500mJ with excellent pulse-to-pulse stability of typically 0.5%, 1 sigma.

2.2 Vacuum system

In order to generate smart material layers most effectively next to the ablation light source which is preferably a short wavelength excimer laser a sophisticated vacuum system is the key to success. Its essential components are the vacuum chamber containing heated substrate holder, target holder and UV optical elements for demagnifying the laser beam to the required on-target energy density of typically 1-5 J/cm^2. Both a constant deposition rate and homo-geneous thin film properties over a large thin film area are provided by the exceptional pulse-to-pulse stability and beam homogeneity of advanced high-pulse energy lasers.

Fig.2 Target holder in an advanced PLD vacuum system, consisting of six rotatable targets.

Fully automated vacuum systems with up to 6 inch diameter substrates enable efficient and reproducible thin film development for scientific as well as industrial research facilities. Rotatable revolvers, as shown in figure 2, allow to variably deposit up to 6 different target materials. The individual targets generally consist of small pellets offering high flexibility and reducing target costs to a minimum.

2.3 Coating capabilities of Pulsed Laser Deposition

Of particular interest both in mechanical and optical engineering are coatings combining hydrophobic functionality with a high degree of trans-parency in a thin layer as provided by poly-tetrafluoroethylene (PTFE). This material cannot be deposited other than with pulsed laser deposition and demonstrates the fle-xibility of PLD. Thin PTFE layers of a thickness of above 100 nm significantly increase the contact angle on a given substrate to 110° as is shown in figure 3 for glass substrate and at the same time provide a transmission of >98 % as useful for e.g. self-cleaning surfaces.

In medical device technology PLD deposited coatings lend the required biocompatibility to novel implants. As in the case of stents many devices cannot be made from biocompatible materials such as titanium directly but need to be chosen in view of their mechanical properties supporting high tensile stress during expansion in the blood vessel. The appropriate layer ma-terial deposited with PLD exhibits high adherence also on the usually four times expanded stent mate-rial which is the prerequisite for its biocom-patibility.

In figure 4, a biocompatible metal oxide target has been used for pulsed laser deposition with excellent thin film homogeneity and strength. Deposition time for a 150 nm film on a 20 mm long stent is in the range of minutes.

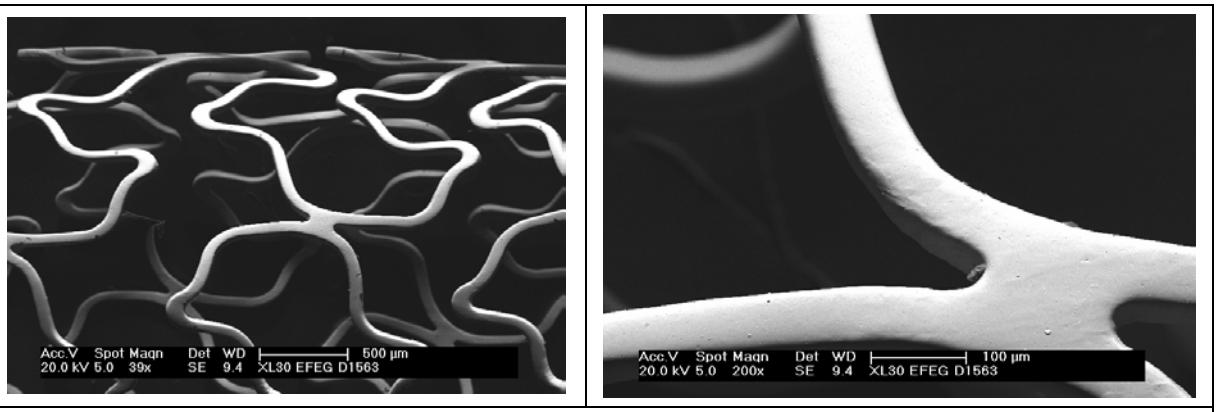

Fig.4 Expanded stent coated with a thin metal oxide layer (left). The enlarged view (right) gives evidence for the high thin film quality (Axyntec GmbH).

3. Microfluidics

Highly miniaturized devices in biomedicine include relatively simple products, such as micro-arrays used in the pharmaceutical industry for high throughput drug discovery, and more complex microfluidic devices. These lab-on-chip devices are widely used in genomics and proteomics, and will soon enable the miniaturization and automation of analytical testing. Typically resembling microscope slides, lab-on-chip devices are fabricated in optically transparent materials, such as pyrex glass and PMMA, to enable analysis using some type of modified microscope setup. Unfortunately, it is difficult to create microscopic channels, grooves, holes and bridges in these materials by traditional methods, particularly in the case of glass. But excimer micromachining can create these features with the desired resolution and without any

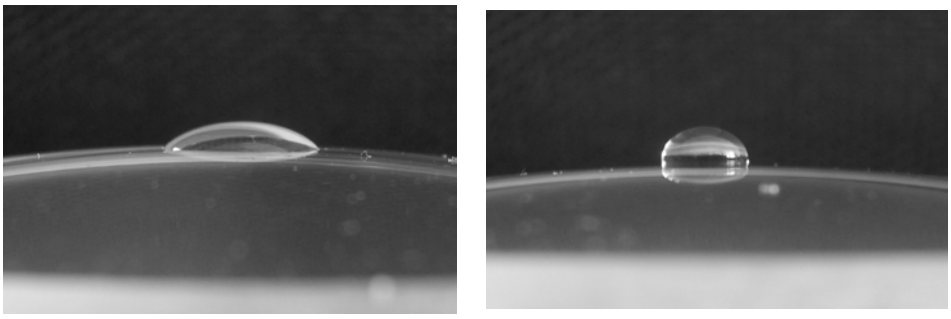

Fig.3 Water droplet on a glass surface before (left picture) and after (right picture) coating with a PTFE thin film (Axyntec GmbH).

microcracking or other problems (see figure). The 248 nm output wavelength is commonly used for polymers and the 193 nm wavelength is mostly used for glass and quartz machining.

In addition, many lab-on-chip systems require electrical contacts, to enable processes such as electrophoresis. The excimer can also be used to fabricate these electrodes in the back-side of the lab-on-chip. Each electrode is produced by ablating a small through hole at the required location. These often have a circular cross-section with typical diameters of a few tens of microns or less. Other shapes can be created with an appropriate photomask, which also allows all the electrodes to be drilled in a single step. After laser-drilling, the holes are completely filled with metal in a vapor deposition or pulsed laser deposition process, forming both a liquid-tight seal and a through electrode (see fig. 5).

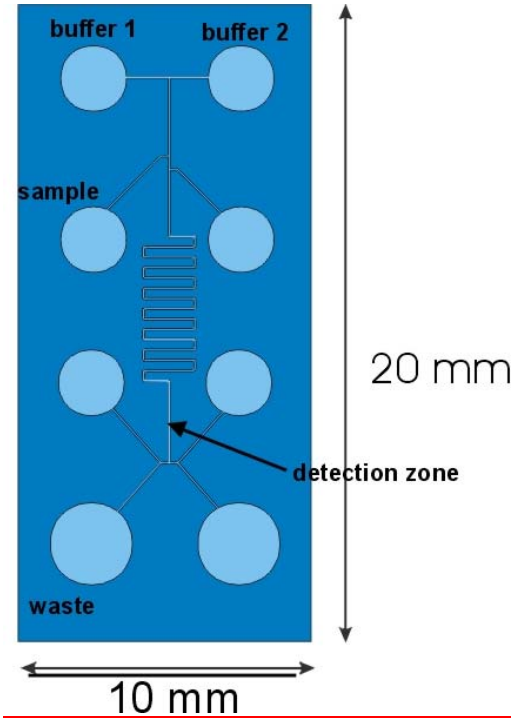

***Fig.5** Microfluidic structure and sensors (Bartels Mikrotechnik, GmbH)*

4. Direct Patterning of Circuits

There is growing demand for low unit cost, miniaturized electrical circuits for applications such disposable medical sensors and radio frequency identifiers (RFID).In this application, the output beam from a 308 nm (XeCl) excimer is reshaped in a beam homogenizer and passed through a photomask (typically chrome on quartz) containing the pattern for one or even several circuits. The mask is re-imaged at the work surface which consists of a plastic film or web on which a thin layer of metal has been vapor-deposited. Most of the UV radiation passes through the film and is strongly absorbed at the plastic-metal interface. This vaporizes a thin layer of the plastic, completely removing the overlying metal film (see figure 6). Providing the metal layer thickness is 150 nanometers or less, a single laser pulse performs a complete lift with clean edges and no breaks even on lines as narrow as 10 microns.

The optimum thickness is actually around 500 angstroms which is more than sufficient for most flex circuit applications, which typically do not carry high current. At this thickness, a circuit with area up to 400 mm^2 can be processed at a pulse energy of 1 J.
Excimer lasers designed for this application typically operate at pulse repetition rates of several hundred Hz. At 300 Hz for example, this "single pulse" laser process can generate 18,000 circuits/minute. The pro-cess can be set up as reel-to-reel with continuous feed because the short pulse of the laser eliminates the possibility of blur even at feedrates of tens of meters/second. Alternatively some manufacturers have implemented a roll-to-roll process in which optics sweep across the web which undergoes stepped motion. Laser direct patterning can be used with several different flexible plastic substrates (PET, polyimide, PEN, and PMMA) and a full range of conductors including copper, gold, silver, platinum, aluminum, and even titanium. Manufacturers cite several process advantages, compared to traditional lithography using wet photochemistry. The most important is process simplicity; a single dry process replaces about seven separate steps. It also eliminates the cost and disposal of the chemical reagents. In addition, the metal debris can be trapped by a vacuum system, allowing recycling of this valuable material.

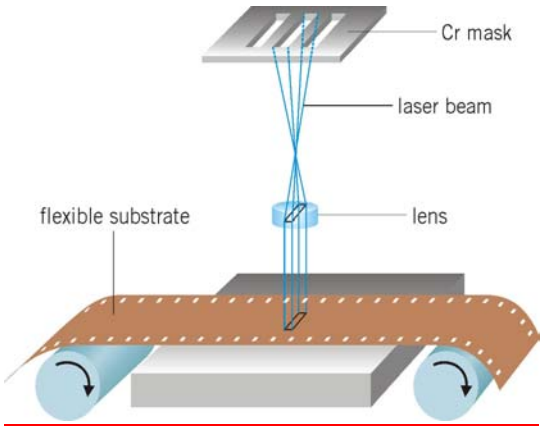

***Fig.6** Laser Direct Patterning process (LPKF AG)*

5. Conclusion

Intelligent thin film development and rapid prototyping for various fields of applications is largely facilitated by means of short excimer laser wavelengths. Combined with compact, automated vacuum systems for fast and convenient substrate handling stoichiometric multi-layer thin-films with good homogeneity and taylored physical characteristics are efficiently generated. Stable, high pulse energy output characteristics provide controlled and reproducible target ablation for nanotechnology which can often be upscaled in output rate by reel to reel approaches.

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IPT6

Precise photonic engines for UV pulsed laser deposition

R. Delmdahl, J. Sieber, B. Fechner
Coherent GmbH, Hans-Böckler-Str. 12, D-37079 Göttingen, Germany
E-mail: ralph.delmdahl@coherent.com

Abstract

High pulse energy excimer lasers with pulse energies between 300 and 1200 mJ/pulse and photon energies between 5eV and 7.9 eV lend maximum flexibility to the technique of pulsed laser deposition. On account of the high energy densities accessible with the latest generation of excimer lasers, the entire material spectrum including high band-gap metal oxides such as ZnO is amenable to precise and controlled ablation with subsequent stoichiometric transfer to the substrat. Because the transferred material needs time to smoothly deposit and position itself optimally on the substrate, the repetition rate of the ablation laser is typically on the order of only 10 Hz. These requirements are best met by pulsed lasers with short wavelengths (248 nm is the most common), high pulse energies (100 to 1000 mJ) and homogeneous spatial energy distribution. Thin film quality is very sensitive to shot-to-shot energy density fluctuations, and because deposition time in a lab takes up to one hour, both spatial (beam profile) and temporal (shot-to-shot) energy stability are essential in order to obtain reproducible results.

1. Introduction

Pulsed excimer lasers are the strongest and most efficient laser sources in the ultraviolet spectral region. Record short wavelengths from 351 nm down to 157 nm as well as record high 1200 mJ pulse energy as available for the 248 nm excimer lasers are commercially provided for numerous laser material ablation approaches[i]. Virtually no material is able to withstand the high photon energies ranging from 3.5 to 7.9 eV emitted by excimer lasers. As a result of the irradiation of material with high energy excimer laser photons at sufficient fluence immediate bond breaking due to electronic excitation is induced. In combination with short-term laser material interaction of only 10 to 30 ns excimer pulse duration, material ablation proceeds via fast vaporization and consecutive ejection of material with only negligible dissipation of heat transfer to the surrounding zone. The effect is an inherently precise and clean ablation quality.
The latest excimer laser versions LPXPro and COMPexPro as described in this paper were specifically redesigned to provide the beam and energy stability required for achieving the homogeneous layer growth essential in todays's most advanced thin film applications.

2. Advances in excimer laser tube design

Excimer lasers used for precise material ablation must meet high standards in regards to performance and output characteristics. For reproducible results of high-quality the excimer laser must keep his performance stable over a long period in order to increase productivity even at very high pulse energies. In the following paragraphs recent technical advances in excimer lasers for pulsed laser deposition and resulting output energy characteristics and beam parameters are discussed.

2.1 Smooth Ceramic Preionization

Based on proven metal-ceramic technology NovaTube®, the preionization concept of both the new LPXPro series and the new COMPexPro series has been optimized in order to obtain highest pulse

energies in combination with homogeneous discharge conditions. The newly employed patented smooth ceramic preionization design uniquely combines the efficiency of a discharge driven preionization source, surch as spark preionization designs with the smoothness and homogeneous volume preionization as provided by e.g. the corona preionization which is far less efficient and thus only viable for low pulse energy excimer lasers.

2.2 Optimized Gas Flow and Gas Purification System

In order to extend the hands-off operation time of both the LPXPro series and the COMPexPro series, the gas flow architecture and the internal electrostatic gas purification systems have been redesigned. Laser gas contaminants are efficiently filtered out by careful optimization of the gas flow via capable electrostatic filter elements. With the sophisticated gas purification system inside the LPXPro and COMPexPro laser gas performance remains to a large extent unaffected during long-term operation even at multi-hundred millijoules of laser pulse energy (see Fig. 1).

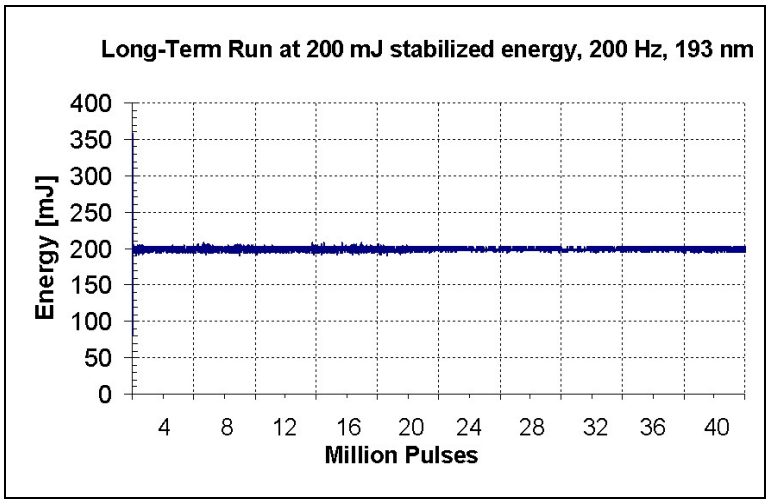

Figure 1: Dynamic gas behavior of LPXPro with smooth ceramic preionization and optimized gas purification. 40 million pulses (>60 hours) non-stop operation are achieved with a single gas fill at a wavelength of 193 nm.

3. Specific advantages of excimer lasers in PLD

In view of optical properties excimer laser have pivotal advantages over Nd:YAG lasers in PLD applications. These advantages are based on superior ablation characteristics and much better energy stability that are available at comparable costs and similar maintenance expenses. Major drawbacks of the Nd:YAG lasers for PLD include, inherently inappropriate gaussian beam profile instead of a flat-top profile as well as temperature-induced polarization and thermal lensing effect create donut-shaped beam profile and lateral distortions, respectively (see Fig. 2, left and right).

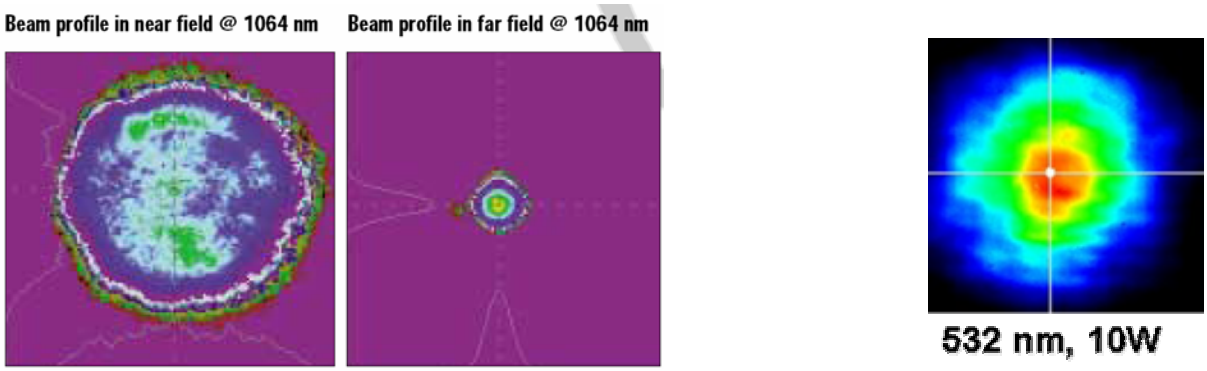

Fig. 2: Typical Nd:YAG laser beam profiles with rod polarization effects (left) and thermal lensing effect (right)

Moreover, poor short-term and long-term pulse-to-pulse stability of typically 10 to 15%, rms are provided by Nd:YAG lasers due to the necessary frequency conversion the efficiency of which is severely degrading toward shorter output wavelengths such as 266 nm.
Another limiting factor of Nd:YAG lasers in PLD experiments is the fixed repetition rate of 10 or 20 Hz which is not alterable but represents a fixed parameter.

Table I gives an overview of excimer laser versus Nd:YAG with regard to photon energies, performance parameters, and maintenance. The overview clearly shows that excimer technology excels in photon energy, variability of use, long-term and short-term pulse stability, and ablation homogeneity.

Parameter	**Excimer Laser**	**Photon Energy**	**Flash-lamp pumped Nd:YAG Laser**
Wavelength	 351nm, 308nm, 248nm 193nm 157nm	1.17eV 2.33eV 3.53eV 4.02eV 4.66eV **5.00eV** **6.42eV** **7.90eV**	1064nm 532nm 355nm 266nm
Output Energy	 **193nm: 50 to 600mJ** **157nm: 15 to 50mJ**		355nm: 60 to 200mJ 266nm: 40 to 90mJ 213nm: 5 to 15mJ
Repetition Rate			
Shot-to-Shot Stability			
Long Term Drift, 4hrs			
Ablation Geometry			
Pulse Width, FWHM	15 to 20ns		5 to 8ns
Consumables	Premix bottle, optics set		Flash-lamps, crystals

3.1 Wavelength and beam parameter considerations

In the following section, the three key laser-related characteristics that are of particular relevance for PLD experimenters are described in detail.

3.1.1 Laser-material interaction

a) High-energy photons are directly absorbed by molecular bonds with lno bulk heating

When a laser interacts with a solid surface, the laser energy is transformed into heat. The temperature of the solid material increases, leading to melting and evaporation of the solid material. Because the temperature in the vapor plume can rise to high values (10,000K and higher), a plasma is formed. Besides atoms, electrons and ions, the material plume also consists of particulates, with dimensions ranging from nm to μm. The smallest particles (~nm size) are probably formed in the expanding vapor plume, by condensation of vapor atoms. The larger particles (~μm size) are probably created by direct ejection from the solid target. Moreover, at very high laser irradiance (above 10^{10} W/cm2), explosive boiling of the target material beneath the surface layer, as well as mass ejection of large particulates, may occur.
Higher photon energies, or equally shorter wavelengths, yield faster plume heating and smaller particle sizes. The result is a preserved stoichiometry and a smoother thin film without unwanted particulates.

b) High photon energy results in better depth control and more controlled ablation conditions

The shorter the wavelength, the smaller the penetration depth of the laser radiation into the material. For excimer lasers at 193 nm and 248 nm, the ablation depth is in the 100 nm range. For 157 nm, penetration depths are on the order of 50 nm. This limited penetration results in very controlled layer-by-layer ablation with virtually no volume heating, thus eliminating the ejection of particulates. Additionally, the laser energy is deposited in a very restricted volume, and the quick and even material evaporation leads to clean ablation zones. These are visible in figure 3, which shows a typical target ablation track cross section obtained with a 248 nm excimer laser.
On the contrary, due to their rippled beam profile structure and longer wavelength, Nd:YAG laser beam ablation profiles (see Fig. 4) induce melting and uncontrolled material splashing due to shallow energy density gradients. Higher photon energies or equivalent shorter wavelengths yield clean ablation zones.

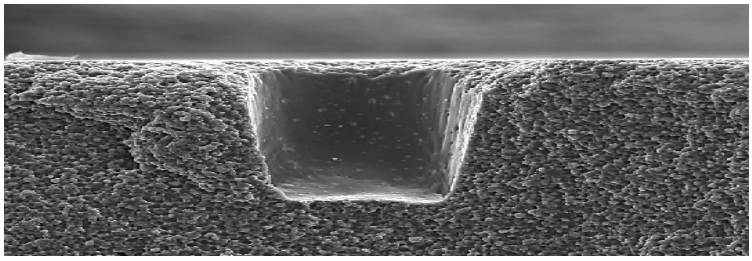

Fig. 3: Excimer laser ablation track in a PLD target.

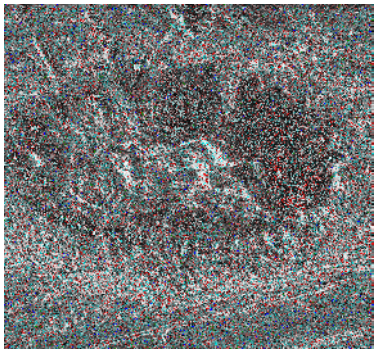

Fig. 4: Nd:YAG ablation profile

c) Shot-to-shot stability

Shot-to-shot stability is absolutely essential in PLD, because it determines the reproducibility of the thin film material properties. Generally, excimer lasers exhibit a much better pulse-to-pulse stability than frequency-converted Nd:YAG lasers (ref. Table I). As a matter of fact, COMPexPro lasers featuring ceramic preionization technology provide superior pulse-to-pulse stability of less than 1% rms at typical PLD conditions, i.e., at pulse energies of several hundred millijoules and repetition rates of typically 1 to 50 Hz. Note that even at 100 Hz operation, the energy stability is still 1% rms (see Fig. 5). This stable, high energy performance of the COMPexPro excimer series even at elevated repetition rates up to 100Hz is unprecedented. An integrated burst generator also enables bursts of pulses with precise energy, from the first to the last pulse of each burst.

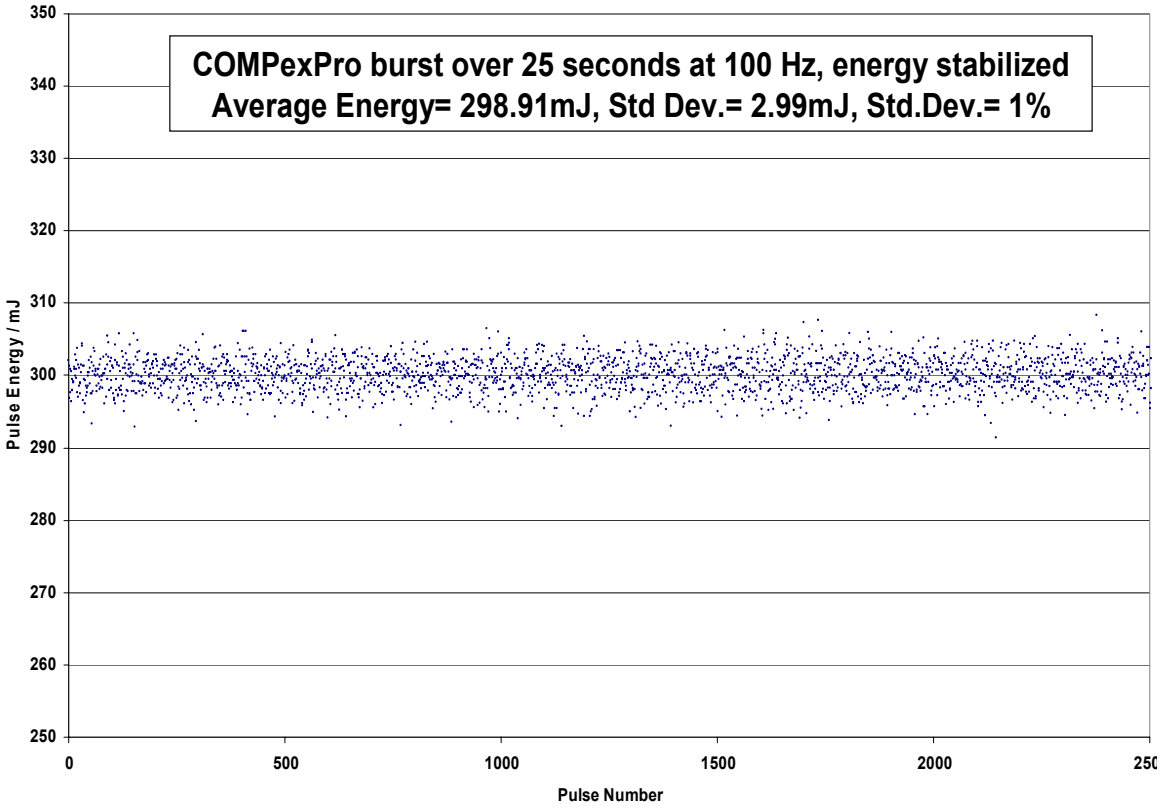

Fig. 5: Burst over 2500 pulses obtained with COMPexPro 110 at 248nm at a repetition rate of 100Hz.

3.1.2 Energy density and spot size

A lack in pulse energy on first sight migh be compensated by tighter focusing. However, this leads to limitations in ablation and hence film quality.
In fact, in PLD the excimer beam is not simply focused, as is shown in figure 6. Instead, the beam profile is preferably imaged onto the target surface in order to achieve clean ablation conditions from a flat-top, on-target energy distribution. Typically, the on-target image has a 1 to 5 mm^2 area. This demagnification is easily obtained with the COMPexPro 100 series and 200 series, which also provide a wide range of homogeneous on-target energy densities of 0.5J/cm^2 to 15J/cm^2, both at 248 nm and 193 nm wavelengths.

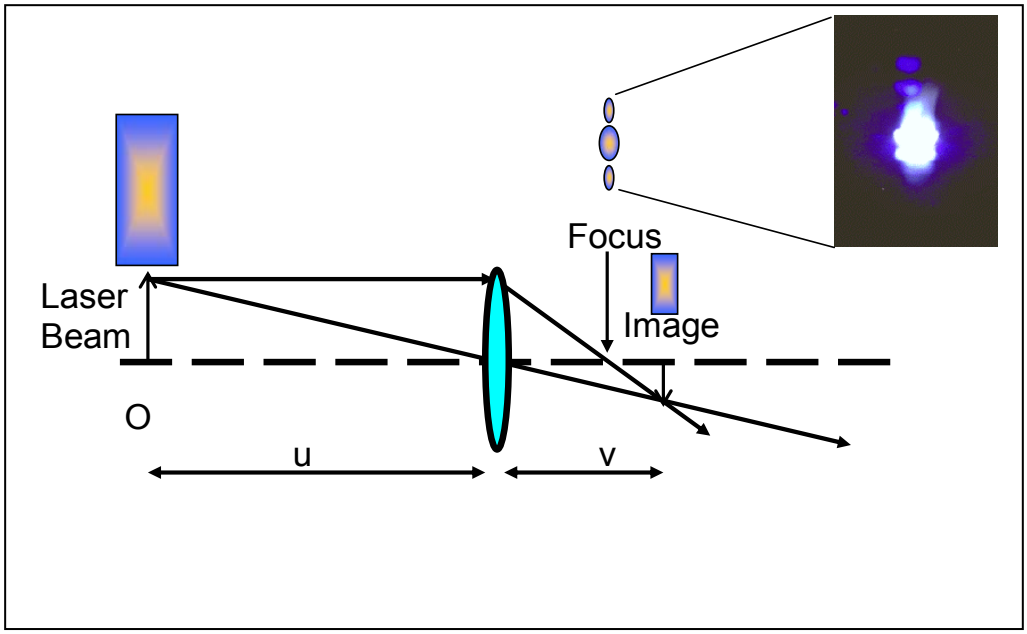

Fig. 6: Excimer laser beam imaging versus focusing in Pulsed Laser Deposition.

When the on-target laser spot size is decreased, the following problems occur: (1) the inhomogeneous on-target energy density distribution in the focal plane induces uncontrolled sub-surface boiling and liquid material splashing; (2) large particulate ejection also occurs; (3) the deposition rate becomes smaller and smaller as the spot size decreases, creating deposition times of an hour or longer; and (4) as the spot size decreases, the plasma plume becomes less directed (see fig. 9). The smaller and smaller spot sizes lead to an increasingly spherical plume geometry and a smaller fraction of material reaches the substrate, which is typically located at a 3 to 5 cm distance from the target.

nall spot size (lef

- **3.1.3 Beam homogeneity**

Due to direct imaging of the laser output beam on the target without the aid of homogenizers or diffractive optical elements spatial homogeneity is essential to achieve stoichiometric material transfer from target to substrate. Only a homogeneous flat-top energy distribution of the excimer laser beam imaged down to a homogeneous area of ca. 2mm^2 onto the target can avoid uncontrolled sub-surface boiling, splashing and material cracking, which otherwise results from energy density fluctuations across the ablation area. Excimer lasers have typically a rectangular beam profile, whereas the long axis has a top head and the short axis has a gaussian like shape. The highly homogeneous spatial distribution of the COMPexPro beam profile obtained from a single shot exposure 70cm behind the laser exit at 400mJ pulse energy is shown in

Figure 8, The short axis cross-section showing a near-gaussian distribution, the long axis the flat-top distribution. Due to the efficient and smooth ceramic preionization scheme in COMPexPro and LPXPro lasers this high homogeneity is maintained at high pulse energy operation.

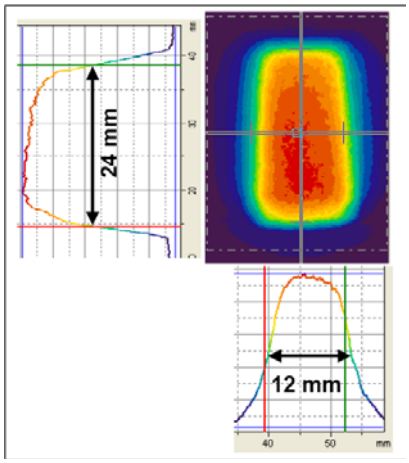

Figure 8: Homogeneous beam profile of the COMPexPro excimer laser, with typical dimensions of 24 mm (FWHM, long axis) by 12 mm (FWHM, short axis). The short axis has a gaussian like distribution, whereas the long axis is flat top.

Table 2 summarizes the main specifications of the COMPexPro and LPXPro excimer lasers for wavelengths of 193 nm and 248nm.

	COMPexPro		LPXPro	
Wavelength	193 nm	248 nm	193 nm	248 nm
Maximum pulse energy	400 mJ	700 mJ	650 mJ	1200 mJ
Average power	12 W	30 W	50 W	90 W
Maximum repetition rate	100 Hz	100Hz	200 Hz	200 Hz
Energy stability (typical, sigma)	< 2 %	< 1 %	< 2 %	< 1 %
Beam size (FWHM, v x h, typ.)	24 x 10 mm²	24 x 12 mm²	10 x 24 mm²	12 x 24 mm²
Divergence (FWHM, v x h, typ.)	3 x 1 mrad²	3 x 1 mrad²	3 x 1 mrad²	3 x 1 mrad²
Beam pointing stability (1 sigma)	< 200 µrad	< 200 µrad	< 50 µrad	< 50 µrad
Pulse Length (typical, FWHM)	13 ns	20 ns	13 ns	20ns

- **4. Thin Film Applications**

With proper focusing conditions the fluence of the excimer laser beam is sufficiently intense to vaporize any hard and transparent target material lending maximum flexibility in terms of the material spectrum which is to be ablated. On account of the unique lateral resolution of 2 µm achievable with short-wavelength excimer laser based ablation systems as well as of the high depth resolution reaching down to 0.1 µm, excimer lasers are extensively used in high-precision marking, surface treatment, micro patterning and micromachining to name but a few. Due to the unique spectral properties of excimer lasers, composites and alloys can be evenly ablated without fractionation of the different constituents. Excimer lasers are hence the first-choice ablation sources to be employed in creating thin films by means of the pulsed laser deposition technique (PLD). In this particularly straightforward method a pulsed excimer laser beam focused on the target leads to rapid evaporation of the target material. The vaporized material recoils perpendicularly to the target surface in a highly directed so-called plasma plume consisting of excited and ionized species. The plume particulates

evolve at high-speed toward the substrate which is typically located at some centimeters distance where they deposit and grow forming a thin film.
The PLD method is straightforward and only a few parameters including pressure, energy density and pulse repetition rate of the excimer laser need to be controlled during the process of thin film creation. The targets used in PLD are small compared with the large size required for other sputtering techniques. Multi-layered films of different materials are easily produced by sequential ablation of assorted targets on a rotating disk. By adapting the number of pulses, accurate control of film thickness down to atomic monolayer is possible. With the short wavelength excimer laser light the stoichiometry of the target like the crystal structure of the target can be retained. A recent overview over latest PLD developments is given in reference[4].

• 5. Conclusion

The advanced high-pulse energy excimer laser series LPXPro and COMPexPro have been described in this paper. Based on proven technologies applied for industrial and lithography excimer laser sources, stable and cost-efficient, high-pulse energy lasers fitted to thin film production demands have been realized. The COMPexPro and LPXPro lasers deliver pulse energies up to 1200 mJ with high stability and beam homogeneity over many 10 million pulses hands-off operation at the preferred laser wavelengths of 193 and 248 nm.

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Research and Development in Pulsed Laser Deposition: A Scientometric Perspective

Ganesh Surwase, B.S. Kademani and Vijai Kumar
Scientific Information Resource Division, Knowledge Management Group
Bhabha Atomic Research Centre, Mumbai-400 085 (India)
E-mail: bskademani@yahoo.co.in; bsk@barc.gov.in

This paper attempts to highlight quantitatively the growth and development of world literature in the field of Pulsed Laser Deposition in terms of publication output as per Science Citation Index (1982-2006). During 1982-2006 a total of 8534 papers were published by the scientists in the field 'Pulsed Laser Deposition'. The average number of publications published per year was 341.36. The highest number of papers 1074 were published in 2005. There were 84 countries involved in the research in this field. USA is the top producing country with 2014 publications (19.35%) followed by Japan with 1553 publications (14.92%), Peoples-R-China with 1106 publications (10.63%), Germany with 763 publications (7.33%) South Korea with 694 publications (6.67%) and France with 615 publications (5.91%). India ranked 9th among other countries with 291 publications during 1985-2006. Authorship and collaboration trend was towards multi-authored papers. There were 8338 (97.70%) multi-authored publications and 196 (2.30 %) single authored publications. Chinese Academy of Sciences (Peoples-R-China) topped the list with 304 publications followed by Nanjing University (Peoples-R-China) with 244 publications, Tokyo Institute of Technology (Japan) with 233 publications and CNRS (France) with 217 publications. The most productive Indian institutions were: Tata Institute of Fundamental Research, Mumbai with 52 publications and Indian Institute of Science, Bangalore with 49 publications. The most prolific Indian authors were: R. Pinto (Indian-Inst-Technol-Bomaby, Mumbai) with 38 publications, M.S. Hegde (Indian-Inst-Sci, Bangalore) with 31 publications, S.B. Ogale (Univ Poona, Poona) with 29 publications, L.M. Kukreja (Raja Ramanna Ctr-Adv-Technol, Indore) with 21 publications, P. Misra (Raja Ramanna Ctr-Adv-Technol, Indore) with 16 publications, R.K. Thareja (Indian-Inst-Technol-Kanpur) with 15 publications. The most preferred journals by the scientists were: *Applied Physics Letters* with 962 publications, *Journal of Applied Physics* with 714 publications, *Applied Surface Science* with 614 publications and *Thin Solid Films* with 541 publications. The high frequency keywords were: Pulsed Laser Deposition (3661), Thin Films (2611), Laser Ablation (1137), Films (571) and Silicon (562).

Introduction

Invention of laser in 1960 has opened up new areas of research and found various applications in many scientific fields. Pulsed Laser Deposition (PLD) is one of the several techniques of the deposition of the thin film on the substrates besides other techniques like Molecular Beam Epitaxy (MBE), Metal Organic Chemical Vapour Deposition (MOCVD) and Sputtering[1-2]. The Pulsed Laser Deposition has several advantages over other deposition techniques. There are several applications of the thin films developed because of its helpful technique in developing quantum dots and quantum wells of several sizes and shapes.

Pulsed Laser Deposition as a film growth technique has gained importance and attracted wide spread interests after it has been used successfully to grow high-temperature Tc superconducting films[3] in 1987. During the last decade, Pulsed Laser Deposition has been used to fabricate crystalline thin films with epitaxy quality. Ceramic oxide, nitride films, metallic multilayers, and various super-lattices grown by Pulsed Laser Deposition have been demonstrated. It has been reported in the literature that Pulsed Laser Deposition is being used to synthesise nanotubes[4], nanopowders[5] and quantum dots[6].

Evaluation is a key component of any research and development activity. One well known productivity indicator is the number of publications produced by the scientists, institutions and

countries. Studies like this will provide some insight into the complex dynamics of research activity and enable the scientists, policy makers and science administrators to provide adequate facilities and proper guidance in which direction the research has to be conducted.

Research publications are clearly one of the quantitative measures for the basic research activity in a country. It must be added, however, that what excites the common man, as well as the scientific community, are the peaks of scientific and technological achievement, not just the statistics on publications. There are also other kinds of research and technology development-mission oriented, industry-oriented, country-specific, etc., and progress in these cannot be obviously measured by counting only the number of publications[7]. Many scientometric studies have appeared in the literature to focus on the performance of science in various domains[8-21].

Objectives

The main objective of the study is to present the growth of world literature in Pulsed Laser Deposition and make the quantitative assessment of the research in terms of year-wise research output, geographical distribution of research output, nature of collaboration, characteristics of highly productive institutions, the characteristics of references cited in the publications and publications with more number of references in the field, the channels of communications used by the scientists, and the high frequency keywords appeared in the Key-Words-Plus and Author-Keywords field in the SCI.

Materials and Methods

Data was collected from the Science Citation Index-On Disc (CD-ROM) (1982-2006) published by a division of the Thomson Corporation (formerly Institute of Scientific Information, Philadelphia). Science Citation Index is one of the very comprehensive databases covering all aspects of science. The study period (1982-2006) is selected as the database is available in machine readable form since 1982. The search string 'PULSED LASER DEPOSIT* OR PULSE LASER DEPOSIT*' in the 'BASIC INDEX' field of SCI was used for the years 1982-2006 to download the records on the subject 'Pulsed Laser Deposition'. A total of 8534 records were downloaded and analysed by using the spreadsheet application as per the objectives of the study.

Results and Discussion

Growth of Publications in Pulsed Laser Deposition

During 1982-2006 a total of 8534 publications were published in Pulsed Laser Deposition by various countries. The average number of publications produced per year were 341.36. The highest number of publications 1074 were produced in 2005. Figure–1 gives year-wise growth and collaboration rate in Pulsed Laser Deposition. It can be clearly visualized from the figure that growth of the literature was very low during 1982-1990 and it peaked during 1991-2006. It indicates that research in Pulsed Laser Deposition received a major impetus during this period.

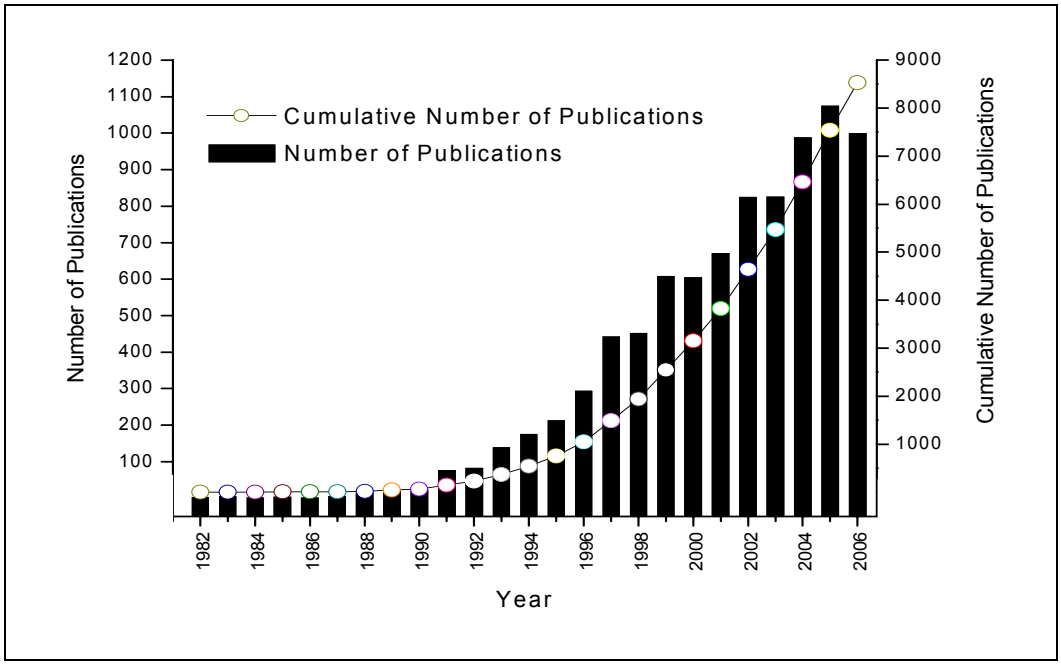

Figure-1: Year-wise publication productivity growth in PLD research

An exponential growth in number of publications was observed during 1982-2006. The highest growth rate (1154.55%) was found during 1987-1991 with 138 publications followed by (552.17%) with 900 publications during 1992-1996, (208.44%) with 2776 publications during 1997-2001 and (69.63%) with 4709 publications during 2002-2006. Table-1 gives the growth rate of publications in Pulsed Laser Deposition research in different five year blocks.

Table-1: Growth rate of publications in different five-year blocks in PLD research

Five Year Blocks	Number of Publications	Growth Rate (1982-2006)
1982-1986	11	-
1987-1991	138	1154.55
1992-1996	900	552.17
1997-2001	2776	208.44
2002-2006	4709	69.63

Geographical Distribution or Research Output

There were as many as 84 countries carrying out research in the field of Pulsed Laser Deposition and produced 10409 authorships. Figure-2 provides a list of countries whose research output is more than 50 publications. USA is the top producing country with 2014 publications (19.35%), followed by Japan with 1553 publications (14.92%), Peoples-R-China with 1106 publications (10.63%) Germany with 763 publications (7.33%), France with 615 publications (5.91%). Italy with 336 publications (3.49%), England with 297 publications (2.85%), India with 291 publications (2.80%) and Spain with 253 publications (2.43%).

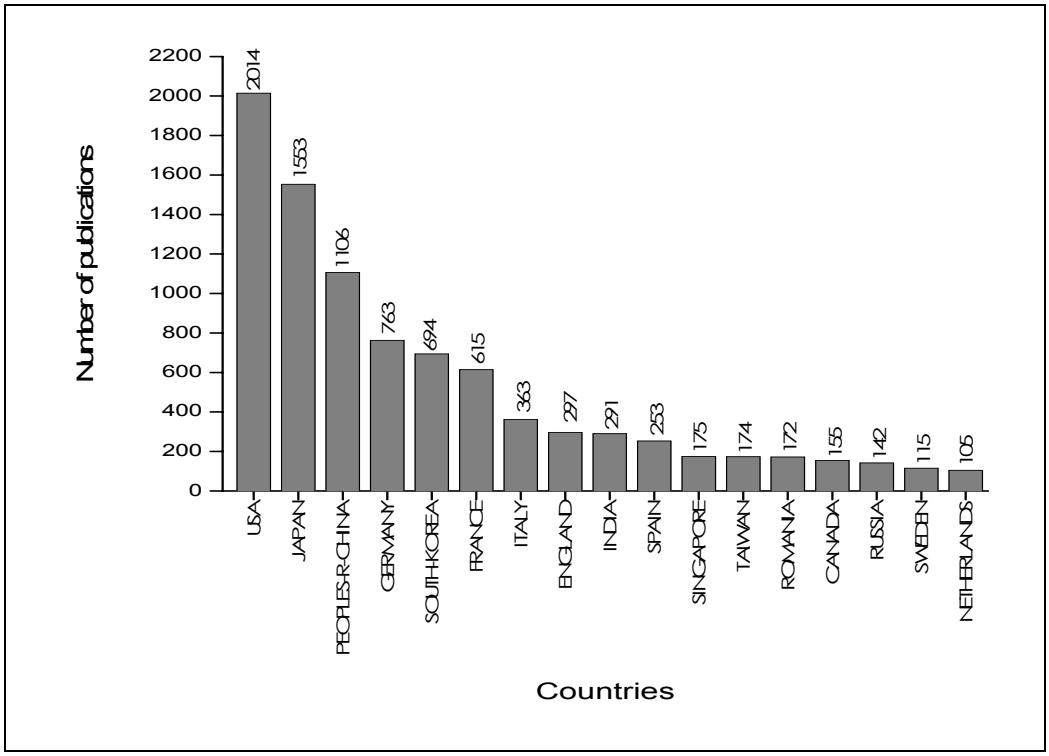

Figure-2: Country-wise distribution of number of publications (≥100) in PLD research (during the years 1982-2006 as per SCI database)

International Collaboration

Table-2 gives the country-wise collaboration trend in Pulsed Laser Deposition research. Out of 8534 publications 1587 publications had international collaboration. Bilateral collaboration was found with 1335 (84.12%) publications and 205 (12.92%) publications had collaboration with three countries.

Table-2: Country-wise collaboration trend in PLD research

Collaborating Countries	Number of Publications	Percentage
2	1335	84.12
3	205	12.92
4	38	2.39
5	8	0.50
6	1	0.06
Total	1587	100.00

Authorship and Collaboration Pattern

Authorship and collaboration trend in Pulsed Laser Deposition research is given in Figure-3. Authorship and collaboration trend was towards multi-authored papers. As there were 8338 (97.70%) multi-authored publications. Only 196 (2.30%) were single-authored publications. Four authored publications (1622) accounted for 19.01 percent, followed by five authored publications (1519) with 17.80 percent, three authored publications (1268) with 14.86 percent, six authored publications (1179) with 13.82 percent and seven authored publications (785) with 9.20 percent.

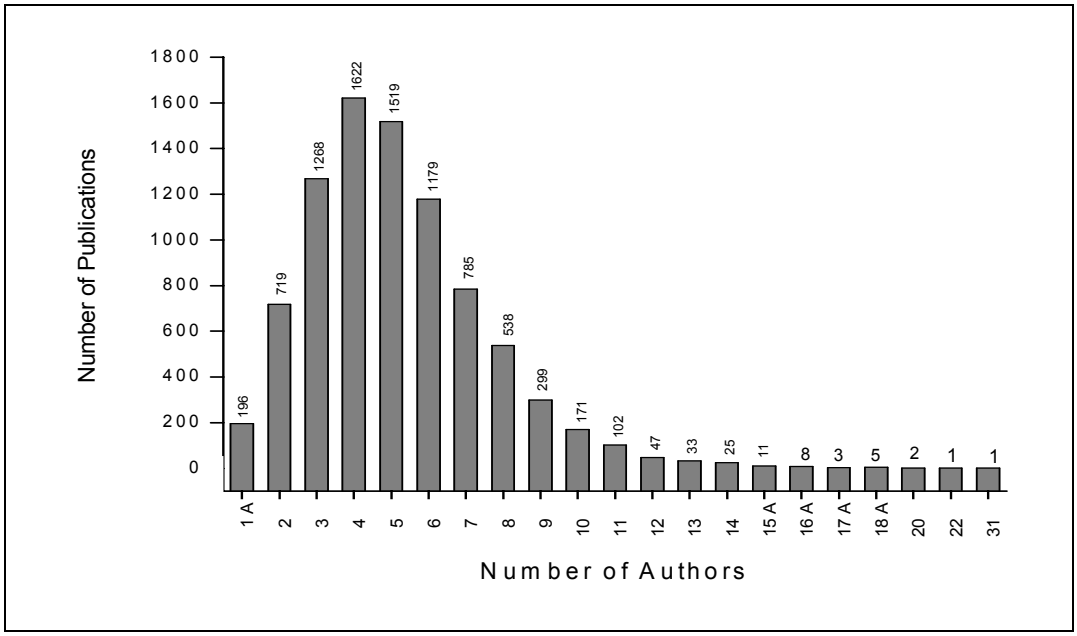

Figure-3: Authorship and collaboration trend in PLD research

Organisation-wise Distribution of Publications

In all, there were 2035 organizations involved in the research in Pulsed Laser Deposition. Table-3 shows the organizations that have contributed 50 or more publications during 1982-2006. Chinese Academy of Science (Peoples-R-China) topped the list with 304 publications followed by Nanjing University (Peoples-R-China) with 244 publications, Tokyo Institute of Technology (Japan) with 233 publications and Centre National De La Recerche Scientifique (CNRS) (France) with 217 publications.

Table-3: Distribution of institutions as per number of publications (≥50) in PLD research

Sl. No.	Institute	Country	Publications
1	CHINESE ACAD SCI	PEOPLES-R-CHINA	304
2	NANJING UNIV	PEOPLES-R-CHINA	244
3	TOKYO INST TECHNOL	JAPAN	233
4	CENTRE NATIONAL DE LA RECERCHE SCIENTIFIQUE (CNRS)	FRANCE	217
5	OSAKA UNIV	JAPAN	196
6	UNIV TOKYO	JAPAN	161
7	OAK RIDGE NATL LAB	USA	158
8	CONSEJO SUPER INVEST CIENTIFICAS	SPAIN	152
9	CONSIGLIO NAZIONALE DELLE RICERCHE (CNR)	ITALY	148
10	UNIV MARYLAND	USA	145
11	NATL UNIV SINGAPORE	SINGAPORE	138
12	LOS ALAMOS NATL LAB	USA	135
13	UNITED STATES NAVY	USA	129
14	UNIV FLORIDA	USA	124
15	INT SUPERCONDUCT TECHNOL CTR	JAPAN	118
16	N CAROLINA STATE UNIV	USA	116
17	HONG KONG POLYTECH UNIV	PEOPLES-R-CHINA	114
18	UNIV PARIS	FRANCE	109
19	TOHOKU UNIV	JAPAN	103
20	YONSEI UNIV	SOUTH-KOREA	101
21	MAX PLANCK INST MICROSTRUCT PHYS	GERMANY	97
22	PENN STATE UNIV	USA	97

23	SEOUL NATL UNIV	SOUTH-KOREA	91
24	UNITED STATES AIR FORCE	USA	87
25	NATL INST ADV IND SCI & TECHNOL	JAPAN	85
26	NATL INST LAERS PLASMA & RADIAT PHYS	ROMANIA	81
27	NAGOYA UNIV	JAPAN	80
28	NATL TSING HUA UNIV	TAIWAN	80
29	UNIV LEIPZIG	GERMANY	80
30	NATL INST MAT SCI	JAPAN	79
31	ROYAL INST TECHNOL	SWEDEN	79
32	UNIV CAMBRIDGE	ENGLAND	77
33	UNIV CALIF BERKELEY	USA	76
34	ACAD SCI CZECH REPUBL	CZECH-REPUBLIC	75
35	FUDAN UNIV	PEOPLES-R-CHINA	74
36	JAPAN SCI & TECHNOL CORP	JAPAN	74
37	KYOTO UNIV	JAPAN	74
38	KYUSHU UNIV	JAPAN	73
39	ELECTR & TELECOMMUN RES INST	SOUTH-KOREA	72
40	RUSSIAN ACAD SCI	RUSSIA	71
41	INST FESTKORPER & WERKSTOFFORSCH DRESDEN	GERMANY	68
42	NAGOYA INST TECHNOL	JAPAN	66
43	UNIV TWENTE	NETHERLANDS	61
44	POHANG UNIV SCI & TECHNOL	SOUTH-KOREA	56
45	INRS ENERGIE & MAT	CANADA	55
46	QUEENS UNIV BELFAST	NORTH-IRELAND	54
47	INSTITUTO NAZIONALE PER LA FISICA DELLA MATERIA (INFM)	ITALY	53
48	TATA INST FUNDAMENTAL RES	INDIA	52
49	UNIV HOUSTON	USA	51
50	UNIV ROMA TOR VERGATA	ITALY	51
51	PUKYONG NATL UNIV	SOUTH-KOREA	50

Most Prolific Indian Authors

There were 673 authors in Indian publications who have published 291 publications with 1423 authorships. The most prolific Indian authors were: R. Pinto (Indian-Inst-Technol-Bomaby, Mumbai) with 38 publications, M.S. Hegde (Indian-Inst-Sci, Bangalore) with 31 publications, S.B. Ogale (Natl-Chem-Lab, Poona) with 29 publications, L.M. Kukreja (Raja Ramanna Ctr-Adv-Technol, Indore) with 21 publications, P. Misra (Raja Ramanna Ctr-Adv-Technol, Indore) with 16 publications, R.K. Thareja (Indian-Inst-Technol-Kanpur) with 15 publications. Table-4 provides the list of authors who have contributed 5 or more publications.

Table-4: Most prolific Indian authors in PLD reseach
(as per SCI database 1982-2006)

Sl. No.	Author	Affialiation	Number of Publications
1	Pinto-R	INDIAN-INST-TECHNOL-BOMABY, MUMBAI	38
2	Hegde-MS	INDIAN-INST-SCI, BANGALORE	31
3	Ogale-SB	NATL-CHEM-LAB, POONA	29
4	Kukreja-LM	RAJA RAMANNA CTR-ADV-TECHNOL, INDORE	21
5	Misra-P	RAJA RAMANNA CTR-ADV-TECHNOL, INDORE	16
6	Thareja-RK	INDIAN-INST-TECHNOL-KANPUR	15
7	Joseph-M	INDIRA-GANDHI-CTR-ATOM-RES, KALPAKKAM	12
8	Kanetkar-SM	UNIV POONA, POONA	12
9	Manoravi-P	INDIRA-GANDHI-CTR-ATOM-RES, KALPAKKAM	12
10	Apte-PR	TATA-INST-FUNDAMENTAL-RES, MUMBAI	11
11	Chaudhari-SM	UNIV POONA, POONA	11
12	John-J	TATA-INST-FUNDAMENTAL-RES, MUMBAI	10
13	Krupanidhi-SB	INDIAN-INST-SCI, BANGALORE	10
14	Kumar-R	CTR-NUCL-SCI, DIV MAT SCI, NEW-DELHI	10

15	Pai-SP	TATA-INST-FUNDAMENTAL-RES, MUMBAI	10
16	Vispute-RD	UNIV POONA, POONA	10
17	Hussain-OM	SRI-VENKATESWARA-UNIV, TIRUPATI	9
18	Patil-SI	UNIV POONA, POONA	9
19	Satyalakshmi-KM	INDIAN-INST-SCI, BANGALORE	9
20	Adhi-KP	UNIV POONA, POONA	8
21	Malik-SK	TATA-INST-FUNDAMENTAL-RES, MUMBAI	8
22	Prasad-V	INDIAN-INST-SCI, BANGALORE	8
23	Subramanyam-SV	INDIAN-INST-SCI, BANGALORE	8
24	Godbole-VP	UNIV POONA, POONA	7
25	Karunagaran-B	BHARATHIAR-UNIV, COIMBATORE	7
26	Lekshmi-IC	INDIAN-INST-SCI, BANGALORE	7
27	Mangalaraj-D	BHARATHIAR-UNIV, COIMBATORE	7
28	Narayandass-SK	BHARATHIAR-UNIV, COIMBATORE	7
29	Ramachandra Rao-MS	INDIAN-INST-TECHNOL-MADRAS, CHENNAI	7
30	Ramamoorthy-K	ALAGAPPA UNIVERSITY, KARAIKUDI	7
31	Sankaranarayanan-K	ALAGAPPA UNIVERSITY, KARAIKUDI	7
32	Sharon-M	BIRLA COLLEGE, KALYAN	7
33	Bhattacharya-P	RAJA RAMANNA CTR-ADV-TECHNOL, INDORE	6
34	Budhani-RC	INDIAN-INST-TECHNOL-KANPUR, KANPUR	6
35	Gupta-LC	TATA-INST-FUNDAMENTAL-RES, MUMBAI	6
36	Gupta-V	UNIV DELHI, DELHI	6
37	Koinkar-VN	UNIV POONA, POONA	6
38	Kumar-RTR	BHARATHIAR-UNIV, COIMBATORE	6
39	Ramana-CV	SRI-VENKATESWARA-UNIV, TIRUPATI	6
40	Raychaudhuri-P	TATA-INST-FUNDAMENTAL-RES, MUMBAI	6
41	Vasanthacharya-NY	INDIAN-INST-SCI, BANGALORE	6
42	Venimadhav-A	INDIAN-INST-SCI, BANGALORE	6
43	Venkatesan-T	UNIV POONA, POONA	6
44	Vitta-S	INDIAN-INST-TECHNOL-BOMABY, MUMBAI	6
45	Choudhary-RJ	UNIV POONA, POONA	5
46	Date-SK	UNIV POONA, POONA	5
47	Ganguli-T	RAJA RAMANNA CTR-ADV-TECHNOL, INDORE	5
48	Gayen-A	INDIAN-INST-SCI, BANGALORE	5
49	James-AR	SOLID-STATE-PHYS-LAB, DELHI	5
50	Jayachandran-M	CENT-ELECTROCHEM-RES-INST, KARAIKKUDI	5
51	Kshirsagar-ST	NATL-CHEM-LAB, PUNE	5
52	Kundaliya-DC	TATA-INST-FUNDAMENTAL-RES, MUMBAI	5
53	Manoharan-SS	INDIAN-INST-SCI, BANGALORE	5
54	Prakash-C	SOLID-STATE-PHYS-LAB, DELHI	5
55	Purandare-SC	TATA-INST-FUNDAMENTAL-RES, MUMBAI	5
56	Sanjeeviraja-C	ALAGAPPA UNIVERSITY, KARAIKUDI	5

Year-wise Distribution of Indian Contribution in Pulsed Laser Deposition

Year-wise distribution of Indian contribution in the field of Pulsed Laser Deposition is given in Figure-4. There were 291 publications published during 1985-2006. There was only one publication in 1985. No publications were published during 1986-1987. The highest number of publications (41) were published in the years 2003 and 2005 respectively. The average number of publications per year was 13.22.

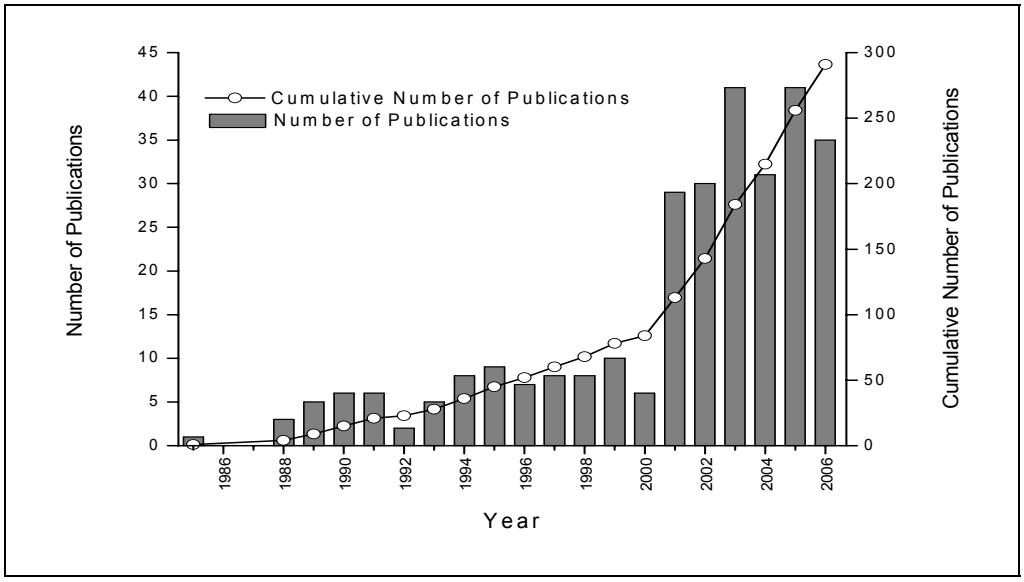

Figure-4: Year-wise distribution of Indian publications in PLD research

Distribution of Indian Institutions in Pulsed Laser Deposition

There were 73 research institutes and universities involved in research in pulsed laser deposition. The leading institutes were Tata Institute of Fundamental Research, Mumbai with 52 publications, Indian Institute of Science, Bangalore with 49 publications, University of Poona, Poona with 38 publications, Indian Institute of Technology, Kanpur with 28 publications, Raja Ramanna Centre for Advanced Technology, Indore with 24 publications and Indira Gandhi Centre for Atomic Research, Kalpakkam with 18 publications. Table-5 provides a list of prominent Indian research institutes which had published five or more publications.

Table-5: Distribution of Indian Research Institutes in PLD research

Sl. No.	Institute	Publications
1	TATA INST FUNDAMENTAL RES, MUMBAI	52
2	INDIAN INST SCI, BANGALORE	49
3	UNIV POONA, POONA	38
4	INDIAN INST TECHNOL KANPUR	28
5	RAJA RAMANNA CTR ADV TECHNOL, INDORE	24
6	INDIRA GANDHI CTR ATOM RES, KALPAKKAM	18
7	CTR NUCL SCI, NEW DELHI	13
8	INDIAN INST TECHNOL BOMBAY	13
9	INDIAN INST TECHNOL MADRAS	10
10	IUC DAE FACIL, INDORE	10
11	NATL CHEM LAB, POONA	10
12	SRI VENKATESWARA UNIV, TIRUPATI	10
13	UNIV DELHI, DELHI	10
14	BHABHA ATOM RES CTR, MUMBAI	9
15	SOLID STATE PHYS LAB, NEW DELHI	9
16	ALAGAPPA UNIV, KARAIKKUDI	8
17	BHARATHIAR UNIV, COIMBATORE	7
18	COCHIN UNIV SCI & TECHNOL, COCHIN	7
19	SAURASHTRA UNIV, RAJKOT	7
20	UNIV HYDERABAD, HYDERABAD	7
21	NATL PHYS LAB, NEW DELHI	6
22	CENT ELECTROCHEM RES INST, KARAIKKUDI	5
23	INDIAN ASSOC CULTIVAT SCI, KOLKATA	5

Preference of Channels of Communication by Scientists

Scientists communicated their publications through variety of communications channels. Table-6 depicts that 97.25 percent of the literature was published in journal articles followed by reviews 1.34 percent, notes 0.46 percent and letters 0.42 percent.

Table-6: Distribution of publications in various channels of communication

Document Type	Publications	Percentage
Articles	8299	97.25
Reviews	114	1.34
Notes	39	0.46
Letters	36	0.42
Meeting-Abstracts	27	0.32
Corrections	11	0.13
Editorial-Materials	4	0.05
News-Items	4	0.05
Total	8534	100

Preference of Journals for Communication by Scientists

The distribution of publications were spread over 315 journals. The leading journals preferred by the scientists were *Applied Physics Letters* with 962 publications followed by *Journal of Applied Physics* with 714 publications, *Applied Surface Science* with 614 publications, *Thin Solid Films* with 541 publications, *Physica* C with 432 publications, *Applied Physics- A* with 320 publications and *Japanese Journal of Applied Physics-I* with 269 publications. Table-7 provides journal-wise scattering of publications. More than 92 percent of the publications were published in the journals with impact factors ranging from 0.01 to 32.18. This indicates that the publication behaviour of scientists who preferred to publish their publications in high impact-factor journals. About 22.43 percent of the publications were published in the journals having no impact-factor. The distribution of journals as per impact factors range is given in the Figure-5.

Table-7: Journals publishing articles (≥50) in PLD research

Sl. No.	Journal	Country	IF-2005	Publications
1	APPLIED PHYSICS LETTERS	USA	4.127	962
2	JOURNAL OF APPLIED PHYSICS	USA	2.498	714
3	APPLIED SURFACE SCIENCE	NETHERLANDS	1.263	614
4	THIN SOLID FILMS	SWITZERLAND	1.569	541
5	PHYSICA -C	NETHERLANDS	0.948	432
6	APPLIED PHYSICS -A	USA	1.990	320
7	JAPANESE JOURNAL OF APPLIED PHYSICS -I	JAPAN	-	269
8	PHYSICAL REVIEW- B	USA	3.185	196
9	JOURNAL OF CRYSTAL GROWTH	NETHERLANDS	1.681	193
10	IEEE TRANSACTIONS ON APPLIED SUPERCONDUCTIVITY	USA	1.071	177
11	SUPERCONDUCTOR SCIENCE & TECHNOLOGY	ENGLAND	1.896	177
12	INTEGRATED FERROELECTRICS	ENGLAND	0.345	161
13	JOURNAL OF MATERIALS RESEARCH	USA	2.104	155
14	JOURNAL OF VACUUM SCIENCE & TECHNOLOGY- A	USA	1.399	137
15	SURFACE & COATINGS TECHNOLOGY	SWITZERLAND	1.646	135
16	MATERIALS SCIENCE AND ENGINEERING- B	SWITZERLAND	-	127
17	JOURNAL OF THE KOREAN PHYSICAL SOCIETY	SOUTH KOREA	0.828	122
18	DIAMOND AND RELATED MATERIALS	SWITZERLAND	1.988	113
19	JAPANESE JOURNAL OF APPLIED PHYSICS - II	JAPAN	-	112
20	JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS	NETHERLANDS	0.985	104

21	FERROELECTRICS	ENGLAND	0.459	96
22	SOLID STATE COMMUNICATIONS	ENGLAND	1.489	94
23	JOURNAL OF PHYSICS- D	ENGLAND	1.957	90
24	MATERIALS LETTERS	NETHERLANDS	1.299	67
25	JOURNAL OF PHYSICS-CONDENSED MATTER	ENGLAND	2.145	64
26	NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH - B	NETHERLANDS	-	56
27	IEEE TRANSACTIONS ON MAGNETICS	USA	1.014	53
28	JOURNAL OF THE ELECTROCHEMICAL SOCIETY	USA	2.190	53
29	MATERIALS SCIENCE FORUM	SWITZERLAND	0.399	52

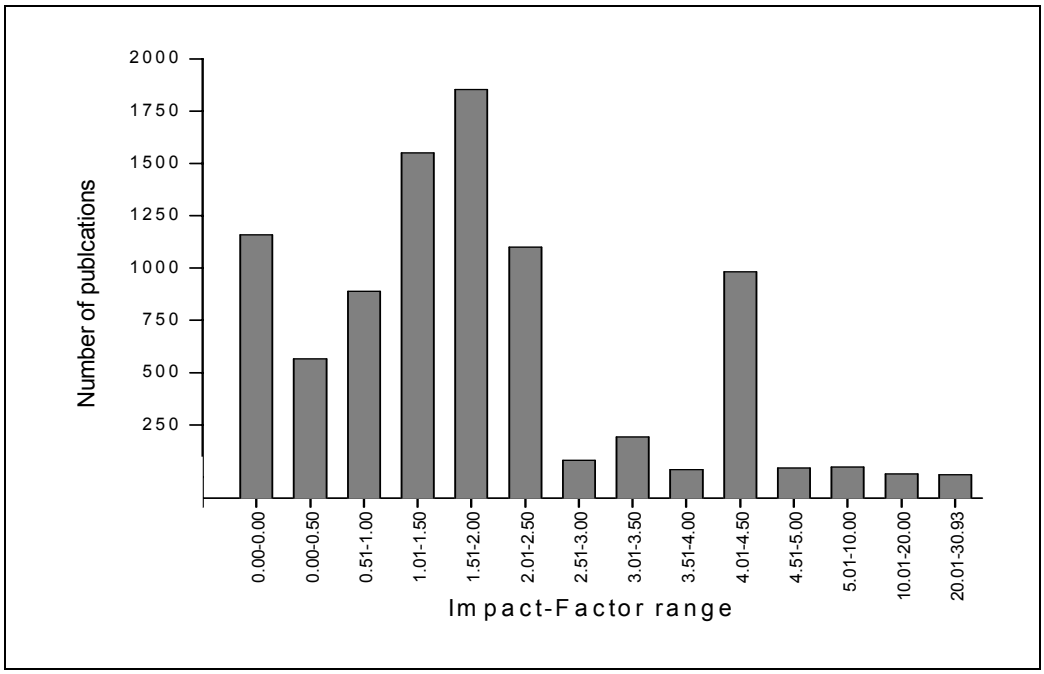

Figure-5: Impact-factor range and distribution of journals publishing articles in PLD research

Country-wise Distribution of Journals

The Journals (315) publishing articles in Pulsed Laser Deposition research were spread over 20 countries. Table-8 gives country-wise distribution of journals and publications. USA has published 3300 (38.67%) publications in 102 (31.29%) journals, publications followed by England with 1257 (14.73%) publications in 83 (25.46%) journals, Netherlands with 1854 (21.72%) publications in 46 (14.11%) journals, Switzerland with 1176 (13.78%) publications in 22 (6.75%) journals and Germany with 129 (1.51%) publications in 21 (6.44%).

Table-8: Country-wise distribution of journals publishing articles in PLD research

Journal publishing country	Number of journals	Percentage	Number of publications	Percentage
USA	102	31.29	3300	38.67
ENGLAND	83	25.46	1257	14.73
NETHERLANDS	46	14.11	1854	21.72
SWITZERLAND	22	6.75	1176	13.78
GERMANY	21	6.44	129	1.51
FRANCE	10	3.07	64	0.75
JAPAN	10	3.07	427	5.00
PEOPLES R CHINA	9	2.76	51	0.60
RUSSIA	4	1.23	6	0.07
SOUTH KOREA	4	1.23	131	1.54
SINGAPORE	3	0.92	76	0.89

AUSTRIA	2	0.61	4	0.05
INDIA	2	0.61	9	0.11
POLAND	2	0.61	13	0.15
CANADA	1	0.31	1	0.01
CZECHREPUBLIC	1	0.31	17	0.20
ITALY	1	0.31	4	0.05
MEXICO	1	0.31	6	0.07
ROMANIA	1	0.31	1	0.01
TAIWAN	1	0.31	8	0.09
Total	326	100	8534	100

Language-wise Distribution of Publications

Table-9 depicts the language-wise distribution of publications in Pulsed Laser Deposition. English was the most predominant language with 8468 (99.23%) publications, followed by Chinese with 36 (0.42%) publications, Japanese with 14 (0.16%), French 184 0.430%) publications, Russian with 9 (0.07%) publications and Spanish with 1 (0.01%) publications.

Table-9: Language-wise distribution of publications

Language	Publications	Percentage
English	8468	99.23
Chinese	36	0.42
Japanese	14	0.16
French	9	0.11
Russian	6	0.07
Spanish	1	0.01
Total	8534	100

Distribution of Keywords

Keywords are one of the best scientometric indicators to understand and grasp instantaneously the thought content of the papers and to find out the growth of the subject field. By analyzing the keywords appeared either in the title or assigned by the indexer or the author himself help in knowing in which direction the knowledge grows. The high frequency keywords will enable us to understand what are all the aspects that have been studied. In the current study the keywords appeared in the Key-Words-Plus field and Author Keywords in SCI were analysed for the purpose. The high frequency keywords were: Table-10 lists the keywords appeared 100 or more times in the Key Word Plus field and Author Keywords in SCI.

Table-10: Keywords with ≥ 100 frequencies appeared in Key-Word-Plus field and Author-Keywords in SCI in PLD research

Keyword	Frequency
PULSED LASER DEPOSITION	3661
THIN FILMS	2611
LASER ABLATION	1137
FILMS	571
SILICON	562
DEPOSITION	478
CHEMICAL VAPOR DEPOSITION	436
TEMPERATURE	391
OXIDES	373
EPITAXIAL GROWTH	367
ZINC OXIDE	367
OPTICAL PROPERTIES	361
LAYERS	303

ELECTRICAL PROPERTIES	286
MICROSTRUCTURE	277
MOLECULAR BEAM EPITAXY	271
BUFFER LAYERS	263
SAPPHIRE	252
MAGNETORESISTANCE	243
SURFACE	225
EPITAXY	219
CAPACITORS	215
X RAY DIFFRACTION	210
DIELECTRIC PROPERTIES	200
PHOTOLUMINESCENCE	195
DIAMOND LIKE CARBON	186
EVAPORATION	183
ROOM TEMPERATURE	179
SUBSTRATE	179
CRITICAL CURRENT DENSITY	172
FABRICATION	171
BEHAVIOR	170
HETEROSTRUCTURES	170
COATINGS	162
SPECTROSCOPY	158
MGO	156
SRTIO3	154
DEPENDENCE	153
DEVICES	153
YBA2CU3O7 DELTA	150
ELECTRODES	149
SUPERLATTICES	146
SUPERCONDUCTORS	143
SYSTEM	142

LUMINESCENCE	139
MAGNETIC PROPERTIES	138
CRYSTALS	135
TRANSITION	134
CERAMICS	133
FATIGUE	133
INTERFACE	132
PEROVSKITES	130
SINGLE CRYSTALS	126
FERROELECTRIC THIN FILMS	123
AMORPHOUS CARBON	122
MEMORIES	122
SUPERCONDUCTIVITY	122
GIANT MAGNETORESISTANCE	119
EMISSION	116
MULTILAYERS	116
SEMICONDUCTORS	116
GRAPHITE	114
RESISTIVITY	111
OXYGEN	107
FERROELECTRIC PROPERTIES	106
PLASMA	106
COATED CONDUCTORS	105
ORIENTATION	105
PHASE	104
STRAIN	104
LASER DEPOSITION	103
GAN	102
TRANSPORT	101
MANGANITES	100

Conclusion

USA is the major producer of scientific output with 2014 publications to its credit in this field. Japan comes next with 1553 publications. The growth of the literature was very low during 1982-1990 which may be attributed for not receiving boost for research in this field. Since 1991, an exponential growth of publications was observed which indicates the sustained impetus received for the research during 1991-2006. Four countries (USA, Japan, Peoples-R-China and Germany) have contributed more than fifty percent of the total publications indicates that these countries have received tremendous official support for the research in this field. Collaboration trend is towards multi-authored papers. Chinese Academy of Sciences (Peoples-R-China) topped the list with 304 publications followed by Nanjing University (Peoples-R-China) with 244 publications, Tokyo Institute of Technology (Japan) with 233 publications and CNRS (France) with 217 publications. India ranked 9th among other countries with 291 publications during 1985-2006. The most productive Indian institutions were: Tata Institute of Fundamental Research, Mumbai with 52 publications and Indian Institute of Science, Bangalore with 49 publications. More than 92 percent of the publications were published in the journals with impact factors which is suggestive of the publications behaviour of scientists who preferred to publish their papers in highly reputed journals. Citation analysis of these papers may give interesting insights into the dynamics of this field.

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OPT1

Large Room Temperature Magnetization of Pulsed Laser Deposited Cobalt Ferrite Thin Film

Subasa C. Sahoo[1], M. Bohra[1], N.Venkataramani[2#], Shiva Prasad[1*], D. S. Misra[1] and R. Krishnan[3]

[1]Department of physics,Indian Institute of Technology Bombay Powai, Mumbai – 400076,
[2]Department of Metallurgical Engineering and Material Science, Indian Institute of Technology Bombay Powai, Mumbai – 400076,[3]Groupe d'étude de la matière condensée, CNRS / Universite de Versailles-St-Quentin, 45, avenue des Etats-Unis, 78035 Versailles Cedex, France
[*]Current Address: Director, Indo-French Centre for Promotion of Advanced Research, 5B, India Habitat Centre, New Delhi-110003
[#] Corresponding Author; ramani@iitb.ac.in

Pulsed laser deposition technique is a very convenient and successful method for the growth of a variety of thin films. We have deposited cobalt ferrite thin films using this technique from cobalt ferrite target. In this work, two films, one deposited at insitu substrate temperature (T_S) of 750 ºC (Film-1) and another deposited at ambient temperature and exsitu annealed at 750 ºC in air for two hours (Film-2) were studied. Single phase cobalt ferrite was observed by XRD in both the films. Fig.1 shows MH loops of both the films and that of the target used. The $4\pi M_S$ value of the Film-1 was found to be 3490G which is less than that value of 5360G of the target, which is generally expected in thin films. But in the Film-2 the $4\pi M_S$ value was found to be 5820G. Coercivity and M_R/M_S ratio were found to be 1.76kOe, 0.33 and 0.86kOe, 0.37 for Film-1 and Film-2 respectively. It was understood that insitu heating and external annealing affect the microstructure and hence the magnetic properties.

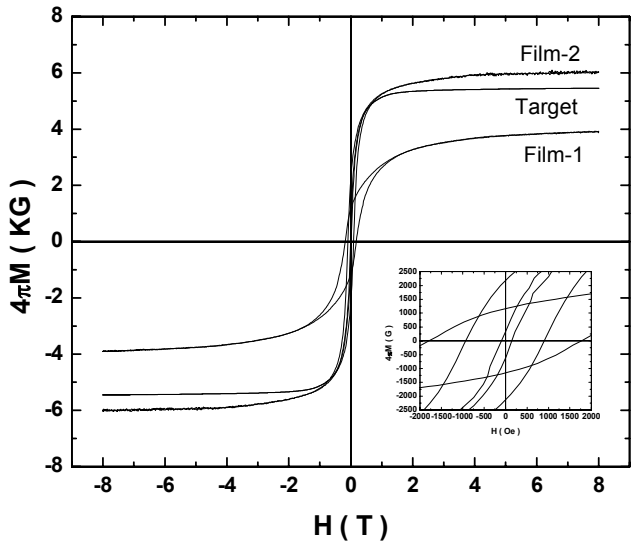

Fig.1 MH loops of both the films and of target used. Inserted fig. shows coercivity of the films and the target.

OPT2

Photoluminescence of ZnO nanowires grown by thermal evaporation on pulsed laser deposited ZnO buffer layer

A. Mohanta, A. P. Singh, Vandna S., and R. K. Thareja
Department of Physics and Centre for Laser Technology,
Indian Institute of Technology Kanpur-208016

ZnO is a semi-conducting material which has many different applications in both microelectronics and optoelectronics. Due to its high excitonic binding energy (~ 60 meV, at room temperature) and direct wide band gap (3.37 eV), it has been a promising candidate for efficient ultraviolet emitters as high excitonic binding energy gives assurance of excitonic recombination at room temperature[1]. The synthesis of 1D nanostructures such as nanowires, nanorods etc. has become a great interest due to the size effect and quantum confinement effect. Several techniques have been employed to fabricate 1D nanostructure. Thermal evaporation is a simple way for formation of ZnO nanostructures. The desired growth of nanostructures on Si substrate is more preferable for nanodevices due to conducting nature of Si. Although growth of nanostructures on Si substrates has been reported, [2, 3] it has required the use of metal catalyst, for example a thin gold (Au) layer has to be deposited on the Si substrate before the growth of nanostructures. This use of catalyst may introduce impurity to the samples and hence become a cause of poor device performances. Recently, a thin buffer layer of ZnO film is used instead of Au catalyst for nanowires or nanorods growth.[4] However, the extensive study of this catalyst-free growth of nanostructures and their optical properties is rarely reported. In this article, we demonstrate a simple approach to synthesize nanowires on Si substrate coated with pulsed laser deposited ZnO thin films. Photoluminescence study is also undertaken. A thin buffer layer of ZnO film was deposited on silicon substrates by PLD system. The target was a ZnO pellet (99.99%) which is sintered at 1000^{o}C for five hours. The silicon substrate was kept at 4 cm distance parallel to the target surface at 515^{o}C. The third harmonics of Nd: YAG laser beam (DCR-4G, Spectra Physics, ν = 10 Hz, FWHM = 5 ns) was focused through a lens onto a rotating target at a 45^{o} angle of incidence. The deposition chamber was initially evacuated down to a pressure of 6.8 x 10^{-7} mbar, and then oxygen gas was introduced into the chamber to maintain oxygen pressure of 1.2 x 10^{-2} mbar. After film deposition, nanostructures of ZnO were fabricated by using a simple thermal evaporation process. A mixture of ZnO powders and carbon with molar ratio 1:1 were used as source materials. The source materials were kept at 950^{o} C for 30 minutes and the ZnO coated Si substrate was kept at 19.8 cm from the source position. The whole system was held at a base pressure of 3 x 10^{-2} Torr under the constant flow of argon with a flow rate of 40 sccm. Figure-1 shows the SEM images of ZnO nanowires deposited on ZnO coated Si substrates. It is obvious that the wires are tending to form closed loop and one such loop is shown in figure-1 (b). The diameters of the wires distribute in the range of 101 – 125 nm and have an average value of 113 nm. Figure-2 shows photoluminescence profile of the nanowires at room temperature. The UV emission band at 380 nm is due to a near-band-edge (NBE) transition which is the recombination of free excitons through exciton-exciton collision process, [4] as shown in figure-2(a). Figure – 2(b) shows a deep-level emission band which falls in the visible region. There are many suggested sources of deep-level emission.[5]In this case; they are expected to be due to oxygen related defects such as oxygen vacancies. However, the actual nature of this deep level emission is still under debate. The temperature dependent photoluminescence and exciton dynamics at various temperatures will be presented at the conference.

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OPT3

Nanostructured Growth of AlN Thin Films by Pulsed Laser Deposition

Gaurav Shukla and Alika Khare*
Department of Physics
Indian Institute of Technology Guwahati, Guwahati 781039
*Corresponding author email: alika@iitg.ernet.in

Growth of high quality epitaxial wurtzite AlN on different substrates is a subject of intensive investigation because of its wide band gap (6.1 eV). The thin films of single crystalline AlN with well defined microstructures are required for electrical insulation, electronics and optical applications. We report in this paper, studies on the crystalline growth of AlN via reactive pulsed laser deposition as a function of background pressure of nitrogen gas and target substrate distance. At low N_2 pressure the columnar growth of single crystalline AlN <002> is observed probably for the first time. The dependence of Photoluminescence spectra of AlN on to the nanostructure formation shall also be discussed.

OPT4

Resistivity of thin films of $YBa_2Cu_3O_{7-\delta}$ and Multilayers of YBCO/Ga_2O_3

L.S.Vaidhyanathan, D.K. Baisnab, M.P. Janawadkar and Y. Hariharan
Materials Science Division, Indira Gandhi Centre for Atomic Research, Kalpakkaam
lsv@igcar.ernet.in

High T_c superconductors exhibit extraordinary transport properties in the normal state. The detailed understanding of the excitations which give rise to normal state resistivity might be important for superconductivity of these materials. For samples with T_c of 90 K, the T-dependence of resistivity (ρ) is linear. For samples with reduced oxygen content, T-linear dependence is generally seen at higher temperature, although deviation from T-linear dependence was measured by several authors.

Thin films of YBCO (500 nm) were deposited by Pulsed Laser Deposition (PLD) system on MgO (100) substrates with KrF (248nm) excimer laser. During deposition, the substrate temperature was maintained at 800 C in flowing oxygen atmosphere of 50 Pa. Films were deposited in the constant energy mode with an energy of 200 mJ. The films were subsequently annealed in oxygen at a pressure of 9.5 x 10^4 Pa and were cooled down to room temperature with different cooling rates but with a 45 min stay at 550 C and at 500 C. Although different contact methodologies were studied such as post-deposition of Ag films on YBCO contact pads followed by indium solder, use of silver paste etc, here we present results obtained by directly soldering indium contacts on YBCO films. Fig.1. shows the normalized resistance versus temperature for various values of applied current I_a in the range 50 μA to 200 mA. The important observation here is that for the entire range of applied currents, we observe a linear resistivity with temperature which is not affected by changing the current from 50 μA to 200 mA. This is in complete contradiction to the observations of Daniel Hsu et.al[1] who reported an abrupt increase of normal state resistivity at 220 K with increasing I_a.

YBCO/Ga_2O_3 multilayers were deposited by PLD on MgO (100) and several other substrates. YBCO thickness was kept at 90 nm and Ga_2O_3 layer thickness was maintained at 3.5 nm. Each multilayer had 10 layers of YBCO and Ga_2O_3. Fig.2. shows the normalized resistance as a function of temperature for these multilayers. Above T_c, unlike YBCO, R is not linear with temperature and shows a behaviour reminiscent of resistance saturation. Analysis of these results will be presented.

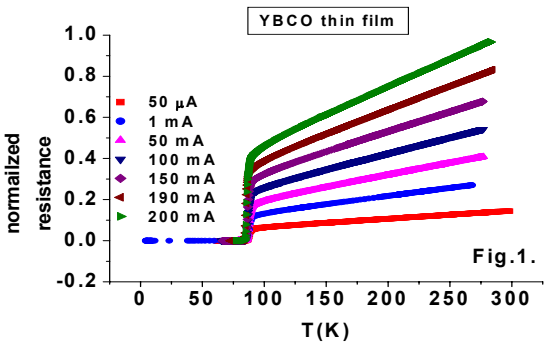

Fig.1. Temperature dependence of normalized resistance for YBCO thin film for various applied currents from 50 μA to 200 mA. The curves actually superimpose on each other but have been scaled along the resistance axis for clarity.

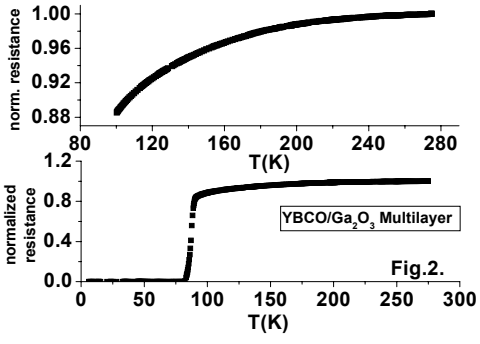

Fig.2. Normalized resistance vs temperature for YBCO-Ga_2O_3 multilayers. Upper curve shows resistance saturation at high temperatures.

1. Daniel Hsu et.al., Appl.Phys. Lett. **90**, 162504 (2007)

OPT5

Morphological and physical property changes in ZnO thin films grown by PLD due to Mg doping

*Shubra Singh and M. S. Ramachandra Rao
Department of Physics and Materials Science Research Centre
IIT Madras, Chennai-36, India
* Corresponding author: shubra@physics.iitm.ac.in

Visible photoluminescence (PL) from ZnO has been found to be tunable through doping. Mg-doped and undoped ZnO thin films were deposited on quartz substrates by PLD method at a temperature of 500°C. The blue-related PL appeared to be caused by energetic shifts of the valence band and/or the conduction band of ZnO. Optical properties (like IR spectra and PL) and structural properties (XRD) exhibit that Mg ion replaces Zn ions in the wurtzite structure of ZnO. The thermodynamic solubility of MgO in ZnO has been reported to be less than 4 mol% according to the phase diagram of the ZnO-MgO binary system. The $Mg_xZn_{1-x}O$ samples can thus be considered as metastable phases. Pulsed laser deposition is actually a suitable method for growth of such metastable phases because of the high peak energy of the laser light.

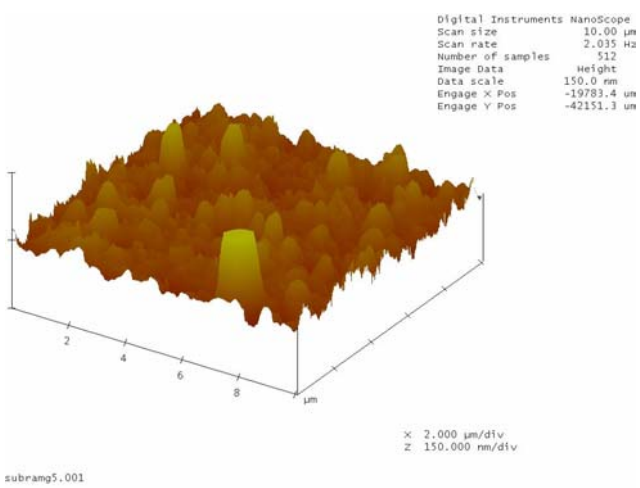

Fig.1. Atomic Force Microscopy image of 5 mol % Mg doped ZnO.

AFM pictures reveal the average grain size of about 300nm. The average roughness of undoped films is 15nm and that of doped films is 50 nm. This shows that the surface of ZnMgO films is not as smooth as the surface of ZnO film.

OPT6

Characteristics of pulsed laser deposited $Zn_{1-x}Ni_xO$/ZnO bi-layer thin films

Subhash Thota, Pankaj Misra*, Lalit M Kukreja* and Jitendra Kumar
Materials Science Programme, Indian Institute of Technology Kanpur, Kanpur-208016, India
*Thin Films Laboratory, Raja Ramanna Centre for Advanced Technology, Indore-452013, India
*Email: jk@iitk.ac.

$Zn_{1-x}Ni_xO$ ($0.01 \leq x \leq 0.163$) /ZnO bi-layer thin films were deposited over [0001] oriented Al_2O_3 substrates using a Q-switched Nd:YAG (wavelength 355 nm, pulse duration 6 ns, repetition rate 10 Hz) at a fluence of ~ 2 J cm^{-2} under oxygen partial pressure of 10^{-4} mbar. For this, a buffer layer of pure ZnO (~50 nm thickness) and $Zn_{1-x}Ni_xO$ film were deposited in succession at a substrate temperature of 700°C and 400°C, respectively. Their x-ray diffraction patterns reveal the presence of wurtzite-type hexagonal structure with preferential growth of (0001) film plane and decrease of c-parameter with increase in the nickel content 'x'. A series of characteristic optical absorption bands (Fig. 1) in the UV-visible regions have been identified with d-d transitions from $3T_1(F)$ to $3A_2(F)$, $3T_1(P)$, and $3T_2(F)$ of the Ni^{2+} ($2d^8$) ions, occupying zinc sites (i.e. centre of oxygen tetrahedron). This is supported by the observed gradual red shift of optical band gap absorption edge with increase in 'x' (typical values being ~ 3.27 and 3.05eV for 'x' = 0.01 and 0.163, respectively). The films exhibit hysteresis loops at room temperature with values of H_c and M_r in the range 99-153 Oe, 3.22-8.45 emu/cm^3, respectively for 2-16.3 at% nickel sample (Fig. 2). The dc and ac transport parameters and magneto-resistance data under -80 to 80 k Oe field in the temperature range 5-300 K suggest the dominance of hopping conduction with evidence of ferromagnetic ordering at room temperature.

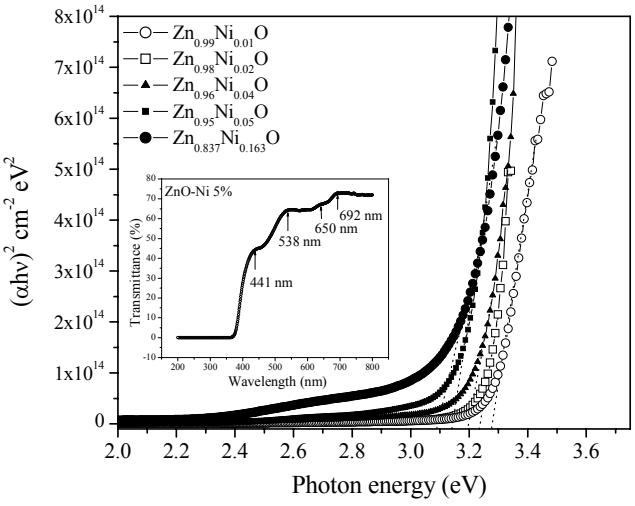

Fig. 1

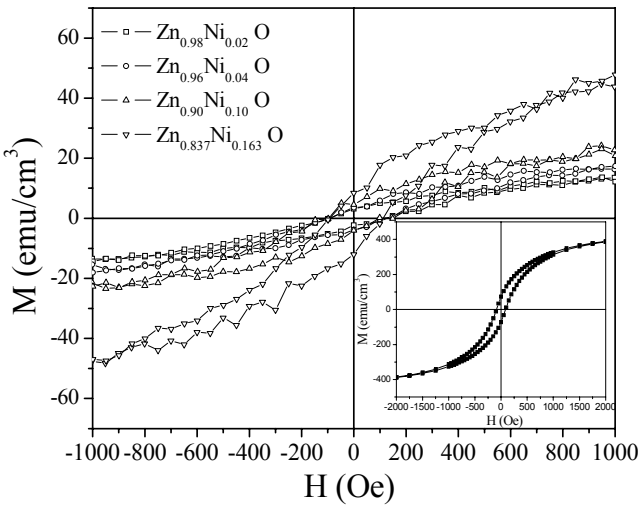

Fig. 2

OPT7

Structural and Optical Characterization of UV-transparent β-Ga_2O_3

V. Sridharan, L.S. Vaidhyanathan, V. Srihari, G. Raghavan, S. T. Sundari, M. Kamruddin, M. Premila, H.K. Sahu, B. K. Panigrahi, V.S. Sastry and C.S. Sundar
Material Science Division, Indira Gandhi Centre for Atomic Research, Kalpakkam 603102.
e-mail: varadu@igcar.gov.in

Introduction: Recently, there is a renewed interest in β-Ga_2O_3 due to its possible application as transparent conducting coating. It has a wide band gap of 4.8 eV and can be converted to a n-type semiconductor by heat treating in inert atmosphere. It is a versatile gas sensor as it can be used for sensing both oxygen above 800 ^oC and reducing gases below 700 ^oC. Due to its wide band gap, is has a potential applications in the field of photolithography. However, for realization of the envisaged applications, thin films of Ga_2O_3 in β-phase should be stabilized against other competing metastable (α, γ and ε) phases. In this paper, we report thin film deposition of polycrystalline β-Ga_2O_3 using pulsed laser deposition and post deposition annealing. Structural, surface, compositional and optical characterizations of the films are also reported in the paper.

Experimental details: Thin films of β-Ga_2O_3 on quartz and silicon substrates have been prepared by pulsed laser deposition method using KrF laser (284 nm excitation) with laser energy of 400 mJ and under oxygen partial pressure of 0.015 mbar. Surface morphology was characterized using atomic force microscopy, structural characterization through glancing incidence X-ray diffraction (GIXRD) and compositional analysis through Rutherford back scattering technique. Optical characterization was carried out using UV-Vis spectrometer and a variable angle rotating polarizer spectroscopic ellipsometer.

Results and discussions: The room temperature GIXRD pattern of the as grown film on silicon and quartz along with that of γ-phase of bulk nanocrystalline Ga_2O_3 are shown in Fig. 1. It is seen that for

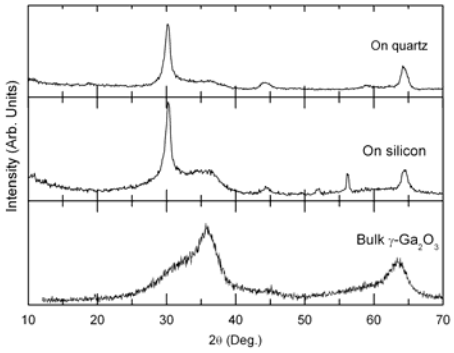

Fig. 1. GIXRD patterns of bulk γ-Ga_2O_3, thin films grown on silicon and quartz

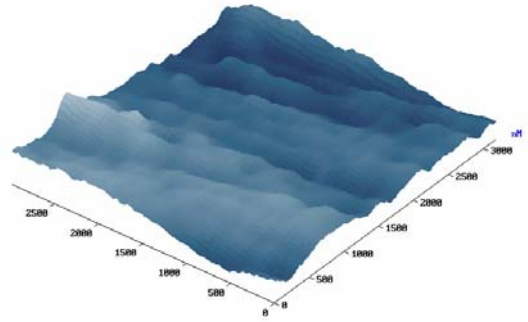

Fig. 2. AFM surface image of the film grown on quartz over an area of 3000X3000 nm.

the same growth conditions, films deposited on quartz substrates contain lower fraction of γ-phase. From the line broadening analysis of the XRD profile, the average grain size was determined to be less than 15 nm. The films grown on quartz are transparent and colourless. A comparison between the relative intensity of the reflection of as deposited films and bulk polycrystalline sample indicates a strong texturing in the as deposited films. AFM studies also indicated that the surface morphology (Fig. 2) of the films is textured with ridge like features, having a rms surface roughness of ~ 8nm. Figure 3 shows the $(\alpha h\nu)^2$ Vs ($h\nu$) plot based on UV-Vis spectroscopic studies. By extrapolation the linear portion of the curve at higher energies to α=0, the band gap (E_g) is determined to be 4.7 eV. From pseudo-dielectric spectra of the films obtained through ellipsomety, the thickness of the film was determined to be 705 nm and the refractive index was fond to increase monotonically from 1.905 to 2.1 in the energy range 1.2 to 4.3 eV and close to the reported value for the bulk. From the ellipsomety studies, the E_g was determined to be 4.8 eV, in agreement with the value estimated from UV-Vis studies.

GIXRD studies on 600 ^oC annealed (12 hr) films indicated the absence of γ-phase. This is in agreement with reported γ→β transformation above 500 ^oC. Detailed structural, compositional and optical properties of the annealed films will be presented.

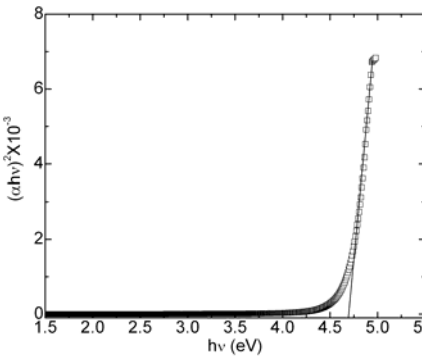

Fig. 3. $(\alpha h\nu)^2$ Vs hν plot for the film grown on quartz substrate. Estimated band gap E_g is ~4.7 eV.

OPT8

Characterisation of pulsed laser deposited PZT and PLZT thin films on oxide pervoskite electrodes

R.Reshmi[1],A.S.Asha[1], M.K.Jayaraj[1] ,M.T.Sebastian[2]

[1]*Optoelectronics Device Laboratory, Department Of Physics*

Cochin University of Science and Technology

Kochi-682022, India

[2]*Regional Research Laboratory, Thiruvananthapuram 695019, India,*

Email: mkj@cusat.ac.in

Ferroelectric thin films have attracted attention for their application in various microelectronic devices such as nonvolatile ferroelectric random access memory and ferroelectric field effect transistors. Pervoskite $Pb(Zr_xTi_{(1-x)})O_3$ or PZT thin films are the most extensively studied due to its small coercive field, large polarisation and high curie temperature. The functional response of ferroelectric thin film strongly depends on the electrode material. $La_{0.5}Sr_{0.5}Co_{1-x}Ni_xO_3$ (LSCNO) is a conducting ceramic which has good potential for use as electrode in hetrostructures for all oxide ferroelectric devices.

In this work we report the growth of PZT and PLZT thin films on the pervoskite LSCNO layer by pulsed laser ablation. The top and bottom LSCNO were deposited by RF magnetron sputtering. The electrodes crystallise in pervoskite structure. The structural and electrical properties of PZT and PLZT thin films deposited on Pt as well as oxide LSCNO are investigated. The polarisation of the hetrostructure gave a coercive field of 56kV/cm and remnant polarisation of 3 $\mu C/cm^2$ and saturation polarisation of 6 $\mu C/cm^2$.

THP1

Oxygen Reduction Kinetics and Transport Properties of $(Ba,Sr)(Co,Fe)O_{3-delta}$ Solid Oxide Fuel Cell Cathode Materials

Lei Wang[1], Rotraut Merkle[1], Frank S. Baumann[1], Jürgen Fleig[2], and Joachim Maier[1]

[1] *Max Planck Institute for Solid State Research, Heisenbergstrasse 1, D-70569 Stuttgart, Germany*

[2] Institute of Chemical Technologies and Analytics, Vienna University of Technology, A-1060 Vienna, Austria

Email: lei.wang@fkf.mpg.de

The oxygen reduction at the surface of cathode materials is crucial for the performance of solid oxide fuel cells (SOFC), but a detailed understanding of the mechanism is not available yet. $(Ba_xSr_{1-x})(Co_{1-y}Fe_y)O_{3-\delta}$ shows strongly improved oxygen reduction rates compared to previously applied perovskite cathode materials. In this work, surface rate constants as well as bulk transport properties are studied.

$(Ba_xSr_{1-x})(Co_{1-y}Fe_y)O_{3-\delta}$ with $0\leq x\leq 0.5$, $0.2\leq y\leq 1$ was synthesized by the Pechini method. Oxygen stoichoimetry was obtained from thermo-gravimetric analysis, confirming that $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-\delta}$ has an exceptionally low oxygen content which is generally smaller than 2.5.

Dense thin films were grown by pulsed laser deposition (PLD) and patterned into circular microelectrodes by photolithography. The surface resistances R_s, which dominate the overall electrode resistance, were measured by impedance spectroscopy on individual microelectrodes at different T, pO_2 and applied electrical bias. PLD technique greatly helps to study the oxygen reduction kinetics since only measurements on dense thin films allow to record absolute R_s values without interference from morphology effects. These R_s values were found to be much lower than those for $(La,Sr)(Co,Fe)O_{3-\delta}$.

The variation of the surface reaction rates with A-site and B-site composition was studied and correlations with bulk materials properties such as oxygen nonstoichiometry, ionic mobility or oxidation enthalpy were examined. Plausible reaction mechanisms as well as possible reasons for the high absolute surface reaction rates will be discussed.

THP2

Study on p-type ZnO thin films and ZnO homojunction LED

Y. F. Lu*, Z. Z. Ye, Y. J. Zeng, L. P. Zhu

State Key Laboratory of Silicon Materials, Zhejiang University, Hangzhou, 310027
People's Republic of China
E-mail: sailinglu27@gmail.com

Fabrication of p-type ZnO promises to be important in realizing ZnO short-wave optoelectronic devices such as light emitting diodes and laser diodes. Among all the available group V and group I p-type dopants, nitrogen substituting oxygen seems to be promising, which has been well confirmed by the reports on ZnO homojunction light-emitting diodes. In this study, we report our research on N-doped p-type ZnO by MOCVD. First, the effects of growth parameters such as substrate temperature, radio frequency power, flux of DEZn, on the optical and electrical properties of N-doped ZnO thin films are discussed. Then the ultraviolet photoconductivity in N-doped p-type ZnO thin film is investigated. Surface adsorption of C and O is believed to be a major contribution to the UV conductivity. Plasma-free growth of N-doped p-type ZnO is also reported, which is easier to operate and more preponderant in growth of p-type ZnMgO and quantum-well LEDs. At last, room-temperature electroluminescence from ZnO:N / ZnO homojunction diode is observed.

Besides nitrogen, group I dopants, such as Li, Na, have also been introduced to realize p-type ZnO. The doping mechanism in Li-N-H codoped p-type ZnO is investigated experimentally and theoretically.

In order to develop ZnO based optoelectronic devices, an ohmic contact to p-type ZnO is another important issue. Ni /Au ohmic contacts on N-doped p-type ZnO are investigated as a function of annealing temperature. And the transport mechanism in the contacts is investigated from the temperature-dependent contact resistance.

THP3

Magnetoresistive and Transport Properties of Pulsed Laser Deposited Manganite Thin Films and Heterostructure.

Jaysukh H Markna
Department of Physics, Saurashtra University, Rajkot-360 005 INDIA
Email Id: jaysukh28@rediffmail.com

In this talk a brief review of our work on thin films and hetero-structures of Manganites suitable for spintronic applications will be presented. We have used Pulsed Laser Deposition (PLD) to synthesize high quality Mangenite structures and studied their structural, electrical and magnetic characteristics. We observed enhanced Magneto-resistance (MR) in Mangenite hetero-structures LPSMO/Al2O3/LPSMO containing a thin sandwiched layer of insulting Al2O3 barrier between the two ferromagnetic La0.5Pr0.2Sr0.3MnO3 (LPSMO) layers. Effect of Swift Heavy Ion (SHI) irradiation on the transport and magnetic properties of these structures has been studied, which will also be presented and discussed.

THP4

Pulsed Laser Deposited Thin Films of ZnO, GaN, AlN, ZnO/GaN
WBSC: Structural, Micro-structural, Optical & Electrical Characterization

Suhas Madhav Jejurikar Guide: Dr. K. P. Adhi, Co-guide: Dr. A. V. Limaye
Center for Advanced Studies in Materials Science and Condensed Matter Physics,
Department of Physics, University of Pune, Pune 411 007, India.
Corresponding author: suhas@physics.unipune.ernet.in

Wide band gap semiconductors (WBSC) such as II - oxide compounds (ZnO) and III - nitride compounds (AlN, GaN and their alloys) are viewed as promising systems for a wide variety of applications in optoelectronic devices like light emitting diodes (LED), Laser diodes (LDs) operating in UV and blue region for digital data read - write applications, wave guides, UV detectors, displays etc. ZnO has applications for electrical devices like varistors, piezo-electric crystals, surface acoustic wave (SAW) devices, field emitters etc. also due to its radiation hardness the devices realized through ZnO have potential applications in space technology.

The technique of pulsed laser deposition (PLD) was employed for the growth of the above-mentioned materials on different substrates. Bulk targets of ZnO, AlN and GaN were used for the ablation and deposition. AlN bulk target was procured from Kurt J. Leskar, USA, while the targets of ZnO and GaN were synthesized in laboratory by the solid-state route. The deposited films were characterized structurally, micro-structurally, optically and electrically using different techniques like X-ray diffraction (XRD), atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), UV-visible spectroscopy, Raman spectroscopy, current - voltage (I-V) measurements (four point probe measurement and field emission studies) and Hall measurement. The thickness of the deposited films was estimated using the Tally step setup.

The work on ZnO thin films was carried out to study the influence of substrate temperature on the properties of ZnO thin films and the role of thermal annealing on the deposited films. During deposition the substrate temperature was varied from 100 ^{o}C to 600 ^{o}C keeping all the other deposition parameters same. Two sets of samples were prepared. One set was annealed in air at 800 ^{o}C for four hours. Expected Ohmic behavior is recorded in case of all the as deposited ZnO thin films. While in the case of annealed ZnO thin films, non-linear I-V behavior was observed which is interesting. The non-linear behavior, in terms of the plateau region in I-V characteristics, symmetry / asymmetry in the plateau, etc is dictated by the substrate temperature maintained during deposition. An attempt is made to correlate the structural as well as the morphological properties with the electrical observations. To comprehend the non-linearity in I-V characteristics observed in case of annealed ZnO thin films the local chemical analysis at the microscopic level was performed using XPS (Mk-II-VG scientific spectrometer) technique. Thin films, deposited at 400 ^{o}C and annealed at 800 ^{o}C in air, have been used for this study. The stoichiometry of ZnO was studied by recording O 1s and Zn $2P_{3/2}$ peaks, as they are very strong. Presence of bound H - OH and the interstitial Zn is observed after annealing the samples. This suggests that ZnOH is formed at the grain boundaries, which probably acts like a barrier between two ZnO crystallites / grains. The tunneling of electrons through such barriers could probably explain the non-linearity in I-V measurement for the annealed ZnO thin films.

Europium (Eu) doping in ZnO for low doping concentrations (1% and 3 %) was studied from the point of view of optical emission. Thin films of Eu: ZnO were deposited on $c - Al_2O_3$ substrate and characterized for structural, optical and electrical variations. The influence of oxygen deficiency on the structural, optical and electrical properties was investigated and discussed using 3 % Eu: ZnO thin films grown on c-Al_2O_3 substrate under different oxygen ambient pressure conditions range between 50 mTorr to 5 x 10^{-5} Torr.

The synthesis, characterization and possible application as a field emitter of GaN was also studied. No suitable substrates are available for obtaining the highly oriented / epitaxial growth of this material, ZnO due to its structural as well as lattice match could prove to be suitable low cost substrate for GaN. Hence the bilayer growth of GaN / ZnO / c-Al_2O_3 was undertaken and under optimized deposition

conditions, highly c-axis oriented bilayers of GaN and ZnO were obtained. Oriented growth of wurtzite GaN along the c-axis was also obtained on c-Al_2O_3 and Si (100) / SiO_x substrates. The growth of GaN thin films is on Si (100) / SiO_x, a highly lattice mismatched, and thermally incompatible substrate did not show formation or development of cracks. The surface morphology of these films was investigated using atomic force microscopy which showed a smooth surface with the presence of randomly distributed needle like structures of nanometer dimensions clustered together. Such films show excellent field emission characteristics like low turn on voltage (field), high field enhancement factor and high stability in electron emission over extended time periods of two and half hours.

A systematic study of the role of substrate temperature (T_s) and the effect of ambient nitrogen pressure on the structural and optical properties of pulsed laser deposited AlN thin films on c-axis Al_2O_3 substrate was also carried out. It is found that along with the band-gap of the pulsed laser deposited AlN thin films, the crystallographic orientation turns from (1000) to (0002) depending on the substrate temperature (T_s) and the ambient nitrogen pressure. Attempts have been made to explain the observations in terms of the temperature and pressure dependent growth modes

THP5

Synthesis and characterization of LaB_6 thin films on tungsten, rhenium and silicon substrates and their investigations as Field Emitters

Dattatray J. Late*
Center for Advanced Studies in Material Science and Condensed Matter Physics, Department of Physics, University of Pune, Pune - 411007, India

Lanthanum hexaboride films were grown on tungsten and rhenium tips and foils and also on silicon substrates by Pulsed Laser Deposition and arc plasma methods. The X-ray diffraction spectra of the LaB_6 films shows crystalline nature. The field emission studies of pointed and foil specimens were performed in conventional and planar diode configurations respectively, under ultra high vacuum condition. An estimated current density of ~1.2 $x10^4$A / cm^2 was drawn at the electric field of 3 x 10^3 V/μm and 6 x 10^3 V/μm from the LaB_6 coated tips of tungsten and rhenium, respectively. The Fowler-Nordheim plots were found to be linear showing metallic behavior of the emitters. The field enhancement factors were calculated from the slopes of the Fowler-Nordheim plots, indicating that the field emission is from LaB_6 nanoscale protrusions present on emitter surfaces. The emitters were operated for long time current stability (3h) studies. The post field emission surface morphology of the emitters showed no significant erosion of LaB_6 films during three hours continuous operation. The observed behavior indicates that it is linked with the growth of LaB_6 films on W and Re. The enhancement in the field emission was observed in the PLD LaB_6 film on Zr and gold coated Si substrates, and this has been explained with the increase in the field enhancement factor.

PSP1.1

Effect of oxygen pressure on the photoluminescence of Gd_2O_3 :Eu^{3+} films grown by PLD

Geo Rajan, Nissamudeen K. M, Sasi B and K.G.Gopchandran
Department of Optoelectronics, University of Kerala
Kariavattom, Thiruvananthapuram-695 581, India
gopchandran@yahoo.com

Luminescent films play an important role in high resolution devices such as cathode ray tubes (CRT's), electroluminescent devices (ELED's), plasma display panels (PDP's) and field emission displays (FED's). Displays with thin film phosphors have higher contrast and resolution, superior thermal conductivity as well as high degree of uniformity and better adhesion. Due to the higher stability of oxide based phosphors, Gd2O3:$Eu3^{+}$ thin films are one of the most promising red phosphor systems. Due to a $^5D_0$-$^7F_2$ transition with europium, Gd_2O_3:Eu^{3+} shows red luminescence at 612nm. In this work, pulsed laser deposition has been used for the growth of Gd_2O_3:Eu^{3+} films. In thin film phosphors brightness may be associated with several factors such as interaction between film and substrate, film processing conditions and compositions of the films. The effect of oxygen partial pressure on structural and optical properties is discussed with X-ray diffraction (XRD), scanning electron microscopy (SEM) UV visible and photoluminescence (PL) spectroscopic techniques.

PSP1.2

A comparative study of nanostructures Co thin films deposited on different substrates by pulsed laser deposition

A. Sharma*, S. Tripathi, R. Brajpuriya, Ram Prakash, R. J. Chaudhari, D. M. Phase and T. Shripathi

University Grant Commission- Department of Atomic Energy Consortium for Scientific Research, University Campus, Khandwa Road, Indore-452 017, India.
anupamsharma2003@yahoo.co.in

Nanostructure materials have attracted intense research interest over the recent years, as they provide the critical building blocks for the booming nanoscience and nanotechnology. Their novel properties can be tailored through extra degrees of freedom, such as structure and constituent materials etc. In this regard, recent progress on magnetism and magnetic materials has made magnetic nanostructures a particularly interesting class of materials for both scientific and technological explorations. For example, studies on interlayer coupling, giant and transmission magnetoresistance, exchange bias, half-metallic ferromagnets (FM), forms a future generation of electronic devices (spintronics) that use the spin of the electron in addition to its charge for manipulating information.

In this respect, Co and Co based alloys has been the subject of a lot of studies in the last decade; they have been investigated as a thin films [1-2], as a part of multilayers system [3-4], as a nanowires [5-6] and as a stripes, or dots [7-8]. The magnetic properties of these materials depend greatly on the methods and condition of preparation. Similarly, in recent years, the study of Co thin films and their interfaces with semiconductor surfaces has received considerable attention due to their potential applications, e.g. formation of Co-Silicide is extensively used as a conductive material in many microelectronic devices [9] and Co/GaAs system as potential candidate in spintronics, giant magneto resistance and many optoelectronic devices because of high spin polarization of the carriers at Fermi level [10-11].

One of the probable barriers for practical applications, however, is thermal stability. For the case of Co, this problem should be carefully consider due to its larger dependence of magnetic crystalline anisotropy (K_{u1}) constant on temperature. The large change in K_{u1} value with temperature makes the easy axis of the crystal parallel to the basal plane, which leads to a change in the magnetization direction of the Co magnetic particle.

Therefore, in the present work, we have deposited Co (400Å) film on three different substrate viz. Si, GaAs and float Glass at room temperature and at 400°C substrate temperature by pulse laser deposition technique using KrF excimer laser with $2J/Cm^2$ energy density. The investigation of structural, magnetic and transport properties were carried out using X-ray diffraction (XRD) Magneto optical Kerr effect (MOKE) and four probe resistivity measurements, respectively. Structural studies shows three different structures in three different cases. The crystallinity increases in case of film deposited at 400°C as compared to room temperature. The corresponding changes in anisotropy, coercivity and resistivity in all the cases will be discussed in terms of structural changes at the interface.

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PSP1.3

Raman Study of oriented thin films of $PrMnO_3$ deposited on different substrates

Aditi Dubey* and V. G. Sathe
UGC-DAE Consortium for Scientific Research, University Campus, Khandwa Road, Indore – 452 017
E-mail: aditidubey@csr.ernet.in

In this study we describe our Room temperature Raman spectroscopy results on c-axis oriented thin films of $PrMnO_3$ compound deposited on $SrTiO_3$ (001) and $LaAlO_3$ (001) substrate of about ~200 nm thickness by Pulsed Laser deposition technique. $PrMnO_3$ bulk compound has peroveskite structure with orthorhombic Pnma space group. At low temperature this compound undergoes from paramagnetic to Antiferromagnetic phase at 99 K. $PrMnO_3$ compound was prepared by using standard solid-state reaction method with intermediate grinding and sintering at very high temperatures. The films were grown in 300 mTorr oxygen pressure and substrate temperature was kept about ~650^0 C.

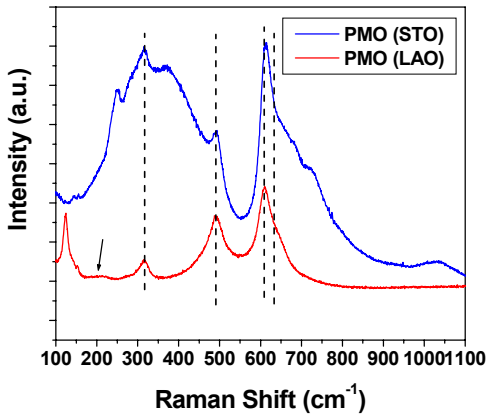
The X-ray diffraction confirms that the films are highly orientated along the c-axis and of very good crystalline quality. The calculated out of plane lattice parameter are shown in table 1. The lattice parameter of bulk compound in respect to the pseudo cubic unit cell is ~3.85 Å. Therefore the film deposited on $LaAlO_3$ substrate (3.79 Å) experiences the in-plane compressive strain and out of plane elongation while the film grown on $SrTiO_3$ substrate (3.90 Å) experience the in-plane tensile strain and out of plane compression.

Figure 2 gives the room temperature Raman spectrum of both the films. The effect of strain of opposite nature on $PrMnO_3$ films is also reflected in the Raman mode position. It is seen that for higher out of plane lattice parameter film (on $LaAlO_3$), the Raman peak positions are relatively at lower positions than compared to film that has lower out of plane lattice parameter (on $SrTiO_3$). To conclude, the variation of phonon frequency with substrate induced strain of opposite nature in-plane tensile on $SrTiO_3$ substrate and in-plane compressive on $LaAlO_3$ substrate) were correlated with appearance of the Raman mode positions.

Table 1: Room temperature out of plane lattice parameter and Raman peak positions and corresponding line widths of $PrMnO_3$ thin films deposited on $SrTiO_3$ (001) and $LaAlO_3$ (001) substrates

Sample	2 θ (Deg)	Out of plane Lattice parameter c (Å)	ω_1 (cm^{-1})	ω_2 (cm^{-1})	ω_3 (cm^{-1})
PMO (STO)	**47.49**	**3.82**	**313.90**	**492.28**	**612.58**
PMO (LAO)	**46.15**	**3.93**	**312.15**	**490.73**	**609.96**

Figure 1: Room temperature (300 K) Raman spectra of $PrMnO_3$ films of thickness 200 nm deposited on $SrTiO_3$ and LaAlO



PSP1.4

Application of pulsed laser deposited ZnO thin films as a solar blind detector

Alka V. Deshmukh, S. M. Jejurikar, K. P. Adhi and S. I. Patil
Center for Advanced Studies in Materials Science and Condensed Matter Physics,
Department of Physics, University of Pune, Pune 411 007, India.
Corresponding author: alka_d@physics.unipune.ernet.in

Highly c-axis oriented thin films of ZnO were grown by pulsed laser deposition (PLD) technique on different substrates. For this study we have used Si (100), SiO_2/Si (100), c-Al_2O_3 and GaAs. The films were grown under identical deposition conditions. Deposited samples were characterised structurally using x-ray diffraction technique. Electrical properties of the samples were measured, by making indium contacts on the surface of the samples. Hall measurement was done to measure the carrier concentration of the above prepared samples. For this Van der Pauw geometry was used. Photo response of all the samples was recorded. For this purpose KrF excimer laser having wavelength 248 nm was used. ZnO deposited on Si (100) and SiO_2/Si (100) shows very interesting results, towards the direct application of these samples as a solar blind window.

PSP1.5

DC-Discharge Assisted Pulsed Laser Growth of Ultra-thin Silicon Oxynitride Films

B. N. Singh*, P. Misra, A. K. Das, R. Kumar[#], Binsu J Kailath[+], M. Mishra[#], D.M. Phase[!], A. DasGupta[+], N. DasGupta[+] and L. M. Kukreja

Thin Film Lab., Raja Ramanna Centre for Advanced Technology, Indore 452 013
[+]Department of Electrical Engineering, IIT Madras, Chennai 600036
[!]UGC-DAE Consortium for Scientific Research, Indore 452 017
Department of Electronics, D D Upadhyay University, Gorakhpur, 273 016
*Corresponding author, email address: bnsingh@cat.ernet.in

We have evolved a novel DC discharge assisted laser induced oxynitridation scheme of silicon to grow ultra-thin films for gate dielectric applications. A 3rd harmonic of Q-switched Nd:YAG laser (355 nm, 6 ns and 10Hz) at a fluence of ~ 60 mJ/cm^2 was used to heat the Si substrates mounted in a growth chamber. Schematic of the growth setup is shown in figure1. The growth chamber was initially evacuated to a base pressure of ~ 5x10^{-6} mbar and then filled with mixture of Oxygen and Nitrogen ambient in different ratios but at constant total pressure of ~2 mbar. The DC discharge was created in this gaseous ambient by applying ~800V (DC) between a circular metal ring kept at ground potential at a distance of ~ 2 cm from the substrate as shown in figure1. The X-ray Photo-electron Spectrum, shown in figure 2 confirmed the presence of N in the grown over layer and hence the formation of Silicon oxynitride.

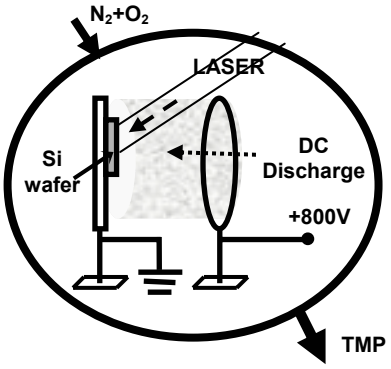


Figure 1

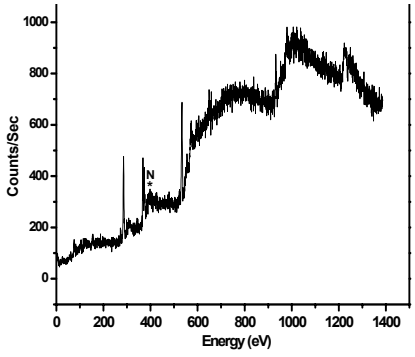


Figure 2

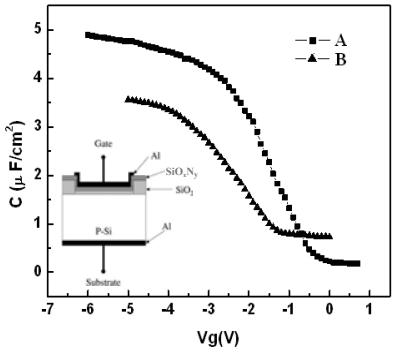


Figure 3

The Capacitance-Voltage measurements as shown in figure 3 on the MOS structures (shown in the inset) containing Silicon oxynitride as gate dielectric revealed an effective dielectric thickness (EDT) in sub-nanometer range. The Current-Voltage studies (figure not shown here) on these devices also revealed low leakage current with high break-down voltage. Further investigations on these structures are underway. Thus laser and DC discharge assisted oxynitridation of Si provides a simple and effective methodology of producing ultra-thin Silicon based gate dielectrics.

PSP1.6

Unique nanostructures in pulsed laser ablated NiO thin films

B.Sasi, K.M. Nissamudeen and K. G. Gopchnadran
Department of Optoelectronics, University of Kerala, Thiruvananthapuram-695 581, India
E-mail: thazhavasasi@sancharnet.in

Nanostructured oxides prepared in the form of rods, fibers, ribbons, channels and other shapes display unique properties that make them suitable for many new applications such as transparent conductors, sensors, lasers, smart windows, luminescent materials and solid electrolytes. Depending on the properties and fabrication route, the crystal boundaries are associated with various degrees of structural and compositional disorder. A very simple but successful way is a slightly controlled oxidation of the surface. In this study preparation of nanostructured nickel oxide and lithium doped nickel oxide thin films were done using pulsed laser deposition technique. Growth of thin films from atoms deposited from the gas phase is intrinsically a nonequilibrium phenomenon governed by a competition between kinetics and thermo dynamics. Direct and indirect oxidation mechanisms involved in the formation of a variety nanostructures like mesoporous, Stranski-krastanov nanoislands, nanochannels, nanochick and self-assembly of nanocrystals in nickel oxide thin films are discussed.

PSP1.7

Influence of Ti^{2+} doping on the structural and optical properties of WO_3 thin films prepared by pulsed laser ablation technique.

Lethy.K.J, Beena. D, Bahna.A.H & V.P.Mahadevan Pillai
Department of Optoelectronics, University of Kerala, Kariavattom, Kerala, India
Corresponding author: vpmpillai9@rediffmail.com

Inorganic nanostructures of metal oxides are of interest as they are the backbone of many smart and functional materials which finds applications in photonics, nano-electronics, information storage, catalysis and biosensors. Tungsten trioxide is a wide band gap n-type metal oxide semiconductor. Intrinsic as well as doped WO_3 thin films are crucial in the fields of electrochromic and gas sensing applications [1, 2]. The essential theme of the present investigation is the structural and optical properties of pure and Ti^{2+} doped WO_3 thin films deposited on heated (600 ^{0}C) quartz substrates in an ambient oxygen pressure of 0.12 mbar. The deposition is carried out using a *Q*- switched Nd: YAG laser (Quanta–Ray INDI – Series, Spectra Physics) with a maximum energy of 200 mJ at frequency doubled 532 nm radiation having pulse width 7 ns and repetition frequency 10 Hz. The deposition of the films are done on quartz substrates kept at an on-axis distance of 45 mm from the target in reactive oxygen atmosphere of 0.12 mbar pressure and at a substrate temperature of 873 K. The targets used are pure WO_3 and TiO_2 doped (1, 3, 5 & 10 wt %) WO_3 pellets. The incorporation of the titanium into the polycrystalline WO_3 matrix was confirmed from X-ray diffraction (XRD) and Energy dispersive X-ray (EDX) measurements. Crystallographic investigation based on X-ray diffraction studies shows an orthorhombic WO_3 crystalline phase existing in these films. No structural phase transformation could be observed with different doping levels. Crystalline grain size deduced from XRD pattern, decreases from 40 nm to 20 nm depending on the TiO_2 doping concentration. Surface morphology analysis at the nano scale domain has been investigated by Scanning electron microscopy and Atomic force Microscopy (AFM) techniques. Crack free surface morphology has been obtained for all the films except the one with 1 wt % TiO_2 doping. To get a deeper insight into the structure and phase existing in these, they were subjected to micro-Raman and FTIR measurements. Optical transmittance spectra recorded using JASCO V550 double beam spectrophotometer reveal that, transmittance in the visible range decreased from 80% for the undoped WO_3 films to 40 % for the 10 wt% TiO_2 doped films. A large red shift (around 50 nm) in absorption edge and hence narrowing of band gap energy was observed for the TiO_2 doped WO_3 films. Additionally, noticeable correlation of the optical constants like refractive index, thickness, extinction coefficient etc of the WO_3 films with respect to different doping level is explored in detail. In conclusion the analysis imply that TiO_2 doping can be applied to tailor make the structural, optical and morphological properties of WO_3 thin films.

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PSP1.8

Effect of Substrate on Pulsed Laser Deposition of InN Thin Film

Gaurav Shukla and Alika Khare*
Department of Physics
Indian Institute of Technology Guwahati, Guwahati 781039
*Corresponding author email: alika@iitg.ernet.in

Indium nitride is emerging as a potential semiconducting material for various applications, viz: high efficiency solar cell, high quality electronics components and sensors. The deposition of thin films of InN for the device applications is challenging due to its low dissociation temperature and the large lattice mismatch with commonly used substrate. The low dissociation energy restricts the use of high substrate temperature and hence the short diffusion length of the growth precursor resulting into poor quality of the thin film. This problem can be overcome by pulsed laser deposition as PLD gives the high kinetic energy to the atom/ions and molecules impinging on to the substrate for deposition. In this paper, we report the deposition of polycrystalline InN thin films via PLD using indium metal as the target in the environment of N_2. The dependence of crystal structure and the surface morphology on to the substrate and the background nitrogen pressure shall also be discussed in the paper.

PSP1.9

Synthesis and Optical Properties of Cr_2O_3 Films Prepared by Pulsed Laser Ablation

G. Balakrishnan[1], P. Kuppusami, T.N. Sairam[2], E. Mohandas and D. Sastikumar[1]
Physical Metallurgy Division, Indira Gandhi Centre for Atomic Research,
Kalpakkam-603 102, Tamil nadu
[1]National Institute of Technology, Tiruchirapalli- , Tamilnadu
[2]Materials Science Division, Indira Gandhi Centre for Atomic Research,
Kalpakkam-603 102, Tamil nadu

Chromium oxide (Cr_2O_3) is material having high hardness, chemical inertness, mechanical strength and stability. Among the various chromium oxides (CrO_2, CrO_3, Cr_2O_3), Cr_2O_3 is the most stable under ambient conditions. Cr_2O_3 thin films are widely used as protective coatings against wear, corrosion and oxidation. It also finds applications as electrochromic coatings, IR transmitting coatings, selective black absorber and optically selective surface of solar collectors.

In the present work, thin films of chromium oxide prepared from a sintered target of Cr_3C_2 by pulsed laser ablation is investigated. Silicon (100) oriented and glass substrates were mounted on the substrate holder in the chamber using silver paste and chamber was evacuated by a turbo-molecular pump backed with a rotary pump. The KrF excimer laser (λ=248 nm) was used to deposit chromia films with varying repetition rates, laser energy, substrate temperature and background gas. The thickness of the prepared films were measured by the Dektak profilometer (DEKTAK 6M-stylus profiler by Veeco, USA).The structure of the deposited films were studied using XRD-INEL XRG – 3000 Diffractometer. For the optical studies, films were analyzed using the UV-VIS-NIR (model No:310/PC, Shimadzu) spectrophotometer in the range of 190-3000nm . The optical band gap energy has been calculated from $(\alpha h\upsilon)^{1/2}$ vs $h\upsilon$ plot.

XRD patterns of the Cr_2O_3 films show peaks which coincide with Cr_2O_3 structure in agreement with JCPDS. However the films formed at 700^{o}C have several reflections with higher particle size than those formed at 600^{o}C. Absorption characteristics of Cr_2O_3 clearly show that the absorption increases with the decreasing wavelength in the range 300-800 nm. The films deposited in base pressure and Ar atmosphere show larger band gap (4.6 eV) and the band gap energy decreases steeply for the films prepared under methane atmosphere (2.5 eV). When the substrate temperature is increased from 600°C to 700°C, the band gap energy decreases further to a value of 2.3 eV due to better crystallinity of the films. The variation in the microstructure and band gap energy as a function of the background gas is presented in detail.

PSP1.10

Synthesis and Characterization of $La_{0.7}Ba_{0.3}MnO_3$-SnO_2 bilayer using Pulsed Laser Deposition Technique

J. Mona[1], Ram Prakash[2], R. Rawat[2], R.J. Choudhary[2], D.M. Phase[2], S.N. Kale[1]
1. Fergusson College, Fergusson College Road, Pune 411004
2. UGC-DAE CSR, Khandwa Road, Indore 452 017
e-mail id: snkale@vsnl.com

Manganite based p-n junction bilayers were deposited using pulsed laser deposition technique as this technique stands to be unique to grow stoichiometric and oriented films. These manganite based bilayers are interesting to study as they are expected to show rectifying properties over a wide temperature range and even work at high temperatures [1-3]. In this context we have deposited p-type manganite $La_{0.7}Ba_{0.3}MnO_3$ and n-type SnO_2 on Si (001) substrates. The $La_{0.7}Ba_{0.3}MnO_3$ and SnO_2 bulk samples were synthesized through chemical routes that were used as target material in the deposition chamber. Thin films were deposited in pulsed laser deposition chamber using KrF eximer laser (λ=248 nm *tp* ~20 ns). Deposition of these bilayers was performed in two steps. In first step a thin layer (~950 nm) of SnO_2 was deposited on Si (001) substrate at 580 °C in the oxygen partial pressure of $1.3x10^{-4}$ Torr, the deposited samples were cooled to room temperature at same oxygen pressure. In the second step a part of this film was masked and then $La_{0.7}Ba_{0.3}MnO_3$ film (~950 nm) was deposited at 500 °C in the oxygen partial pressure of 400 mTorr, the deposited samples were cooled to room temperature in 500 Torr oxygen ambient. In both of the cases laser energy density and pulse frequency was 2 J/cm^2 and 10 Hz, respectively. The bilayers were further examined for the structural and transport properties. The films were characterized by various techniques such as x-ray diffractometry (XRD), atomic force microscopy and four probe resistivity measurements. Crystal structure was determined using XRD. The XRD pattern of $La_{0.7}Ba_{0.3}MnO_3$ shows oriented growth, SnO_2 exhibits polycrystalline growth on Si (001) substrate. Atomic force microscopy reveals that the surface of the $La_{0.7}Ba_{0.3}MnO_3$-SnO_2 films is smooth. Good rectifying characteristics were observed at room temperature, which projects promising applications of these bilayers as diode-like device. Possible scenario of the surface morphology of the bilayers and the transport properties will be discussed. These results indicate that this p-n junction may be developed into functional, strongly correlated electronic devices at room temperature.

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PSP1.11

Semiconductor Nano-pattern formation through laser induced diffusion

U. Das , D. Mohanta , A.Choudhury
Dept of Physics, Tezpur University, Napaam, Tezpur – 784028, India
upam2005@gail.com

Due to strong particle-particle interaction, polymeric/inorganic nano-composites generally have primary affrications even agglomerations of inorganic nanoparticles. The particle agglomeration appears during self assembly of nanostructures and the interaction forces between the molecules and the nanoparticles play an important role in controlling the structures and consequently, the properties of the nanoparticles. When ZnS nanoparticles are embedded in an insulating matrix, it will show long term stability but diffusion of atom in the polymer is present. This material transport is driven by the free surface energy of the nanoparticles and associated with lattice defects and grain boundaries. These diffusion processes result in changes of the size and shape distribution of the embedded particles. The diffusion process is accelerated through laser irradiation. Controlled laser irradiation diffuses the atoms in a particular direction which will form some elongated nano-patterns. Better stability and these nano-patterns, make them a useful candidate for optoelectronics and photonics application.

PSP1.12

Growth of n-Zinc Oxide on various substrates using pulsed laser deposition and its photo conducting properties

G. Naresh Kumar, V.Immanuel, Francis P. Xavier
Loyola institute of frontier energy (LIFE), Physics Department, Loyola college, Chennai 600 034, India
email:naresh_matsci@yahoo.co.in

Pulsed laser deposition (PLD) has been shown to be a very successful method for preparing epitaxial layers as well as amorphous films. The advantages with PLD method are stoichiometric transfer of the target material, fine control of film thickness down to atomic monolayer and simplicity of operation [1]. In the present study Nd:YAG (λ = 532 nm) laser (with power density of 1 x 10^{-8} W/cm^2) has been used as an excitation source to ablate ZnO. Photo conductivity and temperature dependent conductivity of ZnO thin films deposited on sapphire, p-silicon and glass substrates by pulsed laser deposition (PLD) technique have been investigated. The X-ray diffraction (XRD) results indicate that the epitaxial growth has been achieved for sapphire substrate and poly crystalline growth has been achieved for silicon and glass substrates .The photoconductivity studies exhibit maximum photo response for epitaxially grown ZnO on sapphire substrate This might be due to the capture of nonequilibrium holes at surface oxygen states to produce an equivalent number of excess electrons in the conduction band [2]. From the temperature dependent conductivity studies the activation energy of the ZnO on sapphire was found to be 1.1 meV. This can be attributed either to the promotion of carriers to the conduction band, or the thermal field emission of these carriers through grain boundary barrier [2]. It is believed that the defects in the zinc oxide lattice behave as localized hopping centers, as well as carrier suppliers, that give rise to the observed conductivity.

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PSP1.13

The low temperature electrical transport in $La_{0.7}Ca_{0.3}MnO_3$

P.R. Sagdeo, R.J. Choudhary and D.M. Phase
UGC-DAE Consortium for scientific research, University campus Khandwa road indore 452017, M.P.

Email: sagdeo@csr.ernet.in

The electrical transport in manganites is one of the challenging problems to our present understanding of "electrons in matter". The phenomenon of colossal magnetoresistance (CMR), spin polarized transport, scattering of electrons from grain boundaries, low temperature resistivity minima, grain boundary magnetoresistance etc, are still not well understood through a common framework. Extensive theoretical and experimental efforts have been made right from 1951, but the electrical transport in manganites still remains unresolved.

The fellomagnetic metallic manganites are known to show the minimum in the resistivity at low temperature (~40K). But there is a debate regarding the origin of this resistivity minimum. The observed minima have been attributed to quantum interference effects, including weak-localizations and electron-electron interaction effects, and Kondo scattering, whereas the other possibility of inter grain antiferromagnetic coupling has also been predicated in the literature.

As in the literature there are various controversies regarding the origin of such resistivity minimum, i.e. whether is it due to the antiferromagnetic coupling between the grains, in polycrystalline samples, or due to the some scattering mechanisms, in the present studies we have carried out the comparative study on the pulsed laser deposited polycrystalline and oriented thin sample.

The polycrystalline and highly oriented thin films of $La_{0.7}Ca_{0.3}MnO_3$ has been simultenously deposited using pulsed laser deposition technique on silicon [111] and LaAlO3 (001) substrates respectively. The electrical transport measurements on these samples have been carried out starting from room temperature down to 4K. The polycrystalline thin film and oriented sample show the insulator to metal like transition around 250K, with further decrease in the polycrystalline sample of $La_{0.7}Ca_{0.3}MnO_3$ shows the resistivity minimum around 35K, where as the oriented thin film sample dose not show any resistivity minimum. The observation of resistivity minimum for polycrystalline thin film sample has been explained on the basis of disorder produced by grain boundary network.

PSP1.14

Effect of Structural Disorder on Electronic Transport in $La_{0.5}Pr_{0.2}R_{0.3}MnO_3$ (R = Sr, Ba) Manganite Thin Films

P.S. Solanki, R.R. Doshi, J.H. Markna, C.M. Thaker and D.G. Kuberkar
Department of Physics, Saurashtra University, Rajkot – 360 005

K.R. Mavani, D.S. Rana and S.K. Malik
DCMP & MS, TIFR, Mumbai – 400 005

P. Misra, B.N. Singh and L.M. Kukreja
Thin Film Laboratory, RRCAT, Indore – 452 013

Epitaxial thin films of $La_{0.5}Pr_{0.2}Sr_{0.3}MnO_3$ (LPSMO) and $La_{0.5}Pr_{0.2}Ba_{0.3}MnO_3$ (LPBMO) manganites on LAO substrates were synthesized using Pulsed Laser Deposition (PLD) technique with desired thickness of 150nm. To understand the effect of A-site cationic size disorder (σ^2) on the electronic transport properties of $La_{0.5}Pr_{0.2}R_{0.3}MnO_3$ (R = Sr^{+2}, Ba^{+2}) thin films, the d.c. resistivity studies were carried out with and without applied fields. It is observed that the LPSMO films exhibit half metallic behavior in a broad range of temperature below the insulator – metal transition (T_{IM}) while the LPBMO films exhibit low temperature resistivity minima. These results have been discussed in the light of the cationic size disorder at A-site in both the films. Also, the effect of size disorder on the temperature coefficient of resistance (TCR), a parameter useful for temperature sensing application, has been understood in the present work.

PSP1.15

Improvement in field sensitivity of La-based manganite multilayered structure

P.S. Vachhani, J.H. Markna, J.A. Bhalodia and D.G. Kuberkar
Department of Physics, Saurashtra University, Rajkot – 360 005, India

P. Misra, B.N. Singh and L.M. Kukreja
Thin Film Lab, Centre for Advances Technology, Indore- 452 013, India

V. Ganesan and R. Rawat
UGC-DAE CSR, Indore centre, Indore – 452 017

We report the results on the field sensitivity studies on the manganite based $La_{0.5}Pr_{0.2}Sr_{0.3}MnO_3$ [5] / $La_{0.5}Pr_{0.2}Ba_{0.3}MnO_3$ [4] / STO multilayered structure grown by Pulsed Laser Deposition (PLD) technique. It is observed that a large Field Coefficient of Resistance (FCR) ~ 35% alongwith an appreciably large MR ~ 56% is exhibited by this heterostructure at RT. It is proposed that, the improved field sensitivity of the LPSMO/LPBMO/STO multilayer can be attributed to the spin dependent percolative transport at large number of interfaces in the heterostructure. The results on the microstructural, transport and magnetotransport properties of the multilayer studied will be discussed in detail.

PSP1.16

Synthesis and Characterization of $PrCoO_3$ thin films grown by Pulsed Laser Deposition

Ram Prakash*, R. J. Choudhary, D. M. Phase
UGC-DAE Consortium for Scientific Research, Indore (M.P.) 452017, India.
*Email: ramprakash@csr.ernet.in

Cobaltates $ACoO_3$, where A is the rare earth element, form an interesting class of compounds in the perovskite family having miscellaneous interesting properties. These compounds show magnetic and electric transitions. It is believed that such transitions occur due to the thermally driven spin state transition of Co^{3+} ions. The spin transition temperature and mechanism (from low spin to directly high spin or via intermediate spin states) for different A elements are different and the difference is mainly attributed to the different ionic radii of A elements. This leads to different pressure on CoO_6 octahedra of the series members. The ground state of $PrCoO_3$ (PCO) is nonmagnetic insulator. The crystal structure of PCO is a slightly distorted perovskite with orthorhombic structure (space group, Pbnm) at room temperature. To understand the effect of substrate induced strain on these properties in PCO, we have deposited thin films of $PrCoO_3$ on (111) Si, (001) $LaAlO_3$ (LAO) and (001) SrTiO3 (STO) substrates by pulsed laser deposition technique. The bulk target was prepared by sintering the powder, which was prepared by combustion method, at 1200 °C for 12 hours. The KrF (wavelength =248 nm) excimer laser was used as source. The deposition was done at O_2 partial pressure 100-400 mTorr. The substrate temperature was kept at 680 °C. These films were characterized by x-ray diffraction (XRD), scanning electron microscopy (SEM), and x-ray photoelectron spectroscopy (XRD) techniques. XRD results revel that all films are single phase and films on silicon substrates are polycrystalline while films deposited on STO, LAO are highly oriented along c-axis. The SEM images show highly smooth surface and films having very less particulates on the surface of the film. The XPS measurements used to get the chemical state of ions present in the films. XPS results clearly indicate that our films are free from impurity and chemical state are as expected for $PrCoO_3$. The effect of deposition conditions on their physical properties is reported in this paper.

PSP1.17

Effect of laser energy on the structural and optical properties of non-reactive pulsed laser ablated tantalum oxide thin films

Renju R Krishnan, K. M. Nissamudeen, K. G. Gopchandran and V. P. Mahadevan Pillai*
Department of Optoelectronics, University of Kerala, Kariyavattom, Trivandrum-695581, Kerala, INDIA
*corresponding author: vpmpillai9@rediffmail.com

Thin films of Tantalum Oxide (Ta_2O_5) were deposited on glass substrates by non-reactive pulsed laser ablation technique using a 532 nm radiation from Spectra Physik Quanta Ray INDI Pulsed Nd:YAG laser having a pulse width of 9 ns and repetition frequency 10 Hz. Pressed pellets of Ta_2O_5 were used as the target. The chamber was evacuated to a base pressure of 5 x 10^{-6} mbar. The films were deposited by keeping target to substrate distance (On-axis) of 6.5 cm for a deposition time of 15 minutes. The effect of laser energy on the structure and morphology of the deposited films were investigated by varying the laser energy from 45 mJ to 65 mJ , in steps of 5 mJ. XRD studies show an amorphous nature for the as-deposited films irrespective of the laser energy. Stretching vibration mode of Ta-O-Ta was identified from the FTIR spectra of the films. The weak bands observed in the region 1000-1800 cm^{-1} in the spectra of films deposited at 60 mJ and 65 mJ is due to the absorbed impurities by the films. This suggests the possibility of using these films for gas sensing applications. The SEM micrographs showed a granular structure for the film deposited at a laser fluence of 45 mJ which changed to tubular form for the films deposited at 50 and 55 mJ.. The structural change was gradual and is described with SEM micrographs, the transition found effecting at about 50 mJ. At 60 mJ, the tubular form completely disappeared and the morphology again showed a granular form different from that obtained for 45 mJ. This structural change reveals the strong dependence of laser fluence on the morphology of Ta_2O_5 thin films.

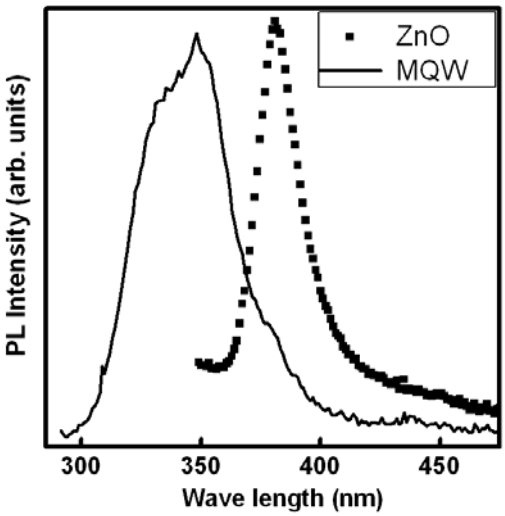
PSP1.18

Room temperature luminescence from low temperature grown ZnMgO/ZnO Quantum wells using pulsed laser deposition.

R.S. Ajimsha, M.K.Jayaraj*
Optoelectronics Devices Laboratory, Department of Physics,
Cochin University of Science and Technology, Cochin-22.
P Misra, L.M. Kukreja
Thin Film Lab, Raja Ramanna Centre for Advanced Technology, Indore - 13
*Email: mkj@cusat.ac.in

ZnO based materials are excellent candidates for optoelectronics applications in the visible and ultra violet (UV) regions. A large exciton binding energy (59 meV) permits excitonic recombination even at room temperature (RT). In fact RT lasing in ZnO epilayers on sapphire (0001) has been experimentally demonstrated. The quantum well approach is necessary towards the goal of current injection laser. When lattice matched substrate $ScAlMgO_4$ (SCAM) was used instead of sapphire, a significant improvement in the structural and optical properties was obtained, which was evident from their efficient photoluminescence. The scarce availability and expensive nature of SCAM substrates necessitated to improve the method of growing ZnMgO/ZnO quantum wells on sapphire. The literatures on the room temperature photoluminescence from ZnMgO/ZnO MQW on sapphire substrate are limited.

In this paper we report the growth of ZnMgO/ZnO MQWs of well layer thickness of 2 nm on sapphire (0001) substrate by PLD at a substrate temperature 400^{o}C. The depositions were carried out with a high purity oxygen pressure of 10^{-4} mbar and laser energy density of 2 J/cm^2. The target to substrate distance was 60 mm and the substrate temperature was kept at ~400^{o}C. The typical growth rate (measured through separate experiments) at these optimized conditions was found to be 0.18 nm /s for ZnO and 0.14 nm/s for ZnMgO targets. These growth rates were used to determine the thickness of well and barrier layer respectively. Initially, a buffer layer of ZnO (thickness 50 nm) was deposited on sapphire substrate to minimize the lattice mismatch between sapphire and barrier layer of MQW. Then, ten periods of ZnMgO/ZnO layers were grown with a ZnMgO barrier layer thickness of 8 nm and a ZnO well layer thickness 2 nm on this ZnO template. Efficient room temperature photoluminescence was observed from these MQW's, which was found to be blue shifted as compared to the RT near band edge PL from ZnO thin film as shown in the figure above. A detailed investigation on the temperature dependence of PL line width and spectral peak position of ZnMgO/ZnO MQW and ZnO thin film was made in a broad temperature range from 77 K to 300 K. The observations have been explained using the existing theoretical models.



PSP1.19

Novel feature of quantum transport through finite width mesoscopic ring

Santanu K. Maiti
[1]*Theoretical Condensed Matter Physics, Saha Institute of Nuclear Physics, 1/AF, Bidhannagar, Kolkata-700 064, India*
[2]*Department of Physics, Narasinha Dutt College, 129, Belilious Road, Howrah-711 101,India*

The advancements in nanoscience and technologies prompting a growing number of researchers across multiple disciplines to attempt to devise innovative ways for decreasing the size and increasing the performance of microelectronic circuits. One possible route is based on the idea of using molecules and molecular structures as functional devices. In 1974 Avriam et al.[1] first studied theoretically the electron transport characteristics in molecular bridge systems. Later several numerous experiments[2,3,4] have been carried out on electron transport through molecules placed between two non-superconducting electrodes with few nanometer separation. From experimental developments, theory can give a better insight in understanding the new mechanism of conductance but yet the complete knowledge of the conduction mechanism in this scale is not well understood even today.

In this article we explore the effect of edge disorder on quantum transport through a finite width mesoscopic ring attached with two semi-infinite metallic electrodes by the use of Green's function technique. Parametric calculations are given based on the tight-binding formulation[5,6,7,8] to describe the transport properties through such bridge system. A novel transport phenomenon is observed which gives the enhancement of the current amplitude with the increase of the edge disorder strength in the strong disorder regime, while, the amplitude decreases in the weak disorder regime. This feature is completely opposite to that of the bulk disordered ring. In this context we also study the effects of the radius and the width of the ring on such transport and see that the transport properties are significantly influenced by them.

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PSP1.20

Structural, Optical and Electrical Properties of Co and Ga codoped ZnO Thin Films Prepared by Pulsed Laser Deposition

M. Subramanian[a*], G. Mohan Kumar[b], P. Mishra[c]. Swati Pandya[c], A. Das[d], B. N. Singh[d], S. Venkatraj[a], S. Vijayalakshmi[a], V. Ganesan[c], R. Jayavel[a,b] and L.M. Kukreja[d]
[a]Crystal Growth Centre, Anna University, Chennai – 600 025
[b]Centre for Nanoscience and Technology, Anna University, Chennai – 600 025
[c]UGC-DAE CSR, Uniersity Campus, Khandwa Road, Indore-652 017
[d]Thin Film Laboratory, RRCAT, Indore-652 013

ZnO, $Zn_{0.95}Co_{0.05}O$ and $Zn_{0.95}Co_{0.05}Ga_{0.03}O$ films have been prepared by Pulsed laser deposition on sapphire substrates. The structural properties were characterized by HRXRD and Raman spectroscopy and the results reveal that the films are having wurtzite structure. But when we introduce Ga, full width half maximum for (002) peak was increases and this may be due to increase the disorder in the film. Surface analysis performed by scanning electron microscopy (SEM). From the UV-VIS spectroscopy were studied and the optical band gap increases for Mn and Ga codoped films compared with undoped ZnO and the results were discussed indetail. The electrical properties were studied and the results will discuss in detail. The magnetic properties were studied by VSM and discussed in detail.

PSP2.1

Structural, Optical and Electrical Properties of $Zn_{1-(x+y)}Mn_xGa_yO$ Thin Films Prepared by Pulsed Laser Deposition

M. Subramanian[a*], P. Ilanchezhiyan[b]P. Mishra[c]. Swati Pandya[c], Amit Das[d], B. N. Singh[d], S. Venkatraj[a], S. Vijayalakshmi[a], V. Ganesan[c], R. Jayavel[a,b] and L.M. Kukreja[d]
[a]Crystal Growth Centre, Anna University, Chennai – 600 025
[b]Centre for Nanoscience and Technology, Anna University, Chennai – 600 025
[c]UGC-DAE CSR, Uniersity Campus, Khandwa Road, Indore-652 017
[d]Thin Film Laboratory, RRCAT, Indore-652 013

ZnO, $Zn_{0.95}Mn_{0.05}O$ and $Zn_{0.95}Mn_{0.05}Ga_{0.03}O$ films have been prepared by Pulsed laser deposition on sapphire substrates. The structural properties were characterized by HRXRD and Raman spectroscopy and the results reveal that the films are having wurtzite structure. But when we introduce Ga, the crystalline quality found to be deteriorated. The surface analysis performed by scanning electron microscopy (SEM). From the UV-VIS spectroscopy were studied and the results will discuss in detail. The optical band gap increases for Mn and Ga codoped films compared with undoped ZnO. The electrical properties were studied and the results will discuss in detail. The magnetic properties were studied by VSM and discussed in detail.

PSP2.2

Effect of doping and substrate temperature on the structural and optical properties of reactive pulsed laser ablated Aluminium Oxide doped Tantalum Oxide thin films

Renju R Krishnan, K. M. Nissamudeen, K. G. Gopchandran and V. P. Mahadevan Pillai*
Department of Optoelectronics, University of Kerala, Kariavattom, Trivandrum-695581, Kerala, INDIA *corresponding author: vpmpillai9@rediffmail.com

Tantalum oxide (Ta_2O_5), a potential candidate in microelectronics industry, has received considerable attention because of its high dielectric constant, high refractive index, chemical and thermal stability and promise of being compatible with microelectronic processing. Thus far, Ta_2O_5 films have found applications in various fields such as gate insulators in metal oxide semiconductor (MOS) devices, optical coatings and antireflection coatings. Thin films of Ta_2O_5 doped with 5 wt. % Al_2O_3 (Aluminium oxide) are deposited on quartz substrates by reactive pulsed laser deposition (PLD) technique using a Q-switched Nd: YAG laser (Quanta-Ray INDI series, Spectra Physics) with frequency doubled 532 nm radiation of energy 200 mJ (pulse width 7 ns and pulse repetition frequency-10 Hz). The chamber is evacuated down to base pressure of 5 x 10^{-6} mbar prior to deposition. The films are deposited at different substrate temperature, viz, 300 , 673 , 773 , 873 and 973 K at an oxygen pressure of 0.002 mbar for duration of 15 minutes, keeping the target to substrate distance at 6.5 cm. The effect of Al_2O_3 doping and substrate temperature on the deposited films are systematically studied using Grazing Incidence X-ray Diffraction (GIXRD), Micro-Raman spectroscopy, Fourier Transfrom Infrared Spectroscopy (FTIR), Atomic Force Microscopy (AFM) and UV-VIS spectrophotometry techniques.

PSP2.3

Optimizing the doping concentration in a single experiment by using Combinatorial Laser Molecular Beam Epitaxy (CLMBE)

Utpal S. Joshi[1], Kenji Itaka[2], Yuji Matsumoto[3], Masatomo Sumiya[4] and Hideomi Koinuma[2,5]

1. Department of Physics, School of Sciences, Gujarat University, Ahmedabad – 380 009, India

2. Institute of Solid State Physics, The University of Tokyo, Kashiwa, Kashiwanoha, Chiba 277-8581, Japan

3. Materials and Structures Laboratory, Tokyo Institute of Technology, 4259 Nagatsuta, Midori-ku, Yokohama 226-8503, Japan

4. Department of Electrical Engineering, Shizuoka University, 3-5-1, Hamamatsu, Japan

5. CREST, Japan Science & Technology Corporation (JST), 4-1-8, Honcho, Kawaguchi, 332-0012, Japan

p-type wide band gap oxide semiconductors are of fundamental importance for optoelectronics and photonics. There are well known *n*-type transparent & conducting oxide semiconductors (TCO), such as ZnO, TiO_2, SnO_2 etc. NiO, when doped with monovalent Li is a promising *p*-type semiconductor with an optical band gap of 3.7 eV. In order to obtain high conductivity with better optical transparency, optimum substitution of Li in NiO is required. It is time and energy consuming to achieve an optimized Li content in the NiO films by using the conventional pulsed laser ablation technique. Here we report on the combinatorial laser MBE technique of parallel thin film fabrication for rapid optimization of dopant concentration. Details of thin film fabrication by CLMBE will be presented. The films were characterized by grazing angle XRD, AFM, optical spectroscopy, secondary ion mass spectroscopy (SIMS) and room temperature conductivity measurements. Atomically smooth surface with RMS roughness comparable to the NiO unit cell was obtained. High optical transparency beyond 75% in the visible region was achieved. Room temperature conductivity of the order of 1.41 mho cm^{-1} was obtained in the 50 nm thick films grown on single crystalline MgO(100) substrates. Detailed SIMS analysis for the optimized Li concentration will be discussed.

This was carried out at Tokyo Institute of Technology under the BOYSCAST fellowship award to USJ by DST India.

PSP2.4

Superparamagnetism in epitaxial thin films of Fe, Cr, Co, Mn and V doped *p*-type NiO

U. V. Chhaya[1], P.S. Raval[2], P.A. Joshi[2], S. Trivedi[2], K. Itaka[3], Y.Matsumoto[4], H. Koinuma[3,5] and U.S. Joshi[2,*]

1. *Physics Department, St. Xavier's College, Ahmedabad-380 009, India*
2. *Department of Physics, School of Sciences, Gujarat University, Ahmedabad – 380 009, India*
3. *Institute of Solid State Physics, The University of Tokyo, Kashiwa, Kashiwanoha, Chiba 277-8581, Japan*
4. *Materials and Structures Laboratory, Tokyo Institute of Technology, 4259 Nagatsuta, Midori-ku, Yokohama 226-8503, Japan*
5. *CREST, Japan Science & Technology Corporation (JST), 4-1-8, Honcho, Kawaguchi, 332-0012, Japan*

e-mail : usjoshi@gmail com

Discovery of room temperature ferromagnetism in Co doped TiO_2, prompted a growing interest to explore new diluted magnetic semiconductors. Recent theoretical calculations showed half metallic behavior in the vacancy induced NiO, which is considered to be an inherent property of almost all the known DMS compounds including transition metal doped III-V semiconductors. To explore a possible magnetic ordering in *p*-type wide band gap oxides, we have investigated the effect of transition metal substitution in NiO. Thin films of $TM_{0.1}Ni_{0.9}O_y$ (TM = Co, Cr, Fe, Mn and V) were fabricated by pulsed laser deposition on MgO(100) substrate using KrF excimer laser (248 nm). XRD confirmed an epitaxial growth with a systematic shift in the NiO(200) peak corresponding to various transition metal ions. RMS roughness of the films, determined from the AFM was about 0.31 nm, which is less than the NiO unit cell. Magneto-optical Kerr effect exhibited negative magnetic rotation with a dip for all the 3d ions and a systematic shift in the dip with the photon energy, is attributed to *d* electron transitions in the dip levels of 3d ions. SQIUD measurements showed a superparamagnetic behavior down to 5 K in fe and Cr doped NiO films. Possible spin interaction of Ni and TM ions will be discussed.

We thank DST, India and Kato Foundation, Japan for financial support.

PSP2.5

Structural and Optical properties of GdO doped ZnO Thin Films by Pulsed Laser Deposition Technique

R.Vinodkumar , D.Beena, Geo Rajan, Jayasree R.S. and V.P.Mahadevan Pillai*.
Department of Optoelectronics, University of Kerala, Thiruvananthapuram, Kerala, India – 695581.
e-mail- vpmpillai9@rediffmail.com

Recent developments in the fabrication of devices like nano-scale lasers, electrochemically gated quantum doted transistor and the highly efficient exciton UV lasing action under optical pumping from the ZnO nanoclusters and thin films, indicate that ZnO is a promising material for applications in modern nano-electronics and nanophotonics. Zinc oxide is an *n*-type semiconductor with a wide band gap of 3□37 eV[1-2]. Wei Lin et.al. have studied the structural, electrical and optical properties of GdO doped ZnO thin films prepared by RF magnetron sputtering[3]. To the best of our knowledge this is the first report PLD prepared GdO doped ZnO films. Undoped ZnO and GdO doped ZnO thin films were deposited on an optically flat fused silica (quartz) substrate using pulsed laser deposition technique. The depositions were carried out inside a vacuum chamber using a Q-switched Nd: YAG laser (Quanta-Ray INDI-series, Spectra Physics) with frequency doubled 532 nm radiation with pulse width 7 ns and repetition rate 10 Hz. The deposition was carried out under room temperature and a base pressure of 6 x 10^{-6} mbar. The distance between the substrate and target was 6 cm and the laser energy for the deposition was 160 mJ. The experiment was repeated at different duration and at different annealing temperatures. The crystal structure and surface morphology of the films were investigated using X-ray diffraction and AFM measurements. Optical absorption spectra were recorded using a UV-VIS double beam spectrophotometer (JASCO V 550) in the spectral range of 200 – 900 nm. Photoluminescence spectra of the samples were recorded by Horiba Jobin Yvon Flourolog III modular spectroflourometer. The optical constants are calculated from the transmission spectra using the swanepoel's envelope method. In addition to the UV peaking there is a deep level emission in the blue and green region. The influence of GdO doping, ablation time and annealing temperature on the structural and optical properties of the ZnO thin films are investigated.

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PSP2.6

Structural, Morphological and Optical studies of Potassium Lithium Niobate thin films prepared under ambient conditions of substrate temperature.

V. Jayasree, R Vinod Kumar, R Ratheesh[a], V. P Mahadevan Pillai & V. U Nayar*
Department of Optoelectronics, University of Kerala, Kariavattom, Trivandrum, Kerala, 695 581 India
[a] Centre for materials for electronic Technology, Athani P. O Thrissure 680771, India.
* nayarvu@sancharnet.in

Filled tungsten- bronze ferroelectrics which have a general chemical formula $(A_1)(A_2)_2C_2(B_1)(B_2)_4O_{15}$ have attracted much attention as materials for the fabrication of optoelectronic devices, especially for nonlinear optical applications because they have a large optical damage threshold originating from their crystal structure. $K_3Li_2Nb_5O_{15}$ (KLN) is a typical compound of completely filled tungsten- bronze ferroelectrics having tetragonal structure and is one of the most promising material for various optical applications because of its large electro optic, nonlinear optic and piezoelectric properties. Pulsed Laser Deposition is a suitable technique for depositing such complex materials .In the present investigation, thin films of the ferroelectric potassium lithium niobate are prepared by pulsed laser deposition technique on glass substrate under reactive atmosphere with different substrate temperatures and their morphological and optical properties are studied. The irradiations are performed using a Q- switched Nd: YAG laser with frequency doubled 532 nm radiation of energy 70 mJ, having pulse width 7 ns and repetition frequency 10 Hz (Quanta – Ray INDI – series, Spectra Physics). The laser impinged on the target at 45^0 with respect to the normal in a dynamic flow of oxygen. The vacuum chamber was evacuated down to a base pressure of $4.8x10^{-6}$ mbar using a diffusion pump and two rotary pumps. The depositions of the films were done on a glass substrate kept at a distance of 70 mm from the target at various background pressures. The target was prepared from the stoichiometric compositions of K_2CO_3 (99.99%), Li_2CO_3 (99.99%) and Nb_2O_5 (99.99%). These materials were mixed well using an agate mortar for an hour using distilled water as solvent. The resultant mixture is dried in an oven at 100 ºC. The mixture is then transferred to an alumina crucible and calcined at 1100 ºC for 2 hours. The powder is then pressed into the pellet of size 7 mm thickness and 11 mm diameter and the pellets are heated to 1000 ºC for 2 hours to get well sintered target for PLD operation. During ablation the target was rotated with constant speed to avoid pitting of target at any given spot and to obtain uniform thin films. The films were prepared in a reactive atmosphere for an ablation time of 20 minutes. This paper reports the effect of the substrate temperature on the structural, morphological and optical properties of laser ablated potassium lithium niobate thin films. The crystalline nature and orientations of these films are characterized by gracing incidence X-ray diffraction (GIXRD) (Siemens D5000 diffractometer) measurements employing Cu Kα radiation with a wavelength of 0.15405 nm. The surface morphology of the deposited films has been investigated using the AFM images recorded by a Digital Instrument Nanoscope E atomic force microscope. AFM tip of Si_3N_4 having a force constant of 0.58 N/m in contact mode operation has been employed for the measurements. The optical transmission and reflectance spectra of the films are recorded using a JASCO V 550 UV-VIS double beam spectrophotometer in the wavelength range of 190-900 nm. It has been found that the substrate temperature has a strong influence on the structure morphology and optical characteristics of KLN thin films.

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PSP2.7

Studies on effect of europium concentration on the photoemission of laser ablated Y_2O_3:Eu based nano-phosphors.

K.M. Nissamudeen, Renju R Krishnan, Geo Rajan and K.G. Gopchandran
Department of Optoelectronics, University of Kerala, Kariavattom, Thiruvananthapuram
gopchandran@yahoo.com

Phosphors are essential materials in display applications. Oxide-based phosphors are likely to emerge as the potential choice for the FED red phosphor. Among those oxide-based phosphors, there has been significant research interest in the development of Y_2O_3:Eu thin films as one of the most promising oxide based red phosphor systems. Yttrium oxide mixed with europium exhibit strong UV and cathode-ray-excited luminescence that are useful in lamp and display applications. Dielectric Y_2O_3 film has recently attracted much attention for its potential application as an electric insulation layer in electroluminescent devices and high-density dynamic random access memory gate dielectrics because of its high band gap (5.8 eV) and large dielectric constant (14 to18). Another important application of Y_2O_3 has been in luminescent displays as a host material for rare-earth ions, specifically europium, in order to get emission of red light. In the present study thin films were deposited under a vacuum of 10^{-6} mbar on fused amorphous quartz substrates using a Q- switched Nd: YAG laser, 532 nm, pulse width 9 n sec, and repetition frequency of 10 Hz, with sintered Y_2O_3 pellets having different europium concentration as target material. Attempts were made to understand the effect of europium concentration and annealing process on the photoemission properties of the films.

A europium concentration of 8 wt% and an annealing temperature of 1173 K were found to be optimum conditions for maximum photoemission. The dependence of structure and morphology of the films on the photoemission intensity are described with XRD patterns and images obtained from AFM and SEM studies.

PSP2.8

Studies on Si Doped ZnO Thin Films Grown by Sequential Pulsed Laser Deposition

A. K. Das*, B. N. Singh, P. Misra and L. M. Kukreja
Thin Film Laboratory, Raja Ramanna Centre for Advanced Technology, Indore 452 013
*Corresponding author email: amitdas@cat.ernet.in

We have grown ZnO films doped with different concentrations of Si on sapphire substrates using sequential Pulsed Laser Deposition. These films show excellent optical and electrical characteristics suitable for transparent conducting electrodes applications. 3rd harmonic of a Q-switched Nd:YAG laser (355 nm, 10 Hz & 6 ns) at a fluence of ~ 1 J/cm^2 was used for the ablation of the Si and ZnO targets consecutively, with variable ratio of their respective times of ablation to vary the Si concentration in these films. The depositions were carried out at 600ºC substrate temperature and 1x10^{-4} Torr of oxygen ambient pressure. All the films were found to be highly transparent (~80%) in the visible spectral region as shown in figure 1. This figure also shows that the band-gap of ZnO increased slightly with increasing Si concentration. The x-ray diffraction studies on these films revealed hexagonal wurtzite structure with high c-axis orientation. Figure 2 shows the variation of the electrical resistivity of the ZnO films with different Si concentrations. As can be seen the resistivity of the films initially decreased drastically and then increased modestly with increasing the Si concentration. This could be because Si, being in group IV, might act as a donor, an acceptor or go to the interstitial sites. However, it appears that the predominant role of Si, particularly at low concentrations is to act as a donor, which in turn is expected to enhance the conduction electron density, thereby decreasing the resistivity.

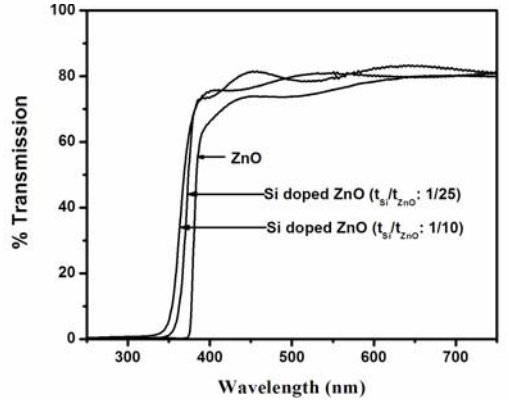


Figure 1

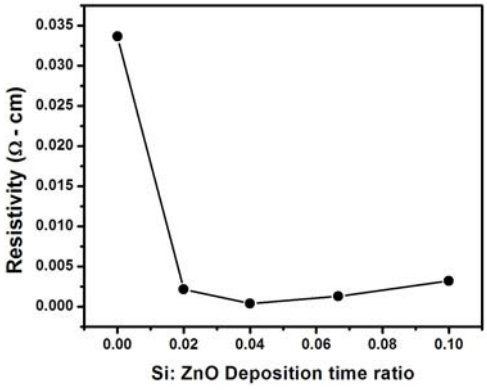


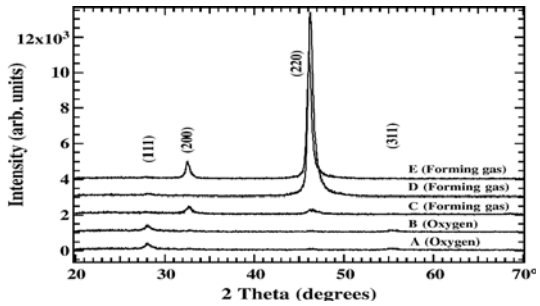
Figure 2

PSP2.9

Textured CeO_2 thin films on amorphous substrate by PLD at room temperature

T K Chaudhuri
Dr. K C Patel Research and Development Centre
Education Campus – Changa, Changa (Petlad), Anand, Gujarat 388 421, INDIA
tkchaudhuri@gmail.com
and
R N Bhattacharya
National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden,
Colorado 80401, USA

Textured CeO_2 thin films are of special interest because of their use as templates for growing textured silicon and yttrium barium copper oxide (YBCO) films. Further low temperature deposition of textured CeO_2 films on amorphous substrates may open up the possibility of fabricating textured Si films on glass and plastics. Textured (200) CeO_2 films have been grown at room temperature on amorphous quartz glass either by PLD based high energy ion beam-assisted deposition (IBAD) or by two-beam IBAD. However, IBAD-like conditions may be attained if suitable laser pulse energy, substrate-target distance and gas pressure is selected. The generation of high speed particles in the plume during PLD is likely to assist in texturing of film. This paper reports the use of such a condition to deposit of textured CeO_2 films on glass by PLD at room temperature. CeO_2 films were deposited at RT (~20 ^oC) in a standard PLD chamber (Neocera) with an excimer KrF laser (Lambda Physik, Compex 201, λ=248 nm) operated at 3 to 10 Hz and fluence of 2 to 4 J/cm^2. Gas used was either 0.4 Pa of O_2 or forming gas (4% H_2 and 96% Ar). The target was aligned parallel to the surface of the substrate separated by 2.5 cm. The thickness of films was around 0.2 μm. The films were characterized by X-ray diffractometer (XGEN-4000, Scintag Inc., USA) and atomic force microscopy (Autoprobe cp, Park Scientific Instruments, USA).



Sample	Gas	Repetition Rate (Hz)	Fluence (J/cm^2)
Film A	oxygen	3	2
Film B	oxygen	10	2
Film C	forming	3	2
Film D	forming	10	2
Film E	forming	10	4

Fig.1 . X-ray diffraction plot of CeO_2 films on glass prepared at different conditions as above.

The XRD plots of typical CeO_2 films prepared at different PLD conditions are shown in Fig. 1 A to B. The figure reveals that in general the CeO_2 films are polycrystalline in nature. Films A and B deposited in O_2 (2 Jcm^{-2} fluence) have weak broad XRD lines of (111) and (311) and very weak (220) implying poor crystallinity. Further, increasing the rate of deposition from 3 Hz (film a) to 10 Hz (Film B) did not have any effect on the crystallinity or orientation of films. Film prepared in forming gas (Film C) with repetition rate of 3 Hz and fluence of 2 Jcm^{-2} exhibits only weak XRD lines of (200) and (220), which is different than that observed in films A and B. However, XRD plots of A, B and C films show that there is a tendency for CeO_2 films to grow along (110) direction if deposited with the experimental conditions of the present investigation. XRD plot of film (Film d) deposited with higher repetition rate of 10 Hz shows a very strong (220) line along with a very weak (111) line. Pole figure in (111) direction did not show any distinct poles but a ring which means that in-plane orientation is absent in these films. This implies that these films are preferentially (out-of-plane) orientated along the (110) direction. The rate of deposition has a pronounced effect on the crystallinity of CeO_2 films prepared in forming gas. By increasing the rate of deposition from 3 Hz to 10 Hz the poor polycrystalline films (Film C) were changed to highly oriented polycrystalline films (Film D) due to increased flux of laser ablated material reaching the substrate. The AFM studies show that CeO_2 films are fairly smooth with Root-Mean-Square roughness of about 2 nm. The above results indicate that the preferred direction of growth for CeO_2 film on glass at room temperature is (110) if deposited by PLD using the conditions mentioned above. This implies that (100) growth may be effected by tilting the substrate by 45^o with respect to the normal of the surface of the target.

PSP2.10

Synthesis of II-VI Oxide Semiconductor Nanocrystals by Pulsed Laser Ablation in Liquid Media

S.C. Singh, R.K. Swarnkar and R. Gopal

Laser and Spectroscopy Laboratory, Department of Physics,
University of Allahabad, Allahabad-211002
Spectra2@rediffmail.com

Pulsed laser ablation in liquid media with different ablation parameters is used for the synthesis of nanocrystals of II-VI semiconductor oxides. Various ablation parameters are wavelength, energy, focusing condition, temperature and pressure of ablation media, nature and concentration of surfactant used, and dipole moment of liquid media. Possible mechanism of the synthesis of these nanocrystals will be discussed. UV-visible absorption, XRD, SEM, TEM, FTIR, Raman, and Photoluminescence spectroscopy will be used for characterization of produced nanocrystals. Oxides and sulphides nanocrystals of Zinc and Cadmium will be main theme of the presentation. A comparative study between different (ZnO, CdO, ZnS, CdS) nanocrystals produced by laser ablation will be investigated.

PSP2.11

Studies on CoZnO thin films grown by Pulsed Laser Deposition

Satyapal S. Rathore*, A.K.Das, B.N. Singh, P.Misra and L.M.Kukreja
*Dept. of Applied Physics, Birla Institute of Technology, Mesra 835 215
Thin Film Lab., Raja Ramanna Centre for Advanced Technology Indore 452 013
* satyapal03@gmail.com

Currently there is world wide interest in developing Diluted Magnetic Semiconductors based on wide bandgap Oxide materials ZnO, TiO_2 and ZrO_2 etc for futuristic spintronic and spin-photonic devices based entirely on oxide materials. Among these materials ZnO is of prime interest due to its rugged wurtzite crystal structure, ability of controlled bi-polar carrier doping and large solubility of magnetic impurities. Recent theoretical and experimental reports indicated that the ZnO doped with transition metal elements (eg, Mn, Co, Ni and Fe etc) may undergo ferromagnetic transitions even at room temperatures. In the present work, we have deposited Co doped ZnO films by Pulsed Laser Deposition and studied their optical and structural properties. 3rd harmonic of a Q-switched Nd:YAG laser (355 nm, 10 Hz & 6 ns) at a fluence of ~ 1 J/cm^2 was used for the ablation of Co doped ZnO pellets. The pellets containing 3, 5 and 7 mole % of Co were prepared by the standard cold ceramic processing techniques and then sintered at 1000ºC for 2 Hrs. Prior to the deposition, the chamber was evacuated to a base vacuum of $1x10^{-6}$ mbar and depositions were carried out at an oxygen partial pressure of $1x10^{-4}$ mbar and at a substrate temperature of 600ºC. The Transmission spectra of these films taken using UV-Visible spectrophotometer in the wavelength range 800 nm to 250 nm is shown in the figure 1 below. The conspicuous mid-gap absorption bands at ~659 nm, 616 nm and 568 nm can clearly be seen in the transmission spectra of all the compositions. These mid gap absorption bands are due to the Co^{2+} interatomic d-d transition associated with the crystal-field splitting in ZnO host. And are represented as the transitions from $^4A_2(F)$ to $^2E(G)$, $^4T_1(P)$ and $^2A_1(G)$ respectively. These transitions implies that Co^{2+} have substituted the tetrahedrally coordinated Zn sites in ZnO lattice. The Bandgap was calculated from the transmission spectra using Tauc plot. The bandgap of the films was found to red shifted with increasing Co concentration. The high resolution X-ray diffraction pattern of these films as shown in figure 2 also confirmed hexagonal wurtzite structure of CoZnO with a high c axis orientation and without any impurity segregation. Further works in this direction are underway.

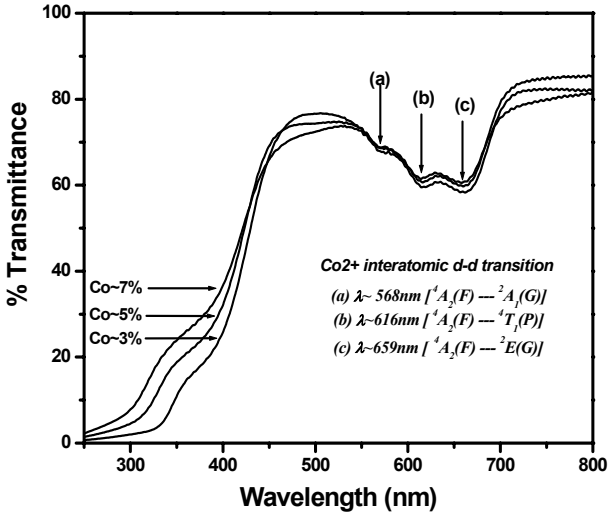


Figure 1

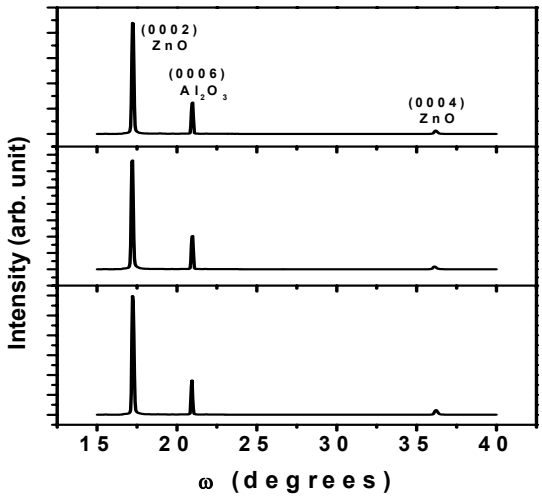


Figure 2

PSP2.12

Laser assisted growth of Eu^{3+} doped $Ba_{0.7}Sr_{0.3}TiO_3$ thin film for optoelectronic and ferroelectric application

R.Reshmi[1],, M.K.Jayaraj[1] ,M.T.Sebastian[2]

[1]*Optoelectronics Device Laboratory, Department Of Physics*

Cochin University of Science and Technology

Kochi-682022, India

[2]*Regional Research Laboratory, Thiruvananthapuram 695019, India,*
Email: mkj@cusat.ac.in

Luminescent rare earth doped materials are extensively being studied because of their technological application in photonic devices and next generation flat panel displays. Rare earth ions exhibit a characteristic intra 4f shell luminescence which is almost insensitive to host material and temperature. This feature can be used to tune the emission spectrum for specific application by the appropriate doping of rare earth ions in host material. Pervoskite structure materials are attractive as host materials for rare earth doping because of their application in integrated light emitting devices, field emission devices (FED's) all solid – compact laser devices operating in the blue-green region and positive temperature coefficient (PTC) resistors. ABO_3 type of pervoskite compounds such as $BaTiO_3$, $SrTiO_3$ and solid solution of them viz $Ba_xSr_{(1-x)}TiO_3$ (BST) have drawn a good deal of attention due to their attractive ferroelectric and electro optic properties.

In this work we report the Pulsed Laser deposition of Europium doped barium strontium titanate (BST:Eu) thin films. The structural, optical properties and electrical properties of the PLD grown BST film have been investigated. The photoluminescence spectrum showed the transitions of Eu^{3+} at 615nm ($^5D_0$ - $^7F_2$) and 699 nm ($^5D_0$ - $^7F_3$) on excitation with 405nm. The PL intensity of the BST:Eu films was found to increase with substrate temperature. The BST:Eu films can be used for both ferroelectric as well as for optoelectronic application.

PSP2.13

Comparative studies of irradiation induced modifications in Fe_3O_4 thin films on MgO and Si substrates grown by pulsed laser ablation

Shailja Tiwari*, Ram Prakash, R. J. Choudhary and D. M. Phase
UGC-DAE Consortium for Scientific Research, Indore-452 017, INDIA

Ravi Kumar
Inter University Accelerator Centre, New Delhi-110067, INDIA
*Corresponding author email: shailja@csr.ernet.in

Magnetite (Fe_3O_4) is an important half metallic ferromagnetic material and has prospects in spintronic devices. Some of its interesting properties are its high Curie temperature (850 K), low electrical resistivity at room temperature, charge ordering at Verwey transition (Tv =120K) with a concomitant structural transition from cubic high temperature to a monoclinic low temperature phase. We have deposited magnetite thin films using pulsed laser deposition technique on single crystal MgO (100) and Si (111) substrates. We have irradiated these films with 200 MeV Au ions and have studied the effect of irradiation on structural properties of these films. The fluence value of irradiation has been varied in the range of 5×10^{10} ions/cm^2 to 1×10^{12} ions/cm^2. Before irradiation, X-ray diffraction study of pristine samples shows the spinel cubic structure of the films with preferential (111) orientation on Si (111) and (100) orientation on MgO (100) substrate. Raman spectroscopy suggests the single-phase growth of Fe_3O_4 films on both the substrates. After irradiation, XRD and Raman spectroscopy suggest that Fe_3O_4 film on Si substrate is more irradiation resistant than on MgO substrate. Possible reason for this behavior could be related to the lattice mismatch of Fe_3O_4 with Si and MgO substrate. Because of the fact that the lattice parameter of Fe_3O_4 is almost half of the MgO substrate, the film is epitaxial with the presence of strain and anti phase boundaries. After irradiation, these defects are annealed and modify the structure of Fe_3O_4. Whereas in the case of Si substrate, due to higher lattice mismatch, the substrate control over the film growth is weak and the growth orientation is determined by the thermodynamically stable state having minimum internal energy. Therefore, such a film is rather free from substrate induced strain and other related defects and, hence possibly more stable.

PSP2.14

Synthesis and Characterization of SnO_2 Thin Films by PLD for Sensor Applications

K. Prabakar, R. Krishnan, B. Yasodhaadevi*, Ashok S. Chauhan*, S. Tripura Sundari, S. Dash and J. Jayapandian
Materials Science Division,
Indira Gandhi Centre for Atomic Research,
Kalpakkam – 603102,Tamil Nadu.

* Amity Institute of Nanotechnology
Amity University, Uttar Pradesh

Tin Oxide (SnO_2) is a transparent n-type semiconductor with high chemical and mechanical stability with a stable tetragonal phase. Tin oxide films have attracted great scientific interest because of its wide applications ranging from manufacturing of flat panel displays, transparent conductive electrodes in thin film solar cells, gas sensors to several opto-electronic devices. In the present work, amorphous and polycrystalline SnO_2 thin films were deposited on silicon and quartz substrates using Pulse Laser Deposition (PLD) technique at different temperatures. Depositions were also carried out for various oxygen partial pressures ranging from 0.003 Pa to 30 Pa. Structure, morphology and optical properties of these thin films were investigated using XRD, AFM, optical absorption and spectroscopic ellipsometry. The films deposited under high vacuum conditions at room temperature were found to be amorphous. Polycrystalline films could be obtained either by post deposition annealing of these films in air at 700 °C or by depositing these films under increased partial pressure of oxygen at 350 °C. The refractive indices of these films were calculated from ellipsometric parameters measured in the range 350-800 nm. The band gap of the as-deposited amorphous films and e polycrystalline films was calculated to be 3.17 eV and 3.67 eV respectively. This corroborates well with the optical absorption measurements made using UV-Visible spectroscopy. The widening of the band gap can be attributed to the reduction in oxygen vacancies that are responsible for n-type semi-conducting behavior. In addition, change in surface electronic properties brought about by embedding metal and/or oxide nanoparticles in SnO_2 matrix by PLD for possible applications in realm of sensors will be presented.

PSP2.15

Structural and electrical characterization of pulsed laser deposited Ga doped ZnO thin films on Si(100)

S.D. Shinde, S.M. Jejurikar and K.P. Adhi
Center for Advanced Studies in Materials Science and Condensed Matter Physics,
Department of Physics,
University of Pune, Pune 411 007, India.
Corresponding author: shashi@physics.unipune.ernet.in

Highly c-axis oriented thin films of Ga doped ZnO were grown on SiO_x/Si(100) substrate using pulsed laser deposition technique. Thin films with different Ga concentrations viz. 0, 3 and 5 % were prepared under identical deposition conditions. Variation of Ga in ZnO thin films is observed to affect its structural properties evident from X-ray diffraction technique. Surface morphology investigations using AFM technique also support X-ray analysis as far as crystallite size is concerned. Electrical measurements using four-point probe technique shows significant decrease in resistance with increase in Ga concentration in ZnO.

PSP2.16

Thickness dependent multiferroic properties of $Bi_{0.7}Dy_{0.3}FeO_3$ polycrystalline thin films grown by pulse laser deposition technique

Prashanthi K., S. P. Dattagupta, R. Pinto and V. R. Palkar
Electrical Engineering, Indian Institute of Technology Bombay, Mumbai 400 076, India
e-mail: palkar@ee.iitb.ac.in

In recent years there is growing interest in developing multiferroic systems that are simultaneously exhibiting magnetic and ferroelectric ordering at room temperature. It is mainly due to their potential for device applications and fascinating physics. Moreover, most of the known multiferroic systems are typically antiferromagnetic with transition temperatures below room temperature. Earlier we have shown that $Bi_{0.6}La_{0.1}Dy_{0.3}FeO_3$ thin films grown on $Pt/TiO_2/SiO_2/Si$ substrate by pulsed laser deposition technique are multiferroic at room temperature[1]. In recent study we observed that the removal of La from $Bi_{0.6}La_{0.1}Dy_{0.3}FeO_3$ phase helps to enhance magnetic properties to a large extent while keeping ferroelectric properties and leakage current undisturbed. It confirms non-requirement of La in case of Dy modified $BiFeO_3$ for stabilization of perovskite phase or to reduce leakage current. Study of thickness dependence on multiferroic properties of $Bi_{0.7}Dy_{0.3}FeO_3$ films has indicated some interesting behavior. Magnetic anisotropy developed non-linearly with the thickness could be correlated to internal stress developed in random order during growth process (Fig. 1). The lattice cell parameter *c* also changes randomly with the thickness of the film. However, the trend is similar to that of stress. The saturation polarization (P_s) values scale with *c* parameter (Fig. 2). This information could be meaningfully utilized while designing device patterns using such advanced but complex system.

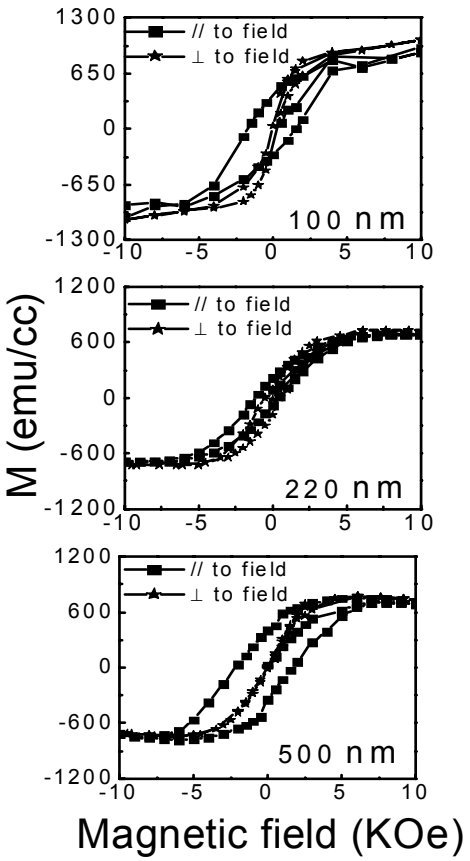


Figure 1

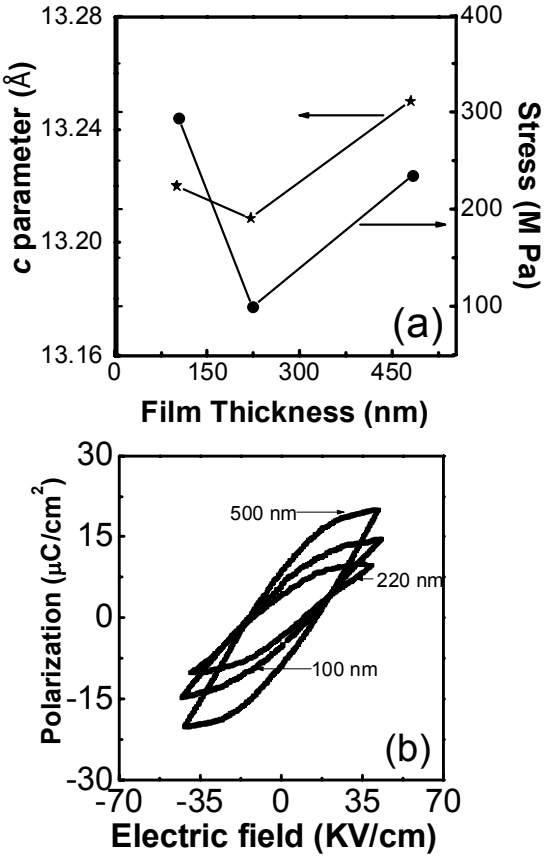


Figure 2

[1] V. R. Palkar, R. Anisha, R. Pinto & S. Bhattacharya, to appear in *Journal of Materials Research* . **22,** 2068 (2007)

PSP2.17

Electroresistive and Magnetoresistive effects in electron doped manganite $La_{0.7}Ce_{0.3}MnO_3$ thin films

Kavita Bajaj[a, b], John Jesudasan[a], Vivas Bagwe[a], Pratap Raychaudhuri[a]

[a]Department of Condensed Matter Physics and Materials Sciences,
Tata Institute of Fundamental Research, Homi Bhabha Rd.,
Colaba, Mumbai 400005, India.

[b]Department of Physics, Mumbai University, Mumbai 400098, India.

The influence of electric current and magnetic field separately and in conjugation on the transport behavior of patterned $La_{0.7}Ce_{0.3}$ MnO_3 thin films on (001) $LaAlO_3$ substrate is studied. Measurements were carried out in the regime of low current densities, for dc currents. In absence of magnetic field significant reduction in peak resistance (R_p) was found with increasing bias current. This effect is also present when a magnetic field is applied though the magnitude of the electroresistance (ER=[R(I=0.05μA)-R(I=50μA)]/R(I=50μA)) decreases. The metal-insulator transition temperature (T_p) increases both with increasing current and with magnetic field. The current-voltage characteristics at various temperatures above and below T_p show nonlinearity for small currents due to electroresistance and large currents due to Joule heating. The behavior of resistance with current is similar at various temperatures decreasing initially with increasing current and then nearly leveling off. We observe an interesting correlation between effect of electric current and magnetic field: The magnetoresistance ($MR = [R_{H=0}-R_{H=1T}]/R_{H=0}$) decreases with increasing bias current, while ER decreases with increasing magnetic field. Both ER and MR show a maximum near T_p. This interesting correlation between these two effects suggests that both these effects arise from the same origin.

PSP2.18

Size dependent study of $CuFe_2O_4$ nanoparticles

Archana Rai* and M. Banerjee
*Department of Physics, Indian Institute of Technology, Powai,
Mmbai-400 076
School of Physics, Vigyan Bhawan, Takshashila Campus, DAVV,
Khandwa Road, Indore: 452017, India
E-mail: archana3@iitb.ac.in ,

The properties of nanostructured magnetic materials are extraordinarily different from those of conventional magnetic systems. Exchange coupling, super-paramagnetism and tunneling magnetoresistance, all describe some of the unique characteristics that could be obtained from nanomagnetic and bulk materials produced from nanomaterials. Nanocryrstalline ferrites have emerged as a new class of technologically important magnetic materials[1, 2].$Cu_{1-x}Ni_xFe_2O_4$ nanoparticles were prepared by co-precipitation and digestion method. The average particles size as determined by XRD was found to be from 3 nm to 11nm. AFM confirms the formation of spherical shape spinel nanoparticles. Mössbauer spectroscopic investigation has been carried out to study the distribution of cations among A and B sites. Mössbauer spectra for x= 0.25, 0.5, 0.75 and 1.0 shows superparamagnetic behavior at room temperature. Mössbauer studies of our samples were also performed at low temperature i.e. at 25 K. Absorption spectra shows clear transformation from super-paramagnetic behavior to ferrimagnetic while going from room temperature to low temperature. Iron is present as Fe^{3+} in both tetrahedral as well as octahedral sites.

Keywords: Ferrites, Mössbauer spectroscopy, Super-paramagnetism

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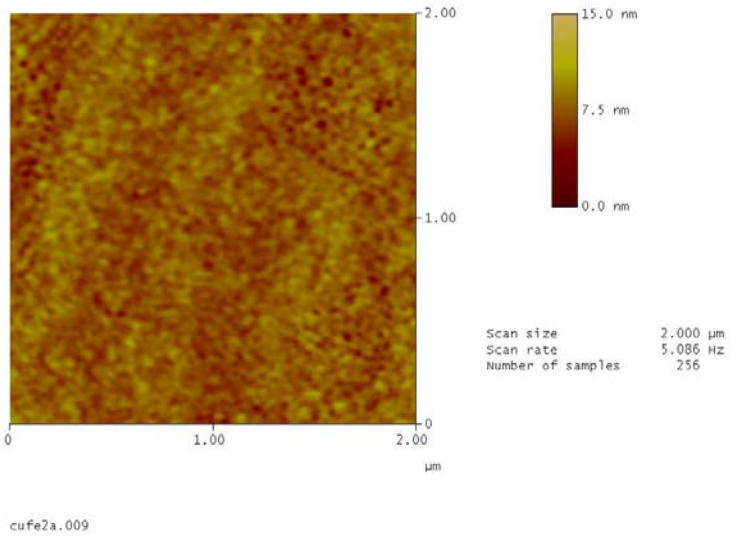


Fig.1 AFM image of $CuFe_2O_4$ nanoparticles of size 7.2 nm

PSP2.19

A theoretical approach to the effect of particle size on the luminescence intensity in nanocrystals

Anamika Awadhwal, B.P. Chandra*
Department of Post Graduate Studies and Research in Physics and Electronics
Rani Durgavati University, Jabalpur-482001
*Ex Vice-Chancellor Pt. Ravishankar Shukla University, Raipur-492010

The recombination of electron and hole occurs when electron is within the capture distance from the recombination center. In ultrafine particles, all the excited electrons may be within the capturing range and recombination will depend on the Coulomb force between them, which increases as the particle size is reduced. This consideration suggest high luminescence intensity for smaller particles.In the present paper the luminescence intensity in nanocrystals and the relation between the intensity and particle size have been discussed.

PSP2.20

Third Order Non-Linear Optical Properties of Eurhodin Dye Doped Ppolymer Film

Rekha R.K*, A. Ramalingam , G. Vinitha
Centre for Laser Technology, Department of Physics, Anna University, Chennai-600 025
* rekhasri71@yahoo.com

There is a continuing interest in the development of optical material, which would be suitable for application in photonic switches, optical limiter, 3D optical data storage etc., One of the possible approaches, is utilizing third order non-linear optical properties of such materials, in particular the ability of these materials to change the value of the refractive index under the action of optical field. This property is usually described in terms of third order susceptibility or non-linear refractive index. We report the third order non-linear response of neutral red dye doped polymer film using Z-Scan technique with polymer (PMMA) host, because they have considerable creative freedom for optical and mechanical design.

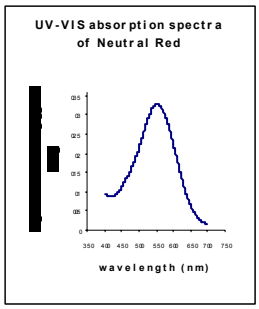
The optical absorption properties of the dye in methanol were investigated in the range 300–800nm using PerkinEimer spectrophotometer & shown in Fig 1. Methanol was chosen as additive because it combines good solubility and enhancement of host laser- damage resistance. The absorption peak wavelength (λ_a), molar extinction coefficient (ε), Bandwidth $(\Delta\nu)_{1/2}$, Oscillator strength (f) were calculated and shown in Table 1.

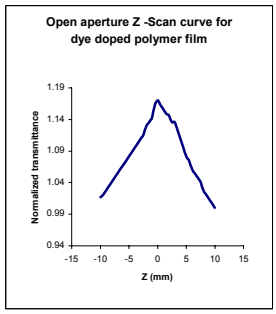
The dye doped polymer film was prepared by bulk polymerization method, by pouring the viscous PMMA + Dye mixture with initiator mixture on to a glass slide placed inside a glass enclosure kept at temperature of 40^0Cin temperature controlled water bath. The Z-Scan experiment was performed using second harmonic Nd:Yag laser which was focused by 3.5cm focal length lens. The laser beam waist ω_0 at the focus is measured to be 18.7μm & Rayleigh range Z_R = 2.1mm.The peak intensity I_o of the incident laser beam was 3.7KMW/cm^2. The Rayleigh length was found to be satisfying the basic criterion of the Z-Scan experiment, $Z_R > L$.

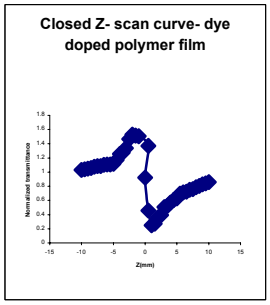
Optical absorption parameters				Non Linear parameters – Dye doped polymer film					
λ_a (nm)	ε X 10^4 Lmol^{-1} Cm^{-1}	$(\Delta\nu)_{1/2}$ cm^{-1}	fX10^{-24} Lmol^{-1} cm^{-2}	ΔT_{p-v}	n_2 X10^{-7} cm^2/W	βX10^{-3} cm/W	$\chi_R^{(3)}$ X10^{-6} (e.s.u)	$\chi_I^{(3)}$ X10^{-7} (e.s.u)	$\lvert\chi^{(3)}\rvert$ X10^{-6} (e.s.u)
553	.07	4700	.0133	1.5192	-1.16	-1.572	5.233	-2.97	5.23

Table1: Optical absorption and Non Linear parameters of Dye doped polymer film

The transmitted energy through the sample was measured by using a photo detector fed to the digital power meter. Both open and closed aperture studies were carried out to find out the absorptive (β)and refractive non- linearity (n_2) in the film. For an Open aperture Z-Scan a lens to collect the entire laser beam transmitted through the sample replaced the aperture. A Pre-focal transmittance maximum (Peak) followed by post focal transmittance minimum (Valley) obtained from the closed aperture Z-Scan data, shown in Fig 3 indicates that the sign of refraction non-linearity is negative i.e self-defocusing. The self-defocusing effect is due to the local variation of refractive index with temperature. The enhanced transmission near the focus in the open aperture shown in Fig 2 is indicative of saturation absorption at high intensity. Pure non-linear refraction of the film is shown in Fig 4 (division of open/closed)







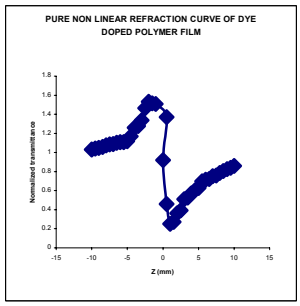


Fig 1 Fig 2 Fig 3 Fig 4

The study shows that neutral red film exhibited saturation absorption and negative non-linearity. The dye doped polymer film with reasonably high third order susceptibility $|\chi^{(3)}|$ can be a promising candidate for optical limiter and photonic application.

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PSP2.21

Nonlinear characterization and optical limiting of organic dye doped polymer

G.VINITHA[1], R.K REKHA., A.RAMALINGAM,
Centre for Laser Technology, Department of Physics,Anna University, Chennai-25, India.
[1]svini2005@yahoo.co.in

There has been a large need for nonlinear optical materials that can be used with low intensity lasers for applications such as phase conjugation, image processing, and optical switching. Large nonlinear optical susceptibility resulting from the nonlinear response of organic molecules has attracted much attention.

The dye doped polymer films of dye concentrations 0.4 mM were synthesized by thermal bulk free radical polymerization method [1]. Films of thickness 0.6 mm were prepared and were considered for further studies.

The *Z*-scan experiments[2] were performed in liquid and solid media using a 532 nm diode pumped Nd:Yag laser beam Fig 1 gives closed, open and ratio of normalized Z-scan of Pararosanilin in 1- Butanol and thin polymer film at concentration 0.4 mM at incident intensity 4.38 KW/cm^2. The peak followed by a valley-normalized transmittance obtained from the closed aperture *Z*-scan data, indicates that the sign of the refraction nonlinearity is negative i.e. self-defocusing. The nonlinear absorption coefficient β can be estimated from the open aperture *Z*-scan data.

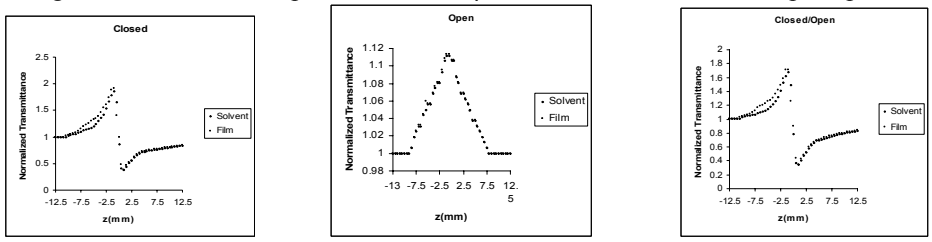

Figure 1. Closed, open and ratio of normalized Z-scan of Pararosanilin in 1- Butanol and thin polymer film

Pararosanilin dye	ΔT_{p-v}	n_2 x 10 $^{-8}$ (cm^2/W)	Δn x10 $^{-4}$	β x 10^{-4} cm/W	$\chi^{(3)}$ x 10^{-6} esu
In 1- Butanol	1.326	-6.8	-2.96	-7.7	3.384
Polymer film	1.371	-7.11	-3.09	-7.93	3.53

Table 1. Nonlinear parameters of the dye

Characteristic curves for the optical limiting behaviors of the sample at focus and beyond focus are as shown in fig.2. From the figure, we can observe that at the valley positions, the optical limiter works at very low powers as the self-defocusing effect induced by photochromism is also enhanced by the thermal effect which is closely related to the absorptive properties of the samples used. Thus we, conclude that the best position of a sample when used for optical limiting based on self-defocusing is at the valley of the Zscan curve of the medium.

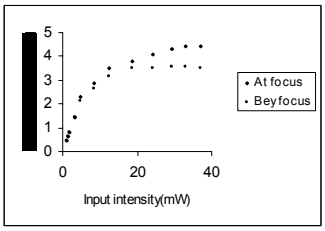

Figure 2. Optical limiting behaviors of the sample at focus and beyond focus.

Conclusion

The nonlinear optical response of thermo-optic origin exhibited by Pararosanilin dye at low continous wave laser powers was studied and optical limiter action based on nonlinear refraction is demonstrated in liquid and solid media .The nonlinear refractive index was determined using the Z scan technique. The origin of the nonlinearity appears to be predominantly thermo-optic. The variation in the output intensity was studied for different sample positions.

Acknowledgement

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PDP2.22

Studies on the Fluorescence emission from nano silver / silver oxide thin films for optical read write memory applications

A.Subrahmanyam and N.Ravichandra Raju

Department of Physics, Indian Institute of Technology Madras, Chennai-600036, India

Email:ravichandra@physics.iitm.ac.in

The fluorescence emission from silver nano clusters is having a potential for read / write nonvolatile ultra high density optical memories. In the present work, nano silver films are prepared by two techniques: DC magnetron sputtering at room temperature (300 K) with pure metallic silver as target and Pulsed laser deposition at 470 and 570 K with pure silver oxide as the target. Films of different thicknesses (5 nm to 60 nm) are grown and the fluorescence property is compared. The as grown films in both the techniques are polycrystalline. Emission spectrum was recorded using fluoro-meter. When these DC Magnetron films are oxidized at 520 K for 30 minutes and are irradiated with blue light (= 485 nm), a fluorescence emission is observed in the red region (~ 650 nm).The PLD grown films also show multiple fluorescence peaks at 565 nm, 587 nm and 660 nm. These films are analyzed by XRD and AFM. It is observed that the fluorescence emission from the silver clusters (of size 35 nm) depends on the growth parameters in sputtering (like substrate temperature or deposition rate) and on the oxidation temperature. The plasma in both the techniques is analyzed using the emission lines. The fluorescence emission is attributed to the surface plasmon resonance.