AMITY UNIVERSITY & AMITY UNIVERSITY DUBAI

INTERNATIONAL CONFERENCE

ON

ACCELERATORS IN MATERIALS AND MEDICAL SCIENCES

5th to 7th October 2017

ION BEAM SOCIETY OF INDIA IBSI

Jointly organised by

Amity University Uttar Pradesh (Noida), India and
Amity University Dubai

ABSTRACTS BOOK

MENA Medical Supplies

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INTERNATIONAL CONFERENCE

on

ACCELERATORS IN MATERIALS & MEDICAL SCIENCES

(ICAMMS'17) (www.amity.edu/icamms)

5th - 7th October 2017

Organized by

Amity University Uttar Pradesh, India &
Amity University, Dubai Campus, UAE

Venue: Amity University, Dubai Campus

The accelerators have been key to scientific and technical developments and have diverse applications in different branches of science. The electrons, photons and ions produced by the state of art accelerators are widely used for materials characterization, materials engineering, medical sciences, cancer therapy etc. Considering the importance of accelerators an International Conference on 'Accelerator in Materials and Medical Sciences'- October 5th -7th, 2017 is being organized jointly by Amity University Uttar Pradesh, Noida, India and Amity University, Dubai campus. This conference will have plenary and invited lectures, besides contributory, oral and poster presentation. The eminent scientists from all over the world will deliver plenary and key note lectures.

Scope: The topics to be covered in the conference are:

- Ions, electrons and photons in
  - Medical diagnostics and therapy
  - Medical imaging
  - Ion beam therapy of cancer
  - Materials characterization
  - Materials engineering and modifications
  - Engineering of nanostructures
  - Food Technology, Forensic Science & Earth Science
  - Materials for energy
- Radiation damage in materials: Relevant to reactor/ tokamak /space electronics
- Developments in Accelerators

Important Dates:

- Online Registration starts : 20 April 2017
- Abstract Submission Starts : 15 April 2017
- Abstract Submission Deadline : 30th June 2017
- Notification for Acceptance : 02nd July 2017 onwards
- Deadline for Early Bird Registration : 07th July. 2017
- Last Date for Registration : 30 Sept. 2017

Abstract and Paper Submission:

The abstract of invited, oral and poster presentation will be published as an abstract booklet. The presented research work will be published in the **"Radiation Effects and Defects in Solids (Tylor and Francis Publisher), after peer review process.**

The best oral and best poster will be awarded by Ion Beam Society of India (IBSI).

Organizing Committee Members

Dr. Kavita Shukla
Dr. Ishu Sharma
Mr. Ved Prakash
Dr. D.C. Sharma
Prof. Alpana Goel
Dr. Richa Krishna
Dr. S.N. Bera
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Abstract should be submitted to: **icamms@amity.edu**

Abstract should be submitted in the attached template. (www.amity.edu/icamms)

Registration Fee:

Delegates from	Early Bird Registration (upto 15th June 2017)	upto 31st August 2017	upto 30th September 2017
Academic	€ 250	€ 300	€ 350
Industry Person	€ 300	€ 350	€ 400
Research Scholar / Students	€ 200	€ 250	€ 300
Accompanying Person**	--	€ 150	€ 200

*Registration fee includes the conference kit, coffee/tea, lunch during the conference and a conference dinner

Payment can be made to Account:

Account Name	**Amity University**
Account No. (EURO)	**102-43395514-04**
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Once you have paid the Registration fee, please send the acknowledgement slip to icamms@amity.edu.

TENTATIVE LIST OF INVITED SPEAKERS:

- Amekura, H. NIMS Tsukuba, Japan
- Amarendra, G. IGCAR Kalpakkam, India
- Bhoraskar V.N., Pune University, India*
- Bhandari, R.K. IUAC Delhi, India
- Dauletbekova, A., L.N. G, National University, Kazakhstan
- Fassbender, J., Rossendorf, Germany
- Gupta Mukul, UGC DAE CSR, Indore, India*
- Gupta Ratnesh, DAU, Indore, India
- Kaur, Amarjeet, DU, Delhi, India
- Parodi Katia, LMU Munich, Germany
- Rao Nageswar, University of Hyderabad, India
- Reddy, V.R., Indore, India*
- Roth, S. DESY, Hamburg, Germany
- Roy, A., VECC Kolkata, India
- Saintigny, Y. CIMAP Caen, France
- Sharma, S.D., BARC, Mumbai *
- Singhal, R., MNIT Jaipur, India
- Som, T., IOP Bhubaneswar, India
- Trautmann, Christina, GSI Darmstadt Germany
- Tribedi, Lokesh TIFR Mumbai, India
- Tripathi,A. IUAC Delhi, India*
- Zegenhagen, J., Diamond Light Source, UK

*To be confirmed

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TECHNICAL PROGRAM

TECHNICAL PROGRAM ICAMMS 2017

TIME	Thursday, 05th October 2017	TIME	Friday , 06th October 2017	TIME	Saturday, 7th October 2017
09.00-10.00	**REGISTRATION**	09.30-10.15	**PL 03 J. Zegenhagen**	09.30-10.15	**PL 06 M. Scholz**
10.00-11.15	**Inaugural Session**	10.15-10.40	IT 05 G. Amarendra	10.15-10.40	IT 12 Y. Saintigny
11.15-11.40	**HIGH TEA**	10.40- 11.05	IT 06 Amarjit Kaur	10.40-11.05	IT 13, G. Mattei
		11.05-11.30	IT 07 P.K. Sahoo	11.05-11.15	OR 09 Anoop K. Srivastava
				11.15-11.25	OR 10 Teerthraj Verma
				11.25-11.35	OR 11 K. Nagabhushana
11.40-12.25	**Key Note Address J. Fassbender**	11.35-12.00	TEA		
12.25-12.50	IT 01 Dr. Amit Roy	12.00-12.25	IT 08 Tetsuya Yamaki	12.00-12.25	IT 14 R.K. Bhandari
				12.25 12.35	OR 12, Renuka S.
				12.35-12.45	OR 13 Prachi Singhal
		12.25-12.50	IT 09 Akihiro Iwase	12.45-12.55	OR 14 Richa Krishna
12.50 -13.45	LUNCH				
13.45- 14.30	**PL01 Katia Parodi**	13.45- 14.30	**PL 04 Christina Trautmann**	13.45-14.10	IT 15 Nageshwera Rao S
14.30-14.55	IT 02 V. N. Bhoraskar	14.30-14.55	IT 10 Ratnesh Gupta	14.10-14.20	OR 15 Basant K Sikarwar
14.55- 15.20	IT 03 Shu Seki	14.55- 15.20	IT 11 Alma Dauletbekova	14.20-14.30	OR 16 M.D. Kirkire
15.20- 15.45	IT 04 A. Kinomura	15.20- 15.30	OR 05 SV Bhoraskar	14.30-14.40	OR 17 S.N. Bera
15.45-15.55	OR 01 J. Schreiber	15.30-15.40	OR 06 Nimmala Arun	14.45-15.30	Outcome Assessment Meeting, CONCLUDING SEESION & CERTIFICATE DISTRIBUTION
		15.40- 15.50	OR 07 Dileep.K. Mishra		
		15.50-16.00	OR 08 A P Gnana Prakash		
16.00-16.15	**TEA**			15.30-16.00	**TEA**
16.15-17.00	**PL 02 Stephan Roth**	16.15-17.00	**PL 05 Hans Hofsass**	16.00-onwards	DEPARTURES
17.00- 17.10	OR 02 Pallavi Pandit	17.00-18.00	POSTERS SESSION / Open House for Dubai School Student		
17.10-17.20	OR 03 Shailendra Kumar				
17.20-17.30	OR 04 Gagan Sharma				
17.30-18.30	Networking Tea with Founder President	18.00- 22.30	CONFERENCE DINNER ON CRUISE		
18.30-22.45	Tour to Dubai Mall /Burj Khalifa				

PL = PLENARY TALK; IT = INVITED TALK; OR = ORAL PRESENTATION

DAY 1 5th October 2017 (Thursday)	
09:00-10:00	**REGISTRATION**
10:00-11:15	**Inaugural Session**
11:15-11:40	**HIGH TEA**
Technical Session I	
Chair: Christina Trautman	
11:40-12:25	**Key Note Address:** **J. Fassbender** - ***Ion Beam Modification of Magnetic Materials***
12:25-12:30	**Invited Talk 1 :** **Amit Roy** - ***Accelerator Development in India: Present Status and Future Perspectives***
12:50-13:45	Lunch
Technical Session II	
Chair: M Scholz	
13:45-14:30	**Plenary Lecture 1:** **Katia Parodi** -***Ion beam therapy: state-of-the-art and research opportunities***
14:30-14:55	**Invited Talk 2 :** **V. N. Bhoraskar** -***Design and development of 6 to 18 MeV electron beam system for medical and other applications***
14:55-15:20	**Invited Talk 3 :** **Shu Seki** -***Organic Functional Nanomaterials by Single Particle Triggered Linear Polymerization***
15:20-15:45	**Invited Talk 4 :** **A Kinomura** - ***A simultaneous irradiation system with ion and slow-positron beams for in-situ characterization of radiation damage***
15:45-15:55	**Oral 01:** Jorg Schreiber - *Laser-driven ION (LION) sources*
15:55-16:10	TEA
Technical Session III	
Chair: J. Zegenhagen	
16:10-16:55	**Plenary Lecture 2:** **Stephan Roth** - ***Synchrotron radiation in materials science***
16:55-17:05	Oral 02: **Pallavi Pandit** - ***Morphological tuning of complex polymer-metal nanostructures via process parameters***
17:05-17:15	Oral 03: **Shalendra Kumar** – ***Near edge X-ray absorption fine structure spectroscopy and magnetic properties of Ni doped CeO2 nanoparticles***
17:15-17:25	Oral 04: **Gagan Sharma – In situ growth behavior of ultrathin Fe and CoFeB films on MgO using synchrotron x-rays**
17:30-18:30	Networking Tea with Founder President
18:30-22:30	Tour to Burj Khalifa/ Dubai Mall

DAY 2 6th October 2017(Friday)	
Technical Session IV	
Chair: H. Hofsass	
09:30-10:15	*Plenary Lecture 3:* *Jorg Zegenhagen - Material and Life Sciences in the Light of Synchrotron Radiation*
10:15-10:40	*Invited Talk 5 :* *G Amarendra - Overview of Accelerator based Materials science studies using Positron Annihilation and Electron Spectroscopy*
10:40-11:05	*Invited Talk 6 :* *Amarjit Kaur - Effect of Swift Heavy Ion Irradiation on Conducting Polymers and Other sp^2 Hybridised Materials*
11:05-11:30	*Invited Talk 7 :* *P K Sahoo - Hybrid nanodot evolution by ion irradiation of thin films*
11:35-12:00	*TEA*
Technical Session V	
Chair : Shu Seki	
12:00-12:25	*Invited Talk 8 :* *Tetsuya Yamaki - Metal Nanocatalysts Prepared by Ion Beam Irradiation for Hydrogen Energy Devices*
12:25-12:50	*Invited Talk 9 :* *Akihiro Iwase - Advantages of Using Ion and Electron Accelerators for Radiation Damage Studies and Materials Modifications*
12:50-13:45	*LUNCH*
Technical Session VI	
Chair: J. Fassbender	
13:45-14:30	*Plenary Lecture 4:* *Christina Trautmann - Material science and nanostructures produced with GeV heavy ions*
14:30-14:55	*Invited Talk 10 :* *Ratnesh Gupta - Influence of Ion beams to tailor the optical properties of metal doped transition metal oxide thin films*
14:55-15:20	*Invited Talk 11 :* *Alma Dauletbekova - Formation of ZnO Nanocrystals in SiO_2/Si Track Templates: Experiment and Computer Simulation*
15:20-15:30	*Oral 05:* *S V Bhoraskar – Electrical Characteristics of Silver Nanoparticles Filled Etched Ion-Tracks In Polyimide*
15:30-15:40	*Oral 06:* *Nimmala Arun – Hafnia based resistive switching devices for non-volatile memory applications and Effects of ion irradiation and thermal annealing on device performance.*
15:40-15:50	*Oral 07:* *Dileep K Mishra – Strain Disorder: new degree of freedom to control structurally dissimilar magnetic phased separation in La5/8-yPryCa3/8MnO3 epitaxial thin films.*

15:50-16:00	*Oral 08:* *A P Gnana Prakash – 5 MeV Proton Irradiation Effects on 200 GHz Silicon-Germanium Heterojunction Bipolar Transistors*
16:00-16:15	*TEA*
Technical Session VII	
Chair: G Mattei	
16:15-17:00	*Plenary Lecture 5:* *Hans Hofsass - Advances in ion implantation and ion beam analysis for low dimensional materials*
17:00-18:00	*Poster Session / Open House for Dubai School students*
18:00-22:30	*CONFERENCE DINNER ON CRUISE*

DAY 3 ***7th October 2017(Saturday)***	
Technical Session VIII	
Chair: Katia Parodi	
09:30-10:15	*Plenary Lecture 6:* *M Scholz - Radiation Biophysics Research at GSI for Ion Beam Tumor Therapy*
10:15-10:40	*Invited Talk 12 :* *Y Saintigny - Multimodal treatments of radio-resistant cancer: emerging effective combined therapy of PARP-1 inhibitors and high-LET particle therapy*
10:40-11:05	*Invited Talk 13 :* *G Mattei - Quantum emitters coupled to plasmonic nanostructures: from quantum efficiency enhancement to nanolasing*
11:05-11:15	*Oral 09:* *Anoop Kumar Srivastava – Comparative evaluation of efficacy of electron photon combination versus photon based VMAT*
11:15-11:25	*Oral 10:* *Teerthraj Verma – Medical Linear Accelerators in radiotherapy: Dose escalation with improved accuracy in lung cancer*
11:25-11:35	*Oral 11:* *K R Nagabhushana – Thermoluminescence studies of Al_2O_3:Tm3+ phosphor for carbon beam dosimetry*
11:40-12:00	*TEA*
Technical Session IX	
Chair: A. Roy	
12:00-12:25	*Invited Talk 14:* *R K Bhandari - Electron Accelerators and Their Applications*
12:25-12:35	*Oral 12:* *Renuka Seenivasan– Growth and irradiation studies of organic single crystal*
12:35-12:45	*Oral 13:* *Prachi Singhal – Enhanced Electrical Conductivity of Carbon Ion Implanted PMMA/nano graphite Nanocomposites*
12:45-12:55	*Oral 14:*

	Richa Krishna – Local structural investigation of doped ZnO nanostructure.
12:55-13:45	*LUNCH*
Technical Session X	
Chair: G. Amarendra	
13:45-14:10	*Invited Talk 15:* *Nageshwar Rao - Ion Beam Studies of Hafnium-based high-k Dielectric Materials: Nanoparticles, Thin-films and Devices*
14:10-14:20	*Oral 15:* *Basant K Sikarwar – Tailoring the wettability of copper surface with Ion Beam Irradiation*
14:20-14:30	*Oral 16:* *M D Kirkire– Effect of Swift (200 MeV) Ag^{9+} ion irradiation on structural and optical properties of indium phosphide*
14.30-14.40	*Oral 17* *S. Bera - Evidence of Domain Formation in Langmuir Monolayers of Ternary Lipid Mixtures by X-ray Scattering*
CONCLUDING SESSION	
14:30-15:30	*Outcome Assessment Meeting, Concluding Session & CERTIFICATE DISTRIBUTION*
15:30-16.00	*TEA*

MESSAGE FROM FOUNDER PRESIDENT

MESSAGE FROM CHANCELLOR

It is a matter of great pride that Amity Institute of Nanotechnology, Amity Centre for Spintronic Materials and Amity Institute of Applied Sciences, AUUP have joined hands with Amity University Dubai to organize an International Conference on ***Accelerators in Materials and Medical Sciences during October 5th – 7th, 2017*** at our Amity University Dubai Campus.

The objective of this conference is to capture creativity and innovative ideas amongst the researchers, to inspire them for applying Ion Beam Technologies to practical projects and create awareness about the new trends in research and technology in this domain.

Ion Beams have a significant role to play in the processing of materials and have contributed in a major way to the development of high technology products. Ion beam processing is used particularly in the semiconductor industry, materials science and increasingly in the biological field for site-specific analysis, deposition, and ablation of materials. Ion implanters are now used in the manufacture of advanced microchips produced by the semiconductor industry for computers, information technology and communications systems. Ion beam technology has and will continue to make significant contribution in "niche" markets ranging from specialized tools used in industry, to surface treatment of intricate devices used in the medical field.

It is a great pleasure to know that the conference brings together a distinguished panel of speakers including academicians from renowned universities and researchers across the world to share their views and to give insights into this significant area. I heartily welcome all the distinguished speakers, scientists and academicians from eminent institutions who have made their valuable and varied contributions, to our Dubai Campus. I am sure that the technical and plenary lectures delivered in the conference and the synergy of brains would definitely pave the way for various joint projects, publications and patents in Ion Beam Technologies.

I wish the Conference a great success.

Dr. Atul Chauhan
Chancellor,
Amity University President,
Ritnand Balved Education Foundation
CEO, AKC Group of Companies

MESSAGE FROM VICE CHANCELLOR

It is a matter of great pride that Amity Institute of Nanotechnology, Amity Centre for Spintronic Materials and Amity Institute of Applied Sciences have joined hands with Amity University Dubai campus to organize an **International Conference on 'Accelerators in Materials and Medical Sciences (ICAMMS)'** from **October 05 – 07, 2017** at Amity University Dubai Campus.

Indigenous research and teaching development in nanomaterials and medical sciences, especially use of accelerators is a new tool in the field of science and technology. The beams produced by today's particle accelerators addresses many of the challenges confronting our nation in the 21st century such as energy, environment, employment, economic security, health care, national defense and the war on terror. The next-generation accelerators have the potential to make still greater contributions to the nation's health, wealth and national security.

The conference aim to capture creativity and innovative ideas amongst the researchers and to inspire them for applying Ion Beam Technologies to practical projects and create awareness about the new trends in research and technologies.

I am confident that the informative sessions during the Conference covering the recent work in the field of accelerators in materials and medical sciences, will be interactive and the participants will benefit immensely from the expertise and experience of eminent speakers from industry and academia.

My Compliments and best wishes to the students, faculty and staff members of the Organizing Team who have contributed to organize this Conference with great zeal and enthusiasm.

I wish the ICAMMS 2017 a grand success!

Prof. (Dr.) Balvinder Shukla
Professor – Entrepreneurship & Leadership
Vice Chancellor
Amity University Uttar Pradesh

MESSAGE FROM PRO VICE CHANCELLOR

It is a great pleasure and privilege to welcome you all to the International Conference on Accelerators in Materials & Medical Sciences (ICAMMS 2017), which takes place in Amity University, Dubai from 5th to 7th October 2017, jointly organized by Amity University, Uttar Pradesh, India.

Accelerator science provides an indispensable research tool that by revealing matter's innermost workings, helps find answers to key questions about the Universe and delivers brand new scientific insights benefiting fields as diverse as medicine, nanotechnology, forensic science, materials engineering etc. The organizing team has worked hard to produce a first class technical conference with an exciting collection of research presentations and speakers from India, Japan, United Kingdom, Italy, France, Germany, Ethiopia, Kazakhstan, United Arab Emirates etc. I would like to express my thanks to all the authors for their outstanding contributions and the efforts of our program committee members and external referees for their invaluable help in the review process. We look forward to an insightful presentation, discussions, and sharing of technical ideas with colleagues from around the globe.

All of us at Amity University, Dubai take this opportunity to heartily welcome all resource persons and delegates for their participation in this prestigious conference and wish them a rich learning experience. We hope you have a pleasant stay with us at Amity University Dubai during the conference.

Dr. N. Ramachandran
Pro Vice Chancellor
Amity University Dubai
Dubai International Academic City
United Arab Emirate

AMITY UNIVERSITY
UTTAR PRADESH

DR. W. SELVAMURTHY, Ph.D., D.Sc.
FAMS, FABMS, FIMSA, FIANS, FIAY

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MESSAGE

It is a matter of great pride that Amity University is organizing the International conference on "'Accelerators in Materials and Medical Sciences' 2017" at Amity Dubai Campus during 5-7 October, 2017. Accelerators find immense application in both material sciences and medical sciences. Advance material synthesis, characterization and application demand the use of accelerators. It also helps in radio therapy, irradiation of materials (food/ medicine) and also in diagnosis and therapy. This conference will bring out the recent advancement in this field by the participation of World renowned experts.

Founder President Dr. Ashok K. Chauhan has envisioned the Dubai Campus of Amity University to emerge as an innovation hub. This conference is yet another important milestone towards that objective. I am confident that this conference will be an outcome oriented scientific event where networking and collaboration, opening new avenues for collaborative research and exchange of knowledge will emerge as fruitful outcome.

I compliment the organizers Dr. D.K. Avasthi, Dr. Ajay Gupta and Dr. O. P Sinha for having brought many experts on a common platform in this event. I also compliment all the members of the organizing committee for formulating a very useful scientific programme with valuable scientific presentations.

Best wishes for the success of the conference.

Dr. W. Selvamurthy

MESSAGE FROM CONFERENCE CHAIRS

The accelerators have been key to scientific and technical developments and have diverse applications in different branches of science. The electrons, photons and ions produced by the state of art accelerators are widely used for materials characterization, materials engineering, medical sciences, cancer therapy etc. Considering the importance of accelerators an International Conference on 'Accelerator in Materials and Medical Sciences' ICAMMS, from 5th to 7th October is being jointly organized by Amity Institute of Nanotechnology (ANIT), Amity School of Spintronics Materials (ACSM) and Amity Institute of Applied Sciences (AIAS), Noida in cooperation with Amity University Dubai. It is worth mentioning here that the above three institutions have a joint project on development of a low energy accelerator in association with Inter University Accelerator Centre New Delhi, funded by Department of Science and Technology, New Delhi.

On behalf of the organising committee, we would like to welcome you to the International conference on 'Accelerators in Materials and Medical Sciences'. The ICAMMS has plenary and invited lectures, besides oral and poster presentation. The eminent scientists from all over the world will deliver key note, plenary and invited lectures. The networking sessions and interaction with school students are other interesting parts of the ICAMMS. It gives an opportunity to young researchers working in the field of accelerator based research specially in materials and medical science to interact with the international experts. The proceedings of the conference will be published after peer review, in an international journal "Radiation Effects and Defects in Solids" by Taylor and Francis publisher.

The Ion Beam Society of India (IBSI) is offering the prizes for best oral presentation and best poster presentation by research scholars.

We would like to take this opportunity to thank all the members of international committee and national advisory committee for their invaluable suggestions for the topics, speakers and other aspects of the conference and to acknowledge active support of the members of the local organizing committee. We sincerely appreciate the support/sponsor ship by MENA medical supplies. The vision and support of Founder President Dr. Ashok K Chauhan, lead us to this venture. We have perpetual encouragement from Chancellor Dr. Atul Chauhan and Vice Chancellor Prof. Balvinder Shukla for scientific missions.

We would like to thank the invited speaker's participants for joining the ICAMMS. We are very happy to welcome and wish you all a very happy stay and fruitful conference.

Prof. Ajay Gupta, ACSM Prof. D.K. Avasthi, AINT

Conference Chairs

TECHNICAL

KEY NOTE

Key Note

Ion Beam Modification of Magnetic Materials

J. Fassbender

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ABSTRACT

In recent years the tailoring of magnetic properties by means of ion irradiation and implantation techniques has become fashionable. Early investigations relied on the fact that the perpendicular magnetic anisotropy of Co/Pt multilayers depend sensitively on the interface sharpness [1]. Subsequently also the ion induced modification of exchange bias phenomena as well as interlayer exchange coupling have been investigated [2]. For single magnetic films ion implantation has been used to reduce the Curie temperature and hence the saturation magnetization [3]. Nowadays also the reverse process, i.e. the creation of nanomagnets within special binary alloys is employed [4-6]. In combination with lithography or with focused ion beams a pure magnetic patterning becomes possible [7] leading to hybrid magnetic materials [8] with properties different from both, the ion irradiated as well as the untreated material. Even ion induced chemical reduction can be employed to create a nanomagnetic pattern [9,10].

An overview of the present status in this research field will be given.

References

1. C. Chappert et al., Science **280**, 1919 (1998).
2. J. Fassbender, D. Ravelosona, Y. Samson, J. Phys. D **37**, R179 (2004).
3. J. Fassbender, J. McCord, Appl. Phys. Lett. **88**, 252501 (2006).
4. E. Menendez et al., Small **5**, 229 (2009).
5. R. Bali et al., Nano Lett. **14**, 435 (2014).
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8. J. McCord, L. Schultz, J. Fassbender, Adv. Mater. **20**, 2090 (2008).
9. S. Kim et al., Nature Nanotechnology **7**, 567 (2012).
10. J. Fassbender, Nature Nanotechnology **7**, 554 (2012).

PLENARY LECTURES

Ion beam therapy: state-of-the-art and research opportunities

Katia Parodi

Ludwig-Maximilians-Universität München, Department of Medical Physics, Am Coulombwall 1, 85748 Garching b. Munich, Germany

ABSTRACT

The application of swift ions to radiation therapy is rapidly spreading worldwide. In particular, their favorable physical and biological interaction properties in matter promise superior clinical outcome, due to the possibility of more selective treatment in comparison to conventional photon radiation. To utilize or investigate these anticipated advantages clinically, about 70 ion therapy facilities are currently operational, predominantly with proton beams, and about the same amount is under construction or at the stage of planning.

Over the last decades, considerable progress has been accomplished in accelerator technology, beam delivery and medical physics to enhance tumour-dose conformity of ion therapy for complex treatments, with excellent sparing of surrounding normal tissue and critical organs. Nonetheless, full exploitation of the ion beam advantages in clinical practice is still hampered by uncertainties in the knowledge of the actual dose delivery during the fractionated course of treatment, thus calling for continued multidisciplinary research.

This talk will review the state-of-the-art in ion beam therapy, giving particular emphasis to remaining challenges and related opportunities for a broad spectrum of ongoing medical physics research, spanning from advanced computations to detector developments and imaging methods for accurate beam and patient modelling as well as in-vivo treatment verification.

Synchrotron radiation in materials science

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ABSTRACT

Modern materials science relies on the tailored engineering of nanostructures. Ever-growing applications such as energy conversion, organic photovoltaics and flexible electronics as well as food technology demand an advanced understanding of the relevant composite structures, from the nanolevel to the mesoscale. Scattering methods allow for observing in real time, operando and in situ the installation of such tailored nano- and mesostructures. At the same time, they allow for closing the observation gap between fundamental investigations and the elucidation of industrially relevant processes using roll-to-roll (R2R) compatible and scalable technologies in nanoengineering. Prominent examples are physical vapor deposition and spray coating [1,2]. I will introduce advanced scattering methods and review their application to organic photovoltaics and electronics.

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Material and Life Sciences in the Light of Synchrotron Radiation

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ABSTRACT

Since more than thirty years, synchrotron radiation is contributing increasingly to the advancement of life- and physical science. Meanwhile more than 50 synchrotron radiation light sources [1] are in use worldwide with this number actually increasing since new facilities are steadily coming into operation. In the UK, Diamond Light Source Ltd [2], located at Rutherford Appleton Laboratory in Oxfordshire, is operating a 3GeV third generation storage ring light source. Diamond is a not-for-profit limited company funded as a joint venture by the UK Government through the Science & Technology Facilities Council (STFC) in partnership with the Wellcome Trust. Founded in 2002, the first beamlines were open to users in 2007 and meanwhile DLS operates at almost its full capacity of some 30+ beamlines. Diamond welcomes annually more than 5000 scientists from UK and all over the world, studying a vast range of subject matter, ranging from new medicines and treatments for disease via chemistry, catalysis or magnetism to innovative engineering and cutting-edge technology.

In my talk I will be briefly reviewing the main properties of synchrotron radiation and some specific exprimental techniques before reporting a few research highlights selected from the field of life science and physical/material science - with some emphasis on results obtained at Diamond.

As a result of further technological development a new generation of storage rings and linear accelerator enabled light sources is presently under construction or coming into operation. Thus, finally, we shall have a glance at the properties and the scientific progress enabled by this new generation of low emittance, high brilliance storage rings [3] and linear-accelerator-based so called free-electron-laser light sources [4].

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Material science and nanostructures produced with GeV heavy ions

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ABSTRACT

The existing and future accelerator facilities at GSI and FAIR (an international Facility for Antiproton and Ion Research) provide unique opportunities for research with ion beams in many different disciplines [1]. The presentation gives a glimpse on the broad activities in the field of materials science and ion-track nanotechnology using swift heavy ions of GeV energy and above. The interest in such beams is based on the large energy deposition along the trajectory of each individual ion creating long nanoscopic trails of severe damage. In nanoscience, the small track size in combination with the large ion range (up to 100 μm and more) allows us to overcome limits of planar structuring techniques Several examples will be presented illustrating how to synthesize e.g. nanochannels and nanowires of tailored diameter, length, or shape with special electrical, optical, or thermal properties.

Ion beams at FAIR will permit materials science experiments with unprecedented ranges and intensities. Injecting for instance relativistic ions through a mm-thick diamond anvil of a high-pressure cell into a target under pressure, drives the local atomic structure far from equilibrium. Under such conditions, stabilization of new materials was evidenced via pathways in the phase diagram which are otherwise not accessible but of importance to simulate conditions existing in the Earth mantle. Testing materials behavior in extreme radiation, pressure, and temperature environments will also have a direct application to the understanding of structural materials degradation in high-dose environment and for shielding of equipment in deep space missions.

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Advances in ion implantation and ion beam analysis for low dimensional materials

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ABSTRACT

Doping of 2D materials by ion implantation has some unique requirements regarding ion energy, ion beam optics and sample preparation. Efficient substitutional incorporation of low energy ions into the graphene lattice requires energies well below 50 eV. We use a low energy mass selected ion beam system with UHV implantation chamber. A 30 keV mass selected ion beam is guided through differential pumping stages and homogenized using a beam sweep. The beam is then decelerated in a UHV-chamber down to energies of as low as 10 eV. An area of about 1 cm^2 can be uniformly irradiated with these ultra-low-energy (ULE) ions with a beam current up to several μA. Results for doping of monolayer graphene with $^{11}B^+$, $^{14}N^+$ an P^+ ions and doping of 2D MoS_2 with Se^+ ions will be presented. Challenges for ULE ion implantation such as non-flat substrates, charging of substrates, cleaning of surfaces and lateral controlled implantation will be briefly discussed.

Low dimensional systems like ultra-thin films or multilayer structures require high depth resolution analysis methods. We present results for Rutherford backscattering of 450 keV He ions using an electrostatic analyzer providing a depth resolution of 1-2 nm.

Another challenge is the analysis of light elements in radiation sensitive thin samples. We use a combination of backscattering and coincidence forward scattering of MeV protons extracted to He atmosphere to determine light element concentration depth profiles, including H profiles in thin films. Utilizing non-Rutherford scattering cross sections, the method is quite sensitive to light elements like C,N,O. Examples for polymer films and water containing samples are presented.

PL-06

Radiation Biophysics Research at GSI for Ion Beam Tumor Therapy

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ABSTRACT

Radiation biophysics research with ion beams is an important pillar of the GSI research activities for more than 30 years. Understanding the mechanisms of the increased effectiveness of ion beams as compared to conventional photon radiation is of particular relevance for issues of radiation protection as well as applications in tumor therapy.

The high energy beams available from the SIS synchrotron opened the possibility to apply ion beams for tumor therapy. Based on the longstanding experience in the physical and radiobiological characterization of ion beams in combination with the engineering expertise available at GSI, a pilot project for patient treatments with carbon ion beams was initiated. More than 440 patients were treated between 1997 and 2008, and as a consequence of the great success of this project a clinically dedicated ion beam therapy facility was established at the University Clinics Heidelberg, which started patient treatments in 2009.

Although no patients are treated anymore at GSI, the research activities in the field of medical applications are ongoing, aiming at a further increase of the accuracy of the treatment delivery and extending the range of applications also to non-cancer diseases.

The talk will summarize the main physical, biological and technical aspects of ion beams that are relevant for therapeutic application. Special emphasis will be put on the integration of these features in the treatment planning procedure.

INVITED TALKS

IT-01

Accelerator Development in India: Present Status and Future Perspectives

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ABSTRACT

History of Accelerators in India goes back to the development of a 37 inch cyclotron at the Calcutta based Institute of Nuclear Physics (now called Saha Institute of Nuclear Physics) in 1940 by Prof. Meghnad Saha. Many small accelerators were installed in several teaching and research institutes. The accelerator technology in India took a great leap in 1978 when an indigenously designed and built 224 cm diameter Variable Energy Cyclotron was made operational at Calcutta. Since early 1990 successful operation of 14 MeV Pelletron at Mumbai and a 15 MV Pelletron at New Delhi for very heavy ions have given tremendous boost to accelerator based research in India. These have been upgraded with superconducting indigenous Linacs. A 700 MeV electron synchrotron at CAT, Indore, feeding into a 450 MeV storage ring INDUS-I and 2.5 GeV ring INDUS-II has been operating for past few years. A K=500 Superconducting Cyclotron is under commissioning at VECC, Kolkata. Some smaller accelerators have recently been installed at GGU,Bilaspur, IIT, Kanpur, Kurukshetra and Allahabad Universities.

These accelerators are being used for nuclear physics, condensed matter and surface physics, atomic physics and biological studies.

The most challenging accelerator development project underway is the High Intensity (1 GeV, >10 mA) proton machine for Accelerator Driven System at BARC, Mumbai and the Indian Spallation Neutron Source at RRCAT, Indore.

During the process of accelerator development extensive expertise has been generated in the country and only a tiny fraction of the potential is being exploited for societal purposes, but certainly more needs to be done. I shall in this talk review the developments and discuss these issues in detail.

Design and development of 6 to 18 MeV electron beam system for medical and other applications

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ABSTRACT

A system for the electron and photon therapy has been designed and developed at SAMEER, Kharghar campus, Navi Mumbai. All the components of the system such as 270^0 beam bending electromagnet, trim coils, magnet chamber, electron scattering foil, slits , Applicators, etc, were designed and fabricated indigenously. The electrons of 6,8,9,12,15 and 18 MeV energies were provided by a linear accelerator, indigenously designed and made at SAMEER,IITB campus, Mumbai. The electron beam from the linac enters the magnet chamber horizontally, and after deflection and focusing in the 270^0 bending magnet, comes out of the exit port, and travels a straight path vertically down. After passing through the beryllium and tantalum scattering foils, the electron beam gets scattered and turn into a solid cone shape such that the diameter increases with the travel distance. The simulation results indicate that at the exit port of the 270^0 beam bending magnet, the electron beam has divergence angle ~ ≤3 mrad and diameter~2 to 3mm, and remain constant over 6 to 18 MeV. On a plane at a distance of 1000mm from the scattering foils the size of the electron beam could be varied from 100mmX100mm to 250mmX250mm using suitable slits. The system was made for electron therapy of skin and malignant cancer near the skin surface over 6 to 18 MeV. Different types of Applicators were therefore designed and fabricated to provide required beam profile and dose of electrons to a patient. For the photon therapy, bremsstrahlung radiations were produced by bombarding electrons on a thin tungsten strip. The 7MeV cyclic electron accelerator called Race-Track Microtron of S.P.Pune University, Pune was extensively used for studying the performances of the scattering foils, electron beam uniformity and radiation dose measurement. Different types of TLD dosimeters were developed to measure dose in the range of 1 to 10kGy. The energy and intensity of the bremsstrahlung radiation were measured from the activities of the radioisotopes produced through threshold (γ,γ) and (γ,n) reactions. Degradation of a few chemicals and dyes were found efficient by 6MeV electron irradiation method.

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Organic Functional Nanomaterials by Single Particle Triggered Linear Polymerization

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ABSTRACT

Low dimensional nanomaterials with precisely controlled sizes (0D nanoparticles, 1D nanowires, nanorods, nanoribbons, etc.) have been demanded highly in recent years particularly in nanoelectronics, nanomechanics, and biomedical fields. Although notable methods to grow nanowires by self-assembly are beautiful, there is an indispensable drawback to struggle and find out specific conditions appropriate for each system. In this sense, universal techniques to fabricate such nanowires from various organic materials have been thirsted for the further progress of the related research field. Here we report one of the promising and facile methodologies to give quantitatively the nanowires with controlled geometrical parameters. In this method, referred to as "Single Particle Nanofabrication Technique (SPNT)" and/or "Single Particle-Triggered Linear Polymerization (STLiP)", organic thin films on a supporting substrate were irradiated with high-energy charged particles accelerated by particle accelerators. Each particle penetrates from the top of the films to substrate with gradually releasing the kinetic energy along its trajectory (ion track), generating reactive intermediates such as radical species that eventually induces propagation reactions. The resulting polymerized products were integrated into nanowires having uniform diameter and length that can be isolated via development with appropriate organic solvents. The widely applicable nature of SPNT/STLiP have been demonstrated to provide electronic conductive materials,[1] biological sensing materials,[2,3] drug delivery platforms,[4] nano-actuators,[5] catalysts,[6,7] etc., thus APNT/STLiP opens a new door to access a number of functional nanowires and their assembly.

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A simultaneous irradiation system with ion and slow-positron beams for in-situ characterization of radiation damage

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ABSTRACT

A slow-positron beamline based on an electron linear accelerator was combined with a small ion accelerator to perform in-situ positron annihilation lifetime measurements under simultaneous ion beam irradiation. Positron annihilation lifetime spectroscopy (PALS) has been recognized as a unique probe to detect atomic-scale vacancies in crystalline materials. In particular, energy-variable slow-positron beams are effective for ion-implantation induced defects formed at near-surface layers with depth-dependent profiles. We expect that the in-situ PALS measurements under ion beam irradiation make it possible to investigate the transient states of irradiation-induced defects (i.e., vacancy-type defects in the case of PALS) and to understand formation and evolution processes of irradiation damage.

Positrons are generated through electron-positron pair creation in a Ta converter by a 70 MeV electron beam from the electron linear accelerator at AIST. The generated positrons are thermalized in a W moderator and magnetically guided along vacuum ducts with solenoid coils to a sample chamber at a beam energy of ~10V.[1] Positron pulses are formed by pulsing electrodes (chopper, prebuncher and buncher electrodes) to perform PALS measurements [2] and high voltage up to 30 kV is applied to the sample holder to accelerate the positrons. On the other hand, an ion beamline from the ion accelerator with a radio-frequency ion source was connected to the positron beamline. A maximum ion acceleration voltage is 150 kV and ion species from gas sources such as He and Ar can be used. In addition to the detail of the simultaneous irradiation system with positron and ion beams, transient measurements of positron lifetimes [2,3] and re-emission yields [4] for pure metal and SiO_2 samples with Ar or He ion irradiation will be introduced in the presentation.

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Overview of Accelerator based Materials science studies using Positron Annihilation and Electron Spectroscopy

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The advent of ion accelerators has paved way for novel synthesis of materials, its modification and characterization at different length and time scales. The ability to have tunable energy range of ion species enables to carry out implantation at selected depth regions, which have immense applications in semiconductor industry. Also, depth profiling of chemical impurities and defect species is an useful and powerful technique for materials science studies. The present talk provides an overview of accelerator facilities available for ion implantation and characterization studies. Various materials characterization techniques that have been set up in terms RBS, Ion Channelling, PIXE etc will be highlighted. Variable low energy positron beam system having depth-resolved vacancy defect profiling capability will be highlighted. Some of the selected studies on amorphisation in Ar-irradiated Si, ion irradiated glasses, heavy ion irradiation studies on various steel samples, and non-linear defect production during cluster ion implantation will be highlighted.

Effect of Swift Heavy Ion Irradiation on Conducting Polymers and Other sp^2 Hybridised Materials

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ABSTRACT

The technique for material modification because of the deposition of localized high energy densities in solid matter, by means of energetic ions produced in accelerators is very old. Tracks of heavy ion insulators have been investigated for more than three decades. However, swift heavy ion (SHI) irradiation of polymers is comparatively, recent technique for physical and chemical modifications of the polymers, so as to alter various properties like density, chain length, solubility and conductivity. We have explored various conducting polymers like polypyrroles, polythiophens and other sp^2hybridised material like graphene oxide. The irradiation introduces carbonaceous regions rich in graphite sp^2 bonding. They may create metal-insulator transition or can increase the conductivity whereas the overall charge transport still remains hopping conduction. The conducting polymers are now explored to replace conventional semiconductors for various electronics, optoelectronics and sensor applications. The increase in conductivity due to irradiation can also be used to create desirable conducting regions which can be used for conductivity specific sensor applications or to create microcontact between two non conducting regions. Also some materials like polypyrrole exhibit giant increase in dielectric constant. The dielectric constant increased for pristine sample from 254 at 100Hz to 4554, when irradiated at the 10^{12}ions/cm^2 fluence at room temperature, where the dc conductivity due to SHI Ag^{8+} irradiation changes from $6.52x10^{-7}$ to $9.43x10^{-5}$S / cm. The ion irradiation also changes the surface morphology, creating microporous regions on the surface. In another independent study we have observed multifold increase in the dc conductivity in reduced graphene oxide samples when irradiated with low energy ion beam of 50KeV N^+ ions at fluence 10^{15}ions/cm^2. The increase in surface porosity made it suitable for gas sensing applications as the surface area for gas adsorption increases. We have observed enhanced sensing of our samples toward sulphur dioxide.

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Hybrid nanodot evolution by ion irradiation of thin films

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ABSTRACT

Unique properties of metal and semiconductor nanostructures make them the key components for present and future applications of nanotechnology. In the present study, we show the evolution of Au-Si bilayer deposited on SiO2 surface from interconnected island network to hybrid nanodot array under medium energy ion irradiation. While the lateral dimension of the nanostructures is found to depend upon ion energy and fluence, existence of a characteristic lateral length scale is also detected at every stage of evolution. The structural evolution, studied using scanning electron microscopy, transmission electron microscopy, and Rutherford backscattering, is understood in terms of dewetting of the bilayer film [1-3]. Ion energy deposition is also found to result in development of Au silicide at the bilayer interface [2]. Thus, this process couples the nanostructure evolution due to dewetting with ion induced mixing and sputtering and therefore opens up a promising general route towards self-organized synthesis of composite nanodots on materials surface, for instance, Au-Ge nanodots [3]. The growing nanostructures are found to be luminescent in the visible wavelength range at room temperature, where the emission intensity and wavelengths vary with morphology. The visible PL emission is found to be related with evolution of the Au-rich silicide nanodots.

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Metal Nanocatalysts Prepared by Ion Beam Irradiation for Hydrogen Energy Devices

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ABSTRACT

We have been developing catalytic materials for next-generation energy devices for future hydrogen society by effective use of accelerated ion beams. The advantage of our overarching research strategy is that these energetic ions can lead to characteristic defect creation, active-site formation via non-equilibrium chemical reactions, and micro-to-nano fabrication. My talk deals with the ion-beam applications to metal nanocatalysts for oxygen reduction reactions (ORRs) in fuel cells.

Platinum (Pt) nanoparticles with the high ORR activity have been actively investigated for widespread commercialization of proton exchange membrane fuel cells (PEMFCs). Many researchers previously proposed that the surface modification of a carbon support by thermal, chemical or plasma treatment enhanced the catalytic activity of Pt nanoparticles. In this study, therefore, we pursued the possibility of ion-induced lattice defects in the support in order to improve the performance of the Pt nanoparticles through the interfacial interaction.

I will present the following topics: (i) the supporting state of Pt nanoparticles on the Ar-ion-irradiated GC substrate, (ii) the irradiation effect on the ORR activity of the supported Pt catalysts and (iii) X-ray absorption fine structure (XAFS) measurements and theoretical calculations to examine the local structures at the nanoparticle-support interface.

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Advantages of Using Ion and Electron Accelerators for Radiation Damage Studies and Materials Modifications

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ABSTRACT

For the study of radiation damage in nuclear reactor related materials, the irradiation experiments by using particle (ion or electron) accelerators have a lot of advantages. They can control independently each irradiation parameter such as irradiation dose, dose rate, PKA energy spectrum, electronic stopping power or nuclear stopping power by changing the energies and/or species of irradiating particles. In the accelerator irradiation experiments, the temperature of samples during the irradiation can be changed easily. Moreover, *in-situ* investigations of irradiation effects on samples during the irradiation are possible by means of the x-ray diffraction (XRD), the Rutherford back scattering(RBS), the transmission microscope (TEM) and so on.

Another feature of the irradiation by accelerators is that high-density energies are deposited instantaneously in narrow regions of targets. Since such energy depositions lead to the state which is far from the thermal-equilibrium, they can be applied to the modifications of materials, which are hardly realized by using conventional materials processing methods.

In the conference, first of all, I will mention briefly the advantages (and also some disadvantages) of using accelerators for the studies of radiation damage and material modifications. And then, I will show our experimental results for the radiation damage on nuclear reactor pressure vessel steels and nuclear fuels, and those for the modifications of magnetic, mechanical and optical properties of several metals and ceramics by using various ion and electron accelerators.

Influence of Ion beams to tailor the optical properties of metal doped transition metal oxide thin films

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ABSTRACT

Transition metal-doped titanium oxide is nowadays a class of materials with promising applications in photo-catalysis, gas sensing, and diluted magnetic semiconductors etc. TiO_2 has drawn extensive research interest, because it exhibits excellent properties. It is active in the UV range, in order to extend the light absorption of TiO_2 into the visible region; Ion implantation of V, Cr and several transition metals shifts the absorption edge to the visible region, thus increasing photo-reactivity of TiO_2 in the visible region.

In the present work, we have studied the effects of metal doped Titanium oxide thin films prepared by pulsed laser deposition on optical properties. Doping metals enhances the optical absorption spectra towards visible range and it decreases the band gap energy in comparison to pure TiO_2 thin films prepared under the similar condition. These films were irradiated with high energy ions which also reduces the band gap energy. Swift heavy ion irradiation enhances the oxygen vacancies in the film, and the extra electrons in the vacancies act as donor-like states. Valence band photoelectron spectroscopy suggests that there is a shift in the Ti 3d peak towards lower energies and the shift is equivalent to the band gap energy obtained from UV spectrum. Evidence for band bending is also provided by the corresponding Ti XPS peak which exhibits a shift towards lower energy due to the downward band bending. X-ray absorption studies on O K and Cr $L_{3,2}$ edges clearly indicate that swift heavy ion irradiation induces formation of Cr-clusters in TiO_2 matrix in case of Cr-doped TiO_2 thin films.

Formation of ZnO Nanocrystals in SiO_2/Si Track Templates: Experiment and Computer Simulation

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ABSTRACT

Amorphous silicon oxide layer with 1μm thickness was formed by the thermal oxidation method of silicon substrate. Latent SHI tracks in SiO_2 layer were created by irradiation of Xe ions (E=200MeV, $\Phi = 10^8 - 10^9$ cm^{-2}). After etching of ion tracks in 1 - 4% water solution of hydrofluoric acid (HF) at 300K, a precipitation of Zinc was performed by electrochemical (ECD) method at room temperature. Morphology of SiO_2/Si structures surface before and after precipitation was examined on SEM and AFM. Frontal surface and cross-section studies showed filled nanochannels. The formation regime of nanocrystals and nanotubes of zinc oxide in the track template is developed. The changes in luminescence and photovoltaic characteristics of deposited samples were investigated. The X-ray diffraction analysis made it possible to monitor the obtained structures.

For a detailed study of nanocrystals synthesis at atomic level, an analysis of absorption processes of various impurities on the oxides surfaces was carried out using computer simulation methods. The energy band structure of pure/doping surface was modeled, where total and partial density of states (DOS) signatures of surface host atoms and impurity atoms was computed. Also, the effective charges on atoms and chemical bounds have been estimated using the Mulliken population analysis.

Multimodal treatments of radio-resistant cancer: emerging effective combined therapy of PARP-1 inhibitors and high-LET particle therapy

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ABSTRACT

Particle therapy with carbon ions beam is an innovative technique of radiation therapy successfully used in the treatment of tumors resistant to conventional radiation-therapy due to a higher biological effectiveness compared to low-LET radiations. In spite of high hope of carbon ion beam in radiotherapy, there are a number of issues yet to be resolved and detailed research of cellular responses after irradiation is urgently required for better therapeutic approach.

Poly (adenosine diphosphate-ribose) polymerase (PARP) is a family of enzymes involved in a wide number of cellular processes, including DNA replication, transcription, repair and cell death. Since a decade, it has been shown that PARP-inhibitor could impact radioresistant cells by a replication dependent radiosensitization effect which could be exploited for specifically target tumor tissue with slight or no effect on surrounding healthy tissues. Thus, pharmacological inhibitors of PARP-1 alone or in combination with other chemotherapeutic drugs as Temozolomide show good results in clinical trials for treatment of various cancer-types in combination with conventional radiation therapy (photons).

Treatment of radioresistant cancers as high-grade chondrosarcoma or glioblastoma may be improved by a combined exposition to PARP inhibitors and carbon ion beams. As expected, we observed that depletion of PARP-1 induce a clear and significant radiosensitization of glioblastoma or chondrosarcoma cells compared to photons irradiation. Moreover, such combination decrease cell proliferation and cancer stem cells population in both models. Finally, we sequence the cell lines used for a 69 genes panel involved in DNA repair in order to seek correlation with our experimental findings.

Taken together, our data show undoubtedly a beneficial impact of combined treatments on the control of radioresistant tumor

Quantum emitters coupled to plasmonic nanostructures: from quantum efficiency enhancement to nanolasing

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ABSTRACT

Single quantum emitters (QE) have become a common tool for the development of new light sources, such as lasers, LEDs, and single-photon sources, for electronic nanodevices. Among different possible QEs, rare-earth (RE) ions are particularly interesting for their intense room temperature emission as a two-level system. For instance Er^{3+} ions in silica emit at $\lambda = 1.54$ μm where silica fibers exhibit the minimum losses. To this respect, the consistent development of a quantum network based on silica fibers strongly relies on the availability of single-photon sources at that wavelength. This demand makes Er^{3+} ions in silica a very interesting and promising quantum system for single-photon source development. On the other hand, ion implantation is a very versatile nanofabrication technique for local doping on predefined patterns of functional substrates. This is of paramount importance for instance when investigating optical phenomena arising from the near-field coupling of QE ions with plasmonic nanostructures, in which a highly controlled positioning of the emitters with respect to the metal nanostructures is required.

In this work, we present two examples of the coupling of QEs with plasmonics nanostructures to achieve (i) quantum emission enhancement or (ii) coherent emission or nanolasing.

In the first case, we have investigated the non-resonant, non-radiative energy-transfer coupling between Er^{3+} ions in silica and quantum clusters (QC) of Ag or Au made of 10-20 atoms obtained by ion implantation [1-4].

The second example deals with the production of coherent nanosources of photons by coupling a dye molecule with an ordered array of Au nanostructures. Above a given pumping threshold, the broad incoherent emission transforms into a much narrower emission arising from the coupling of the emitters with the Bragg modes of the 2D plasmonic lattice [5].

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Electron Accelerators and Their Applications

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ABSTRACT

Electrons as energetic projectiles have some unique features that have been extensively utilized for investigating the structure of matter. Several fundamental discoveries have been made using energetic electron beams. More are expected by using the international linear collider (ILC) or a similar electron machine/s when built in the near future. Being very lightweight, the electrons become relativistic rather quickly during the acceleration process. Therefore, these accelerators have different characteristics as compared to those for ions. Both circular as well as linear accelerators are used to accelerate electrons. An important aspect of the circular accelerators for electrons is the emission of synchrotron radiation while being accelerated. This aspect, earlier considered a nuisance by the accelerator builders, has now become a boon for material scientists, biologists etc.

The field of electron accelerators and their utilization is extremely broad. In this talk, after a brief mention about various possibilities, a discussion on their beneficial applications in industry, medicine and environmental control will be presented. The machines for such applications are small but mostly with high beam power. Material engineering and modifications, cancer treatment, product sterilization, food processing, wastewater treatment, pollution control, non-destructive testing, etc. are some important applications. Majority of these applications are already in public domain. Challenges in developing very high beam power (~ MW) electron accelerators e.g. for wastewater treatment, flue gas treatment etc. will be discussed.

Ion Beam Studies of Hafnium-based high-k Dielectric Materials: Nanoparticles, Thin-films and Devices

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ABSTRACT

Application of ion beam techniques to analyze and tailor various properties of materials is the main theme of our research programs. Here we present our recent results on the ion beam characterization and modification of HfO_2 nanoparticles and thin-films prepared by various methods. These materials have recently attained significant interest owing to their applications in new generation metal oxide semiconductor (MOS) devices. Ion induced interface mixing effects on HfO_2 based MOS structures have been studied by employing high resolution Rutherford Backscattering Spectrometry and X-ray reflectivity techniques. Consequent effects on the electrical properties of these devices have been examined by *in-situ* measurements during irradiation. The influence of various tunneling mechanisms governing the leakage current will be discussed in detail. Further, we report on the ion induced crystallization and grain growth of HfO_2 nanoparticles in thin-films. Amorphous clusters in thin-films got transformed to monoclinic phase after irradiation. Whereas the thicker films got transformed from monoclinic to tetragonal phase under similar irradiation conditions. The observed results will be explained within the framework of thermal spike model. These findings provide useful information for understanding the mechanisms that govern the stability and long-term reliability of *state-of-the-art* electronic devices.

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ORAL

Laser-driven ION (LION) sources

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ABSTRACT

The high power laser driver enables detailed investigation of ultrafast laser-plasma interactions at extreme fields. Energetic particle and photon yields of these interactions are diagnostic but also indicate promise for laser-driven energetic particle acceleration as the basis of candidate sources for innovative laser-driven accelerator development. With the advent of the petawatt era, the extent of progress is indicated by the laser pulse energy scaling of typical ion source spectra at the single shot level [1]. However, applications will typically require repetition-rated delivery of confined particle beams that are stable, reproducible, controllable and suitably monitored. For laser-accelerated ions we then must consider the integrated laser-driven ion accelerator system or ILDIAS. Mindful of the potential for multiple applications, due emphasis on the integrated full system in an accelerator context goes beyond the microscopic scale of the localized laser-plasma setting and is therefore essential. ILDIAS is defined and its component progress is briefly discussed. A variety of applications can present a variety of ILDIAS requirements; one of the most stringent being laser-driven ion beam radiotherapy or LIBRT. Given the rapid impressive cyclotron and synchrotron developments in industry, a comparative assessment of the laser-driven case must be ongoing with a commensurately developing vision of en route milestone applications. As an innovative contribution to accelerator advancement, ILDIAS machine development and applications must pursue and exploit the uniqueness enabled by the high power laser-driver. Some guidance points are given for realistic long term strategic planning where the distinction between ILDIAS as the machine and specific applications is critical.

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Morphological tuning of complex polymer-metal nanostructures via process parameters

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ABSTRACT

Nanocomposites, a high performance material exhibit unusual property combinations and unique design possibilities. Nano-structuring the polymer-metal interface in thin films is crucial for organic photovoltaics, flexible electronics and sensors [1, 2]. Extensive research has been done concerning the morphological effects on functional, electrical and optical properties but tuning of the physical properties of sub-monolayer nanogranular metal films and layered structures via processing parameters still needs to be explored. Hence, we investigated in real-time the different growth kinetics of nanostructured metal-polymer bilayer and multilayer structures [3]. In bilayer systems we have canvased the effect of applied bias voltages from 0V to - 400V and in multilayer structures we have analyzed the effect of varying volume fraction of metal in polymer using grazing incidence X-ray scattering and UV-Vis spectroscopy [4]. Optical response was correlated to the morphological properties at all growth stages during in situ measurements [5]. Electron microscopy confirmed a transition in the nano-granular structure at a bias voltage around -300 V from a densely packed via a worm-like transient stage to a large cluster layer in bilayer system. In multilayer structures nanoparticles exhibited a lognormal size distribution with rather well defined inter-particle correlation in lateral and vertical direction. Linear dependence of the size of nanoparticles with annealing time and temperature suggests a diffusion control growth of nanoparticles. Our results offer a versatile route for fabricating tailored metal arrays.

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Near edge X-ray absorption fine structure spectroscopy and magnetic properties of Ni doped CeO_2 nanoparticles

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ABSTRACT

In recent years a remarkable research effort has been made to control and tailor the physical properties of the dilute magnetic semiconductors (DMS's) due to their potential applications in the spintronics devices. DMS materials can be designed by adding few percent of magnetic ions inside a nonmagnetic semiconductor matrix such as TiO_2, ZnO, SnO_2 and CeO_2 etc. In the present work, we reported the structural, magnetic and electronic structural properties of Ni doped CeO_2 nanoparticles. X-ray diffraction (XRD), Raman spectroscopy and high-resolution transmission electron microscopy results show the single phase nature of Ni doped CeO_2 nanoparticles and exclude the presence of any secondary phase. The lattice parameters, particle size and strain of Ni doped CeO_2 nanoparticles calculated using XRD data was found to decrease with Ni doping. Near edge X-ray absorption fine structure (NEXAFS) spectra at Ce $M_{5,4}$, Ce L_3 and O K-edge determine that the Ce-ions are in +4 valence state in pure as well as in Ni doped CeO_2 nanoparticles. DC magnetization measurements show Ni doped CeO_2 nanoparticles exhibits room temperature ferromagnetism.

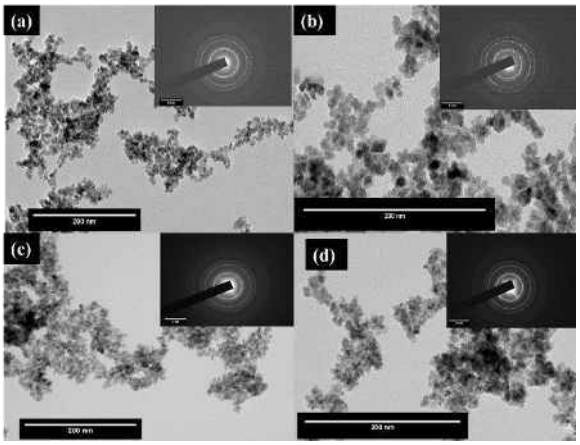

Figure 1. TEM micrograph of $Ce_{1-x}Ni_xO_2$ nanoparticles (a) x = 0.0, (b) x = 0.01, (c) x = 0.05, and (d) x = 0.10.

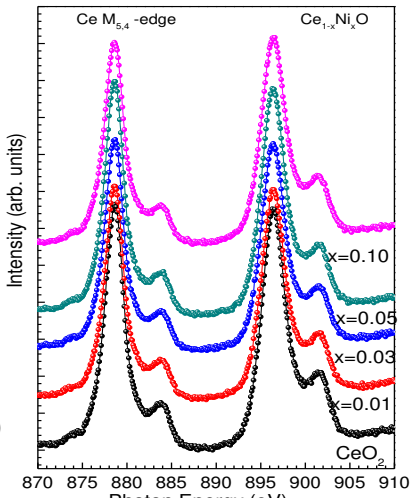

Figure 1. NEXAFS spectra of $Ce_{1-x}Ni_xO_2$ nanoparticles at $M_{5,4}$ edge.

Acknowledgements: One of the authors (Shalendra Kumar) would like to thank to Department of Science and Technology, New Delhi (YSS/2015/001262) for financial s

In situ growth behavior of ultrathin Fe and CoFeB films on MgO using synchrotron x-rays

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ABSTRACT

Magnetic tunnel junctions with thin MgO barrier layers have been investigated extensively because of the giant tunnel magnetoresistance (TMR) achievable in these systems Although a high TMR values have been observed at room temperature for M/MgO (M=Fe/CoFeB) based MTJs [4], but still fall significantly short of the theoretically predicted value of 1000% [5, 6]. Interfacial imperfections in terms of possible oxidation of transition metal in the interfacial region or oxygen vacancies etc. are suggested to be possible reasons for deterioration in TMR value [7, 8]. However contradictory results have been reported in the literature, which may at least partly be attributed to the limitations of the techniques used in the study. Furthermore, PMA is observed in ultrathin films of Fe and CoFeB in the range of a few nanometer thicknesses. In view of the ultrathin nature of the film, its properties can also get affected significantly by its growth behavior. Therefore in the present work in situ study of growth behavior of ultrathin Fe and CoFeB films on MgO has been carried out using some novel synchrotron based techniques with sub-monolayer sensitivity. Evolution of structural properties with increasing film thickness has been investigated using in situ GISAXS (grazing incidence small angle x-ray scattering) which is further co-related to the evolution of magnetic properties as seen from in situ (grazing incidence nuclear resonant scattering) GINRS. No signature of magnetic dead layer is observed at M/MgO interface (M= Fe/CoFeB) instead a weak perpendicular magnetic anisotropy is observed for ultrathin Fe film on MgO.

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Electrical Characteristics of Silver Nanoparticles Filled Etched Ion-Tracks In Polyimide

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ABSTRACT

150 MeV silicon ions, with a fluence of ~ 10^{12} ions/cm^2 ,were used to register latent tracks in 100 μm thick polyimide films. Different shapes and sizes of the tracks were obtained upon chemical etching of the ion- irradiated samples by varying the solution temperature and etching period. Silver was diffused into the latent tracks by electron assisted process using 6.5 MeV electrons, at different fluences varying from $1x10^{15}$ to $5x10^{15}$ cm^{-2} ,in a separate experiment. Morphological and elemental analysis using Scanning Electron Microscopy and Energy Dispersive X-ray Analysis (EDAX) revealed that the etched tracks were filled with silver nanoparticles throughout the track, up to a length of ~100 μm, for an electron fluence of $5x10^{15}cm^{-2}$.The d.c. resistance of an array of tracks, measured across the polyimide film, was orders of magnitude higher as compared to the resistance of silver wires of equivalent sizes connected in parallel. The results indicated that the electrical current in these tracks flows through the silver nanoparticles randomly connected with each other. Under the same conditions, the a.c. resistance was found to decrease continuously with the frequency of the applied signal at a constant voltage. These results indicate that the etched tracks filled with silver nanoparticles play an important role in exhibiting frequency dependent resistance, suitable for making electronic devices.

OR-06

Hafnia based resistive switching devices for non-volatile memory applications and Effects of ion irradiation and thermal annealing on device performance

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ABSTRACT

The Hafnia (HfO_2), a metal transition oxide, is employed for fabricating resistive Random Access Memory devices by lithographic processes. The required Metal-Insulator-Metal (MIM) structures are fabricated by sandwiching HfO_2 thin-film in between two metal electrodes. Crossbar matrices patterns were obtained by using appropriate mask layouts. To study the annealing [1] and irradiation effects on conduction mechanism of these devices, we performed thermal annealing in the range of 100^0– 400^0 C in a tubular furnace and Swift Heavy ion (SHI) irradiation with Au and Ag with different ion fluences. The X-ray reflectivity (XRD), Rutherford Backscattering Spectrometry (RBS) and energy-dispersive X-ray analysis measurements were performed to determine the thickness, crystallinity and stoichiometry [2] of these films.

The top and bottom metal electrodes were deposited by using the thermal evaporation and oxide layer was deposited by the RF/DC magnetron sputtering technique. These fabricated devices were irradiated with high energy ions (Au, Ag) with different fluences [3] to study and investigate the structural modifications and ion diffusion in the HfO_2 layer (Insulator layer). Switching characteristics were investigated by using the semiconductor device analyser. Sample structures of $Ag/HfO_2/Au/Si$, with different thickness of dielectric layer, were studied in detail.

The Set and Reset voltages are measured to be around 0.85 V, 0.7 V respectively for the 100 nm HfO_2 based devices and 0.65 V, 0.425 V respectively for the 50 nm HfO_2 based devices. The conduction mechanism favouring in these devices may be attributed to cation migration of the top electrode. These ion migration affects are redox processes [4] which cause the resistance change leading to the observed switching mechanisms. The influence of thermal annealing on the conduction mechanism in these devices has been investigated. The electrical characteristics such as resistive switching [5], endurance, retention time [6] and switching speed can be measured by the semiconductor device analyser. These results will be discussed in detail in this conference. The effects of ion irradiation, gamma irradiation and thermal annealing on the resistive switching properties of HfO_2 based RRAM devices will also be discussed in detail.

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Strain Disorder: new degree of freedom to control structurally dissimilar magnetic phase separation in $La_{5/8-y}Pr_yCa_{3/8}MnO_3$ epitaxial thin films

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ABSTRACT

Understanding of micrometer sized phase separation in $La_{5/8-y}Pr_yCa_{3/8}MnO_3$ (LPCMO) has been debated. Some researcher believed that strain interaction between structurally dissimilar magnetically contrasting phases shapes the larger sized phase separation. Present study reveals that the length-scale of phase separation in $La_{5/8-y}Pr_yCa_{3/8}MnO_3$ thin films can be controlled by strain disorder invoked during the growth and relaxation process of the thin films. Strain disorder provides an additional degree of freedom to tune colossal magnetoresistance.

Reciprocal space mapping of thin films demonstrates coherent epitaxial growth of the films and also evidenced that strain relaxation mechanism during thin film growth resulted in inhomogeneous distribution of lattice strain termed as '*Strain Disorder*'. Presence of '*Strain Disorder*' stabilizes ferromagnetic phase while coherent uniform strain stabilizes antiferromagnetic phase. Raman spectroscopy confirms the coexistence of charge-ordered-insulating and ferromagnetic-metallic phases which are structurally dissimilar and possess $P2_{1/m}$ and R-3C like symmetries, respectively; therefore the larger sized lengthscale of phase separation is found to be highly correlated with strain field inhomogeneities.

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5 MeV Proton Irradiation Effects on 200 GHz Silicon-Germanium Heterojunction Bipolar Transistors

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ABSTRACT

The bandgap engineered silicon-germanium heterojunction bipolar transistor (SiGe HBT) is an attractive candidate for operation in extreme environments, including: radiation-intense surroundings such as space and high energy physics experiments. The SiGe HBTs are well known to be inherently total dose tolerant without any additional hardening, making them prime contenders for a variety of terrestrial and space-borne applications, nuclear installations, high energy physics experiments and military applications. The electronics employing in such applications must be hardened against radiation to operate reliably for long time. The electronic systems operated in space environment experience persistent exposure to large and potentially lethal fluxes of high-energy protons, neutrons, electrons, gamma rays, X-rays and high-energy heavy ions. A typical orbital satellite is expected to be exposed to fluence of the order of 10^{10}-10^{12} cm^{-2} of protons, 10^{6}-10^{9} cm^{-2} of electrons and 10-1,000 krad (Si) of gamma radiation during its flight lifetime (typically 10 years). In the high-energy physics experiments, electron or proton beams having energies as high as 500 GeV are used to study elementary particles with a short lifetime such as bosons, muons and quarks. Generally, ^{60}Co gamma, neutron and proton facilities are using to study the reliability of semiconductor devices and number of researchers has investigated effects of these radiations on silicon bipolar junction transistors extensively, but there is less literature on high energy proton irradiation effects on SiGe HBTs. Therefore in the present investigation we have studied 5 MeV proton induced effects on characteristics of SiGe HBTs in the dose range of 1 Mrad to 100 Mrad. The different electrical characteristics like Gummel characteristics, excess base current, current gain, damage constant and output characteristics were studied before and after proton irradiation. We have also studied geometrical dependence on parametric degradation caused by proton irradiation. The complete results will be presented in the conference.

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Comparative evaluation of efficacy of electron photon combination versus photon based VMAT

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ABSTRACT

6 MV photons has been choice for treatment of head and neck cancers. Limited tolerance of spinal cord, posed the impediments in case of radical dose delivery to the target volume. Multi energy electron beams facilitated the requisite radical doses deliveries even to the nodal areas without exceeding the tolerance as electrons have limited penetration with sharp cutoffs. The practices of using electrons shifted slightly due to amalgamation and clinical integration of higher end modalities of VMAT and IMRT. In the developing countries use of electron either a boost or in combination with photon beam is still considered standards of practice. Present study attempts to analyze the equivalence of electron photon combination versus only photon based VMAT. Computed tomographic simulation of all Patients was performed and images were transferred through dicom 3.0 to treatment planning system. Target volumes and organ at risks (OARs) were delineated for further treatment planning. Conventional beam portals included two bilateral fields and one lower anterior neck (LAN) with 6MV photon up to 44.0 Gy of dose in phase I. LAN field was removed and posterior border of bilateral fields were reduced to keep spinal cord out of the radiation field in phase II. To treat the posterior nodes electrons were used with proper abutment. Same CT data was used to generate a VMAT plan using only photon with required constraints. Treatment plans were evaluated with the help of dose volume histograms (DVH) as per international protocols (ICRU 50,62 & 83). Results suggested that the coverage of the targets whether primary or nodal were almost similar. In case of VMAT dose to spinal cord were substantially low and varied from 35-42 Gy. However for conventional plans D_{max} for spinal cord was 44-45 Gy. Comprehensive study based on 35 cases will be discussed and analyzed.

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Medical Linear Accelerators in radiotherapy: Dose escalation with improved accuracy in lung cancer

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ABSTRACT

As soon as the treatment of cancer by ionising radiation started, the radiation toxicities were reported. That demanded very controlled and accurate dose delivery. In cancer treatment, Medical Linear Accelerator (LA) has been very useful because of its improved, efficient and accurate dose delivery features. These features have helped in great extent in achieving the goal of radiotherapy i.e. maximal dose to target and at the same time minimal dose to normal structures. In the present study clinical benefit of Medical Linear accelerators over conventional open field radiotherapy in terms of higher dose to target and minimal dose to adjacent critical structures in lung cancer radiotherapy have been demonstrated. For this, ten patients of lung cancer having comparably small volume of tumor adjacent to chest wall or mediastinum were included. The IMRT planning of each case was attempted using MC algorithm and 6 MV photon beams for total prescribed dose of 60 Gy in thirty fractions for Elekta infinity linear accelerator (Elekta Med systems, UK) equipped with MLCi2. The values of different radiotherapy planning parameters for target, contralateral lung, heart, easophagous, Spinal cord and Total monitor unit, Volume of 50 % isodose lines were recorded for all the ten patients. Compared to open field conventional treatment such as with Co-60 unit, the increased tumor coverage, dose distribution homogeneity in planning parget volume and minimal dose to organ at risks were found. The features of LA helped in execution of lung cancer radiotherapy with dose to critical structures well below their respective tolerance doses. Thus higher dose in lesser fraction can be delivered. That will result in reduction of normal tissue radiation complications.

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Thermoluminescence studies of $Al_2O_3:Tm^{3+}$ phosphor for carbon beam dosimetry

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ABSTRACT

Carbon ion beam dosimetric properties of Tm^{3+} doped Al_2O_3 are discussed. Al_2O_3 phosphors have been synthesized by solution combustion method for different concentration (0.05, 0.1, 0.2, 0.4, 0.8, 1.0 and 1.5 mol%) of Tm^{3+} ions. The samples are annealed 1473 K for 2 hour. Crystalline phase is analyzed by X-ray diffraction (XRD) and average crystallite size is found to about ~135 nm. TL glow curves of 80 MeV C^{6+} ion irradiated Tm^{3+} doped Al_2O_3 phosphors are recorded for low fluence (5.06×10^6 to 2.05×10^8 ions cm^{-2}) and high fluence (1×10^{10} to 5×10^{12} ions cm^{-2}). The effect of Tm^{3+} concentration on TL is also investigated. The optimum concentration of Tm^{3+} ions in Al_2O_3 is found to be 0.05 mol% and its TL intensity is 18 times enhanced than the pure Al_2O_3. TL glow curves of C^{6+} ion irradiated (5×10^{11} ions cm^{-2}) $Al_2O_3:Tm^{3+}$ shows prominent peaks at ~474 K along with a small hump at 630 K. TL emission (TLE) of both the TL glow peaks show similar emissions at 356, 466, 479 and 528 nm along with characteristic emissions of Cr^{3+} and Mn^{4+} [1]. The emission peaks 356, 466, 479 and 528 nm are corresponds to $^1D_2\rightarrow{}^3H_6$, $^1D_2\rightarrow{}^3F_4$, $^1G_4\rightarrow{}^3H_6$ and $^1D_2\rightarrow{}^3H_5$ characteristic emission transitions of Tm^{3+} respectively [2]. TL multiple peaks are deconvolution and their trapping parameters are calculated by employing computerized glow curve deconvolution (CGCD) method with Kitis equation. Dosimetric properties viz sensitivity, linear dose response, repeatability and fading of $Al_2O_3:Tm^{3+}$ (0.05 mol%) phosphor indicated its suitability for carbon ion beam dosimetry.

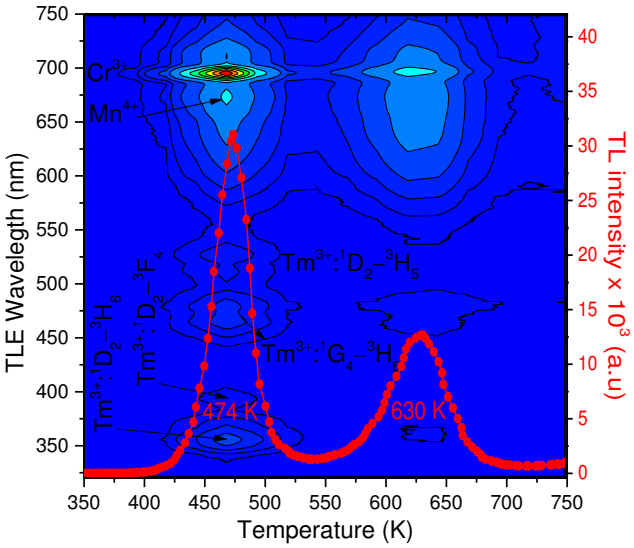

Fig. TL glow curve and TLE spectrum of 80 MeV C^{6+} ion irradiated (5×10^{11} ions cm^{-2}) $Al_2O_3:Tm^{3+}$.

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GROWTH AND IRRADIATION STUDIES OF ORGANIC SINGLE CRYSTAL

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ABSTRACT

In recent years, nonlinear optical materials play an important role in the field of telecommunications, optical data storage devices etc. Many researchers involved in the search of new type of materials with improved nonlinear optical properties. The addition of impurities (dopants) and ion irradiation plays a vital role to tune the physical properties like mechanical stability, optical transmittance and dielectric constant. In this present work, L-arginine acetate (LAA) was grown by conventional solution growth method and their physical properties were studied. Furthermore, oxygen ion irradiation studies were performed on LAA single crystals and their influence on the structural and optical properties were studied. The results obtained in this present work will be discussed in detail.

Enhanced Electrical Conductivity of Carbon Ion Implanted PMMA/nano graphite Nanocomposites

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ABSTRACT

Ion implantation is a surface treatment process in which the surface of a sample is bombarded with a beam of energetic dopant ions to implant ions into the matrix of the substrate. In the present work, nanocomposites of PMMA and nanographite platlets were prepared and subjected to swift heavy ion implantation using the same ion as that of the filler in the nanocomposites. PMMA/nanographite nanocomposites have been synthesized by solution blending method. The prepared PMMA/ nanographite nanocomposite films were irradiated with Carbon ions (C ion beam, 50 MeV) in fluence range of 3×10^{10} to 3×10^{12} ions/cm^2. The nanocomposite films were characterized by SEM, XRD and Raman spectroscopy before and after C ion implantation and were evaluated for their electrical properties. SEM and XRD studies clearly depict the homogeneous dispersion of nanograhite in polymer matrix along with densification of the polymer nanocomposite. The implanted nanocomposites exhibit better electrical properties.

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Local Structural Investigation of doped ZnO nanoparticles

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ABSTRACT

Doped ZnO nanostructures with different dopants were prepared using wet chemical synthesis method. The nanostructures obtained in dry powder form were subjected to optical and structural characterizations using absorption spectroscopy, photoluminescence spectroscopy, X-ray diffractometry and Scanning Electron Microscopy along with Energy dispersive X-ray analysis. The synthesized materials exhibit polycrystalline behaviour in the X-ray diffraction studies. Promising results have been obtained in the optical studies, which make these doped nanoparticles potential candidates for applications like organic light emitting diodes, photocatalysis etc. The scanning electron microscopic results of the doped nanoparticles confirm their controlled size distribution. The compositional investigation using EDAX has shown a close match with the intended dopant concentration.

A comparative study of doping of different elements in ZnO has been undertaken and the optical properties in view of tuning of band gap has been explored. To locate the position of the dopant element within the crystal of ZnO, the Extended X-ray Absorption Fine Structure studies (EXAFS) were carried out at the Synchrotron radiation source, RRCAT, Indore. The analysis of the results is underway. The obtained results will give a deep insight about the local coordination and valence of dopant within ZnO lattice.

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Tailoring the Wettability of Copper Surface with Ion Beam Irradiation

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ABSTRACT

Hydrophobic and hydrophilic surfaces have raised great interest in the last decade for instance in self-cleaning applications and in phase change heat transfer. In the present work, a simple and scalable processes are described to fabricate hydrophobic and hydrophilic by ion beam irradiation. In these methods, superhydrophobic surface are conventionally prepared employing following steps. The cooper surface is rubbed using 1200 grit paper and dried. A direct 30 DC voltage is applied between two copper surfaces immersed in the dilute ethanoic stearic acid for 3 hours. The contact angle measured on this surfaces were 145± 5^{o}. The contact angles were also measured on these surfaces using ion beam irradiation with the Ne ions of 15 keV at 10^{15}, 10^{16}, 10^{17} fluences, resulting in decrease of contact angle to 106±5^{o}. The research is concluded that the ion-beam irradiation reduces the hydrophobicity of super-hydrophobic copper surface.

Effect of Swift (200 MeV) Ag^{9+} ion irradiation on Structural and optical properties of Indium Phosphide

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ABSTRACT

Single crystal indium phosphide samples were irradiated with 200 MeV Ag^{9+} ions using 15 UD Pelletron facilities at Inter University Accelerator Centre (IUAC), New Delhi. The values of the nuclear and electronic energy deposition per ion and unit length calculated by the SRIM code for the indium phosphide were found to be 4.815 and 1.628 $x10^3$ eV/ Å respectively. The samples were irradiated with various ion fluences ranging from 1 x 10^{11} to 2 x 10^{13} ions cm^{-2}. The surface morphology of non-irradiated and samples irradiated with various ion fluences were studied using Atomic Force Microscopy. The non-irradiated indium phosphide samples showed relative smooth surface with r.m.s. roughness 0.24 nm. The increase in the r.m.s. roughness after irradiation was evident due to the impact of swift heavy ions on the surfaces of indium phosphide samples. Rutherford backscattering spectrometry measurement was carried out in channeling geometry with 2 MeV He ions at back scattering angle of 170^0. The RBS/C measurement showed the increase in the yield over the energy range (800-1000 keV) with respect to ion fluence which indicated the increase in the amount of disorder. The optical properties of the samples irradiated with various ion fluences were evaluated by Spectroscopic Ellipsometry in the wavelength range of 240 to 1000 nm. (M-2000U, J.A. WOOLLAM CO. INC.). Ellipsometry parameters, psi (Ψ) and delta (Δ) were recorded for as-irradiated indium phosphide samples. The data was fit to three phase model i.e. thickness of the oxide surface layer, thickness of the irradiated layer and thickness of undamaged layer in order to determine the refractive index and extinction coefficient . It was observed that indium phosphide exhibits higher refractive index in Visible and infrared region than ultraviolet.

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Evidence of Domain Formation in Langmuir Monolayers of Ternary Lipid Mixtures by X-ray Scattering

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ABSTRACT

We have measured X-ray reflectivity (XRR), grazing incidence x-ray diffraction (GIXD), and x-ray diffuse scattering (XDS) from a series of phospholipid Langmuir monolayers. The monolayers are a 1:1 molar ratio of a saturated lipid, palmitoyl sphingomyelin (PSM) and an unsaturated lipid, dioleoylphosphocholine (DOPC), with varying molar percent (0%, 10% and 30%) cholesterol. The scattering pattern is measured as a function both of the cholesterol concentration in the monolayer and of the monolayer surface pressure. X-ray reflectivity measurement, provides the structural details in surface normal direction, shows monolayer thickness of all samples increases with increasing surface pressure. The in-plane crystalline order in high-surface-pressure sample is disturbed by cholesterol, evidenced by the sharp and strong nearest-neighbor peak observed in the GIXD pattern for without cholesterol sample changes to weak and broad peak from samples with cholesterol. We find in the diffuse scattering data that for all samples, two characteristic domain patterns emerge: one with domain size approximately tens of microns, and other with domain size on the order of a micron. The small domain size decreases slightly with increasing pressure for all samples. The interesting finding is that large domain size decreases with increasing surface pressure in null cholesterol sample whereas it increases in cholesterol sample. To the best of our knowledge, this is the first x-ray scattering experimental evidence of domain formation in mixture of lipid monolayers at air-water interface and changes its size due to pressure change.

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P-01

Increased Porous Morphology and Thermal Degradation of Electron Beam Irradiated PVdF-co-HFP/$LiClO_4$ Composite Electrolyte

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ABSTRACT

The effect of 8 MeV electron beam energy (EB) irradiation with 40, 80 and 120 kGy dosage on the surface morphology and thermal properties on the lithium perchlorate doped poly (vinylidene fluoride-co- hexafluoropropylene) electrolyte films have been prepared by the solution casting method. The morphology results shows micro-porous structure of unirradiated film drastically modified to large and deep porous structures for irradiation for 120 kGy. The size of host polymer spherulites reduced with increasing dose rate confirmed the irradiation influence on morphology. The estimation of root mean square values of surface roughness significantly changes from 116.8 nm to 123.4 nm with hill-like pattern for dose 120kGy indicates the increase in amorphicity of the irradiated films and hence enhancement in the ion transport. The melting point of unirradiated films decreased from 160.86 ^oC to 155.24 ^oC for 120kGy dose and which also confirms the decrease in the crystalinity with increasing dose rate. The irradiation causes chain scissioning in host polymer matrix resulting in formation of defects or imperfections, fragmentation is attributed to the degradation of irradiated films.

Effect of Gamma Irradiation on Synthesis and Characterization of Bio-Nanocomposite SF/Ag Nanoparticles

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ABSTRACT

In situ synthesis of Silver nanoparticle (Ag NPs) was done using Silk Fibroin (SF) solution under the gamma irradiation. The Silk Fibroin is derived from cocoons, which belongs to *Bombyx Mori* family, and its solution was prepared, to which $AgNO_3$ is added. The reduction of Ag NPs were takes place when it is exposed to gamma radiation, where SF acts like reducing and stabilizing agent. The final solution contains SF with Ag nanoparticles, whose free standing films were obtained by solution casting method, to get SF/Ag bio-nanocomposites. The reduction of Ag NPs were confirmed by XRD and TEM analysis. The spherical size of AgNPs were confirmed by TEM image, and size of the AgNPs were confirmed by DLS analysis. Also, we have varied the gamma dosage, from 20kGy to 80kGy for reduction of Ag NPs, and we have studied the dose dependent variation of surface morphology, thermal property and optical properties of SF/Ag NP bio-nanaocomposites by comparing with that of pure SF polymer films. The surface morphology is studied by SEM analysis and we found that, surface becomes smoother at higher gamma dosages. The optical properties were analysed using UV-Vis spectrophotometer, and it is found that band gap energy decreases with increase in gamma dosages.

Keywords: Silk fibroin, gamma radiation, silver nanoparticles, UV-visible, XRD, TEM, DLS

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NEXAFS, PL and TL study of SrBaS:Ce phosphors

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ABSTRACT

Alkaline earth sulfide phosphors find many applications such as in optical memory devices, radiation dosimetry, EL devices etc. We have synthesized $Sr_{0.75}Ba_{0.20}S:Ce_{0.50}$ (hereafter referred to as SBSC) phosphors using solid state diffusion method in the presence of sodium thiosulphate as flux. The details of the synthesis have been already reported elsewhere [1]. X-ray diffraction of the SBSC sample is similar to that of SrS:Ce phosphors except some minor shifts in angles. The absence of any secondary phases pertaining to Ba or Ce confirms the single phase cubic structure of synthesized sample. Since doping in host matrix play an important role in luminescence, the presence and valence state of dopant was confirmed by near edge x-ray absorption spectroscopy collected at Ce-$M_{5,4}$ edges. We simulated Ce $M_{5,4}$-edges for Ce^{3+} ion using atomic multiplet calculations, which agrees well with the experimental data, clearly suggesting that Ce enters as Ce^{3+} in SrBaS. A similar result was also found in case of SrS:Ce [2]. The photoluminescence spectra of SBSC comprised of a major peak at 491 nm along with a broad shoulder around 545 nm, which have been assigned to the 5d-4f transition in Ce3+ levels under the crystal field splitting of cubic host matrix. Thermoluminescence (TL) behavior of SCBS was also investigated after irradiating the sample with ultra-violet radiations of wavelength 254 nm. TL glow curve of UV irradiated sample shows a single peak at 372 K, which varies slightly towards lower temperature on increasing UV exposure time. The TL glow curve was analyzed using Chen's peak shape method and trapping parameters were evaluated.

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A Comparisons of 5 MeV Proton and Co-60 Gamma irradiation on Silicon NPN rf Power Transistors

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ABSTRACT

The bipolar junction transistors (BJT) are key components for many applications like space exploration programs, military and high energy physics experiments. The influence of radiation on the electrical characteristics of BJT are analyzed by mainly three parameters i.e., conductivity, minority carrier lifetime and surface recombination velocity. The radiation induced recombination centers cause the reduction in minority carrier lifetime which results in degrading the device performance, as it decreases the current gain and increases the leakage current. Therefore, survivability of devices under such radiation harsh environment is an important aspect. In space environment, the transistor need to withstand few 10's krad to few 10's Mrad of gamma equivalent total dose but for high energy physics experiments like in Large Hadron Colliders (LHCs), the devices need to withstand 100 Mrad of total dose in their five year life time. In the present work the NPN transistors were irradiated with the 5 MeV Protons at National Centre for Accelerator based Research (NCAR), Bilaspur and Co-60 Gamma radiations at University of Mysore in the dose range of 1 Mrad to 100 Mrad. The different electrical characteristics like Gummel characteristics, excess base current ($\Delta I_B = I_{B\text{-}Post} - I_{B\text{-}Pre}$), DC current gain ($h_{FE}$), damage constant (K) and output characteristics were studied before and after proton and gamma irradiation. The results were compared with 1 MeV proton and Co-60 gamma irradiated results in the same dose range. The result showed that the degradation in electrical parameters is more for proton irradiated devices when compared to Co-60 gamma radiation. The degradation in the observed electrical characteristics of the transistors is mainly due to generation-recombination centers created in E-B spacer oxide (SiO_2) and displacement damage in the bulk of the transistor structure. In addition to G-R centers, high energy protons can also create various types of defects in the transistor structure.

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The Effects of High Energy Ion Irradiations on the I-V Characteristics of Silicon NPN Transistors

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ABSTRACT

The advancements in the semiconductor processing techniques have made it possible to use semiconductor devices in the instrumentations of deep space exploration spacecrafts and high energy physics experiments. However, devices operating in these applications are prone to radiation effects wherein a high density of high energy deterrent radiation exists. These radiations include energetic photons and charged particles that can cause severe degradation in the performance and operating life of the semiconductor devices [1-2]. Therefore, it is essential to know the effects of different radiations on semiconductor devices, so that specific design margins can be implemented during fabrication of devices and to make them operate reliably in radiation environments.The high energy ion irradiation facility is suitable for assessing semiconductor device degradation under high total doses. Since heavy ion irradiation needs a relatively shorter time when compared with the conventional irradiations such as proton, electron and gamma irradiations. Thus in the present study high total dose effects of 80 MeV Carbon [C^{6+}], 50 MeV Lithium [Li^{3+}] and 150 MeV Silver [Ag^{12+}] ions on the I-V characteristics of Silicon NPN transistors were systematically analyzed. The different DC electrical characteristics such as the Gummel characteristics, excess base current (ΔI_B), transconductance (g_m), dc current gain (h_{FE}), displacement damage factor (K) and output characteristics (I_C-V_{CE}) were studied before and after irradiation. The transistors were irradiated with different ions in the dose range of 1 Mrad to 100 Mrad. The ion irradiation results were compared with the ^{60}Co gamma irradiation results in the same dose range to quantify the influence of different ion irradiations on the various characteristics of transistors. A considerable increase in base current (I_B) and a decrease in h_{FE}, g_m and I_{CSat} was observed after irradiation. The degradation for 150 MeV Ag^{12+} ion irradiated transistors was significantly more when compared to 80 MeV C^{6+}, 50 MeV Li^{3+} ion and ^{60}Co gamma irradiated transistors.

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Structural properties of heavy energy ion beam irradiated In/Se bilayer

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ABSTRACT

Indium-Selenium based alloy thin films have wide range of applications in solar energy conversion, diodes, infrared devices, lasers and thermoelectric devices. The ion beam processing is one of the unique ways of fabrication of thin films and has been used recently for thermoelectric thin films. These ion beam synthesized thermoelectric films were shown to be nanostructured having higher Seebeck coefficient [1,2]. In the present work In(~150nm)/Se (~150nm) and Se(~150nm)/In(~150nm) thin films were deposited successively on the glass substrate by thermal evaporation method under 10^{-5} mbar pressure at room temperature. The In/Se bilayers were irradiated with four different ion beams: 100 MeV Ag, 80 MeV O, 100 MeV Ni, and 100 MeV Si. These four set of samples were then characterised by High resolution XRD (HRXRD) and Rutherford backscattering spectrometry (RBS). The HRXRD study reveals InSe phase formation in the case when In is on uppermost layer. Other studies related to the thermoelectric properties of the InSe thin film like electrical conductivity, thermoelectric power and Hall measurements are in progress.

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P-07

Irradiation effect of low energy ion on polyurethane nanocoating containing metal oxide nanoparticles

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Abstract

Irradiation effect of low-energy peptization process. Particle size were obtained 107 nm for titania and 240 nm for core-shell nanoparticles prepared through sol-gel process and 75 nm for TiO2 and 140 nm for core-shell nanoparticles prepared ion beam has been investigated on nanocoating developed with silica, titania and silica-titania core-shell nanoparticles embedded in organic binder for nanopaint aplication. In this work we have taken polyurethane as model organic binder. Silica nanoparticles has been prepared through sol-gel synthesis with particle size 85 nm. Titania and core-shell nanoparticles have been prepared through both sol-gel and through peptization process. The coating formulation were developed with the above nanoparticles individually and nanoparticle concentration was varied from 1 to 6 wt % and we got the best performance with 4wt % of the nanoparticles in polyurethane coating formulation. The various coating formulation were applied on glass substrate with dry film thickness around 100 μm. These dried films on glass substrate were irradiated by a ion beam with energy of 26 keV and current of 650 nA at fluency of 10^{14} to 10^{16} ions/cm^2.The irradiation of low energy ion beam on coating were performed but the measurement of contact angle , scratch test and antimicrobial property for the irradiated samples are in progress.

Keywords: Low-energy ion beam, sol-gel synthesis, peptization process, hydrophobic surface, nanocoating.

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Swift Ag^{9+} Ion Beam Induced Surface Modification of Gallium Phosphide

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ABSTRACT

Single crystal gallium phosphide samples were irradiated with 200 MeV Ag^{9+} ions using 15 UD Pelletron facilities at Inter University Accelerator Centre (IUAC), New Delhi. The samples were irradiated with various ion fluences ranging from 1×10^{11} to 1×10^{13} ions cm^{-2}. Atomic force microscopy studies of non-irradiated indium phosphide samples showed relative smooth surface with r.m.s. roughness 0.24 nm. The increase in the r.m.s. roughness after irradiation at higher fluences was evident due to the impact of swift heavy ions on the surfaces of indium phosphide samples. Rutherford backscattering spectrometry measurement showed the increase in the yield over the energy range respect to ion fluence which indicated the increase in the amount of disorder. Phonon confinement model (PCM) employed to first order Raman spectra revealed decrease in phonon coherence length with respect to incident ion fluences.

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Study of ZnO-CdS Core Shell Nanostructures using synchrotron source

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ABSTRACT

ZnO has been researched extensively for its versatile properties, owing to its wide band gap, stability, ease of formation and adaptive nature for a wide range of dopants. It is a wide-band-gap (3.37 eV) semiconductor having the only disadvantage of not being able to absorb the visible part of the solar spectrum. In order to overcome this, CdS (band-gap of 2.4eV) has been introduced as photosensitizer. These structures are supposed to act as energy harvesting species for photovoltaic application. The material has been synthesized using wet chemical method using analytical grade reagents. The hybrid material with tuned band gap extends the absorption spectra in the range from 400-700 nm. This in turn extends its applicability as an efficient material for applications in photovoltaics . The conventional techniques used for structural characterization were not able to completely characterize these hybrid nanostructures due to which the mechanism of energy transfer cannot be established completely, in view of these limitations we utilized synchrotron light source in order to study fine structural details of these complex structures, the EXAFS(Extended X-ray Absorption Fine Structures) measurements successfully explains the structural properties of material , this also enabled us to purpose the energy transfer mechanism in these nanostructures. The nanostructures were further characterized by X-ray diffraction (XRD), Photoluminescence Spectroscopy (PL), UV-visible spectroscopy .

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Optimization of Manganese Doped Zinc Sulphide Nanophosphor for Opto Electrical Applications

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ABSTRACT

In the search of nanomaterials for efficient solid state lighting system, a lot of thrust have been given to nanophosphor materials in recent years. Semiconductor nanostructures have been one the promising materials due to their tunable bandgap and so engineering the light emission. In this work, we synthesize various samples of Manganese doped Zinc Sulphide nano particles while varying the concentration of dopant and the capping agent to explore the variation in the optoelectronic properties. Synchrotron light source was used for the structural characterization of the sample. X-ray diffraction was done at 12.2 eV and the results were found to be better than conventional XRD due to very high signal to noise ratio. Sample characterization carried out using UV Visible spectroscopy, Photoluminescence Spectroscopy, X-Ray Diffraction and Extended X-ray absorption fine structure. The results showed that emission characteristics is directly proportional to the dopant concentration which will in turn affect the electroluminescent properties of Zinc sulphide nanoparticles. Unique phosphorescent and fluorescent properties exhibited by the optimized sample synthesized can be used for the synthesis of various opto-electronic devices like LED's.

Keywords: ZnS, Nanophosphor, Mn doping, Mn doped ZnS, LED's

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[1] PACS: 68.35.bg, 68.35.bj, 78.60.Lc, 78.67.Bf, 42.70.-a, 42.70.Qs, 81.07.Wx.

Use of Ion Beam Technology for Forensic Science Applications

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ABSTRACT

The nature of crime has extensively changed. It has not geographical boundaries and technical limitations. The forensic evidence is key to obtain a conviction and often only very small quantities of forensic material are found on a suspect. The ion beam analysis is a group of techniques which can be used to study forensic materials. Ion beam analysis has a very high sensitivity to trace quantities of most elements in the periodic table compared with other non-destructive techniques. Ion beam analysis is based on the interaction, at both the atomic and the nuclear level, between accelerated charged particles and the bombarded material. When a charged particle moving at high speed strikes a material, it interacts with the electrons and nuclei of the material atoms, slows down and possibly deviates from its initial trajectory. This can lead to the emission of particles or radiation whose energy is characteristic of the elements which constitute the sample material. The spectrometric analysis of this secondary emission may lead to the detection of specific elements in diverse samples as well as the determination of the concentration of these elements, the determination of nature, thickness, position or concentration gradient of several layers of elements or compounds. The technique can be used to identify forensic specimens such as gunshot residues, explosives residues, fingerprints, soils and inks, with the ultimate aim of linking a suspect to a scene of a crime by comparing the elemental composition of forensic material found on the suspect to the composition of forensic material at the crime scene. Ion beam analysis can be applied to solve research problems in forensic science with great emphasis.

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Ion Beam Surface Modification of Chemically Etched Silicon for Enhanced Anti-Reflection Property

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ABSTRACT

Hierarchical structured silicon (Si) surfacehave been widely used for applications like self-cleaning and anti-reflection.[1–3] Various methods, like vapor-liquid-solid, reactive ion etching (RIE), electrochemical etching, metal assisted etching, wet anisotropic etching have been used to realize these combined micro- and nanostructuring on a Si surface.[4–8]

In the current work, hierarchical structures of Si have been developed on n-type (100) Si wafer using wet anisotropic etching method followed by low energy Argon (Ar) ion beam irradiation. Anisotropic etching of (100) oriented Si is widely known to form micro- pyramidal structures.[9] Some of the anisotropic wet etching agents for silicon are potassium hydroxide (KOH), ethylenediamine pyrocatechol (EDP), or tetramethylammonium hydroxide (TMAH). KOH etching is known for excellent uniformity and reproducibility. High KOH concentrations more than 25 wt.% (often 30 wt%) are normally applied in the fabrication of micropyramidal structures. In this work, chemical etching was performed using 30 wt% KOH solution and methanol as an alcohol additive at 80^0C bath temperature. After trials with different alcohol additives like, isopropanol, ethanol and methanol, it was found that methanol additive was optimum to lower the etch rate of Si and smoothen the microstructure surfaces especially at the wall edges. Reflectance measurements were performed on different dimensions of microstructures (3-10μm) formed using wet anisotropic etching process for various time durations. A significant reduction in the reflectance was observed on the microstructured Si surfaceas compared to planar Si surface (~40%) in wavelength range of 400 nm to 1000 nm. Microstructures with height ~3μm demonstrated minimum average reflectance of 4% in the range of 400 nm to 1000 nm.

Nanoripples or nanofaceting on Si surface using ion beam irradiation is already established.[10,11] However, hierarchical structure formation using ion beam irradiation has not been reported previously. In this work, ion beam irradiations have been utilized on Si microstructures to form hierarchical nanostructures of Si. Briefly, post wet chemical etching; the microstructured Si wafer was irradiated with 100 KeV Ar ion beam, at an incident angle set normal to the mictrostructured Si surface. The beam fluence was varied from $5x10^{17}$ to 10 x 10^{17}ions/cm^2. Currently experiments are ongoing at different energies and fluencies to develop nanoripples or nanofacets on the as-grown micropyramidal Si surface, so that a hierarchical Si surface is realized. Reflectance mesurements will be performed again and compared with the microstured Si surface. Here we are anticipating that formation of nanoripples/nanofacets on the micropyramidal Si surface can further reduce the optical reflectance considerably and hence enhance the anti-reflection property. Based on other literatures, these hierarchical Si structures are also anticipated to demonstrate good hydrophobic property.

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Ion irradiation based modification of zinc oxide nanotetrapods for enhanced amperometric immunosensing of *Helicobacter pylori*

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ABSTRACT

H. pylori is a spiral shaped, gram negative, microaerophillic bacteria. This bacteria colonizes the human gastric mucosa (inner lining of human stomach). Interestingly, this bacteria causes gastric ulcers which in later stages turns into gastric adenocarcinoma (gastric cancer). In this work, the specific aim is to develop an electrochemical immunosensor for the fast and enhanced determination of *H. pylori.* **After electrodeposition of ZnO-T (Zinc oxide nanotetrapod) onto Screen Printed Electrode (SPE), ZnO-T/SPE was irradiated with N_2 and Ar ion of energy 500 keV.** The prepared immunosensor interface is based on immobilization of the CagA Antigen onto ZnO-T electrodeposited on the surface of SPE. The work described here provides methods for the detection of *H. pylori* in serum samples. Different stages of immunosensor fabrication were characterized by Dynamic light scattering, Transmission electron microscopy, scanning electron microscope, electrochemical impedance spectroscopy and cyclic voltammetry. The sensing interface demonstrated wide linear range and a low detection limit. The ZnO-T based immunosensor showed good precision, analytical recovery and anti-interference ability which makes this sensing interface suitable for of biological samples. Few parameters are under study and results are awaited. However, this developed electrochemical immunosensor is a great contribution to the field of clinical analysis when it will be miniaturized.

Keywords: Zinc oxide nanotetrapods, ion beam, *H. pylori,* immunosensor, Screen printed electrodes

Li doped ZnO nanorods for efficient Organic Light Emitting Diodes

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ABSTRACT

Pure ZnO and Li doped ZnO nanorod have been synthesized by simple wet chemical method for its potential application in Organic Light Emitting Diodes (OLED). X-ray diffraction was done using Synchrotron radiation source at Indus-2, at RRCAT Indore at beamline 12. The results were found to be better than conventional XRD. XRD confirms the hexagonal structure of ZnO. The peak intensity got increases while FWHM got decreases with increasing dopant concentration. Further both pure ZnO and Li doped ZnO has been characterized by SEM, UV-Visible spectroscopy and Photoluminescence spectroscopy for its morphological and optical characteristics. Later,pure and Li doped ZnO have been blended with PFO and proto type OLED have been fabricated. These proto types have been tested for its performances and it is found that Li doping in ZnOhas enhanced the device performance in comparison to undopedZnO. The turn on voltages have been also found to be reduced with increasing doping concentration. Li doping in ZnOenhances the conductivity and thus mobility of the charge carriers in OLEDs.

Keywords: ZnO, OLED's, Li doping, Li doped ZnO.

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Studying the early stages of the galvanic corrosion of steel controlled by electrochemical potential

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ABSTRACT

Corrosion is the subject of intense research since the costs to the global economy are estimated at 3% of the world's GDP [1]. When a metallic alloy such as steel comes into contact with an aqueous electrolyte, e.g. acid rain or seawater, it is susceptible to galvanic/electrochemical corrosion [2]. This leads to structural and compositional changes and loss of material, causing failure under stress. We aim at understanding the very early stages of this process, studying the corrosion of steel alloys in acidic and alkaline solution by controlling the process by an externally applied potential. Information about compositional changes is obtained by quantitative cyclic voltammetry (CV) and X-ray photoelectron spectroscopy (XPS). XPS is carried out using laboratory Al K-alpha source and synchrotron radiation. We will present first CV and XPS results on the potential controlled corrosion of 304L and 316 stainless steel alloys in 0.1 M potassium chloride and sulphuric acid.

We will also report on our future research plan, studying the early onset of corrosion using ultra-thin films of the two types of stainless steel. X-ray analysis before, during and after the galvanic corrosion process allows quantifying exactly even minute changes of the interfacial stoichiometry. Films with a thickness ranging from 3 to 80 nm have been prepared at the Indore centre (UGC-DAE Consortium for Scientific Research) on different substrates using DC magnetron sputtering a characterised by various means. We will describe the electrochemical cells, which will allow studying the process *in situ* by X-ray absorption and emission spectroscopy as well as using the X-ray standing wave technique [3].

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Investigation of mechanism of Fe surfactant assisted nanoripple formation on Si using GISAXS

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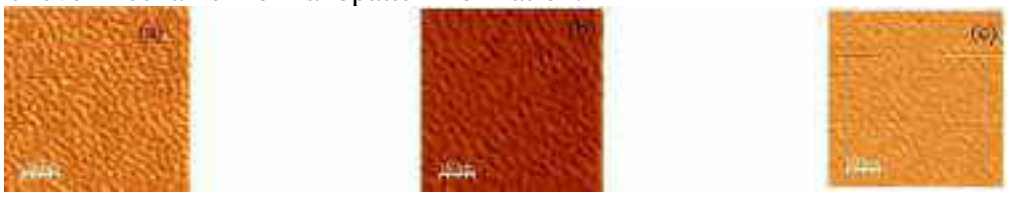
ABSTRACT

The formation of patterned structures with length scale varying from several nm to a few μm caused by ion-beam assisted erosion processes on semiconductor surfaces has attracted significant interest because of promising applications in optical devices [1], memory devices [2] and also serve as templates to grow thin films and multilayers in order to tailor their functional properties [3-5]. A detailed understanding of the atomic level mechanism is needed for nanopattern formation in order to have a better control on the structure of the nanopatterns and to tailor them accordingly. In the present study nanorippled Si (100) substrates were prepared by surfactant (Fe) assisted ion beam erosion. Objective is to understand the mechanism of nanopattern formation and to observe its variation as function of distance. Grazing incidence x-ray scattering measurements (GISAXS) measurements at 1 mm interval combined with AFM measurements will enable us to understand the atomic level mechanism of nanopattern formation. AFM



GISAXS

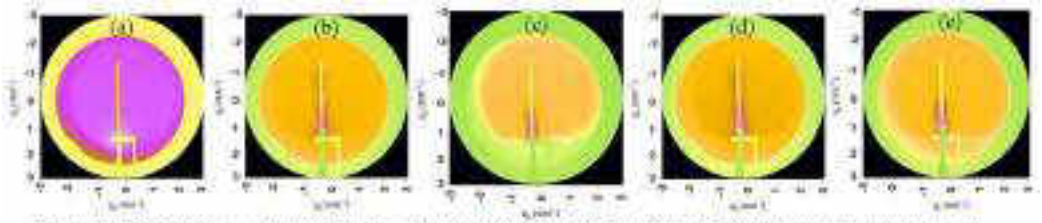


Figure 2: GISAXS images of nanopattern at y = (a) 0 mm (near contact of Fe and Si) (b) 5mm (c) 8mm (d) 11mm (e) 14 mm

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STUDY OF KINETICS OF $L1_0$ TRANSFORMATION IN FeCuPt ALLOY FILM AND Fe(Cu)/Pt(Cu) MULTILAYER

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ABSTRACT

Films of $L1_0$ phase of FePt possess one of the highest known magnetic anisotropy and are potential candidate for high density recording media. Extensive studies have been done in the literature to reduce the ordering temperature which for equiatomic alloy lies in the range of 500ºC. In the present work, it is envisaged that combination of multilayer structure along with impurity incorporation will further reduce the ordering temperature. Therefore kinetics of $L1_0$ ordering in FePtCu alloy film and $[Fe_{0.85}Cu_{0.15}/Pt_{0.85}Cu_{0.15}]_{x10}$ multilayer were studied using *in situ* XRD at elevated temperatures.

Two films, one consisting of 60 nm thick single layer of $(Fe_{50}Pt_{50})_{0.85}Cu_{0.15}$ and the other in the form of a multilayer $[Fe_{0.85}Cu_{0.15}$ (2.4 nm) $/Pt_{0.85}Cu_{0.15}$ (2.7 nm)$]_{x10}$ have been studied. In situ x-ray diffraction measurements at elevated temperatures were done at SAXS beamline of Elettra. Sample was kept in a miniature furnace under flowing N_2 atmosphere. The furnace was mounted on a New Port tilt stage in order to align the sample in grazing incidence geometry. Diffraction pattern in a limited q range was acquired using a 100 K Pilatus detector covering an angular range of 22º to 52º 2θ. Films were annealed at 300ºC and diffraction patterns were recorded continuously with data accumulation time for each diffraction pattern being equal to 121 sec. Thus evolution of the structure was monitored with time resolution of 121 seconds.

In situ x ray diffraction measurements reveal that kinetics of $L1_0$ transformation is significantly faster in multilayer as compared to alloy film. Present study shows that combination of multilayer structure with impurity incorporation can be used to further enhance the kinetics of $L1_0$ transformation in FePt system.

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Ternary Nanocomposites through Ion Beam Irradiation as Chemiresistive Sensor

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ABSTRACT

Polymer nanocomposites have been widely used as sensing material for detecting explosives. In the present study, one pot synthesis of ternary nanocomposite was attempted by incorporating the nanographite platelets (NGPs) and tungsten disulphide (WS_2) nanoparticles within the polystyrene matrix. The synthesized NGP@WS_2@PS composites were irradiated with 600 keV Ar^{+3} ions at a fluence of 1×10^{15} ions/cm^2. The ion irradiation of NGP@WS_2@PS composites results in homogeneous dispersion of WS_2 within the PS matrix and cross-linking of filler with polymer. The morphology and size of NGP@WS_2@PS films were investigated by SEM technique. The radiation induced changes in the extent of exfoliation of WS_2 within the composites system was confirmed by FTIR, Raman, XRD, and AFM techniques. Moreover, the electrical properties of the NGP@WS_2@PS nanocomposites films were investigated and were found to possess the resistance of 1.09 x 10^5 Ω before irradiation and 4.3 x 10^3 Ω after irradiation, respectively with only 0.07 wt% of WS_2. The understanding of certain structural rearrangements influence on the suitable tunable properties of NGP@WS_2@PS composite films opens a way to design chemiresistive sensors for various gases.

Effect of ion beam exposure on graphene quantum dots

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ABSTRACT

Graphene quantum dots (GQDs) are nanosized fragments of graphene displaying quantum confinement effect. They have shown to be prepared from various methods which include ion beam etching of graphene. However, recently the modification of the GQDs have garnered tremendous attention owing to its suitability for various applications. Here we have studied the effect of ion beam irradiation on the properties of GQDs. The ion beam treatment on the GQDs exhibited the change in observed photoluminescence of GQDs as they exhibited a blue shift due to the reduction in size and removal of the carboxylate (-C=O) and hydroxyl (-OH) groups present on the quantum dots. This was confirmed by the particle size analysis and FITR spectroscopy.

Keywords: Graphene quantum dots, ion-beam, photoluminescence

Nanopattern formation on Si(100) using reactive ion beam erosion

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ABSTRACT

Nanopatterns on silicon substrate by low energy ion beam are formed. For Nanoripple formation, N_2+ molecular ion beam is used. Generally inert gas like Argon or Xenon ions are used to be bombarded on substrate because of its non reactive nature and heavier mass but it has been reported that nanopatterns are well formed with N2+ atoms as compared to Argon ion. Si_xN_y is formed with the initial ion bombardment. The change in chemical composition leads to non uniform sputtering yield of the sample surface which results in perturbation and consequent quick ripple structure formation [1].

5 keV N_2+ molecular ion beam is extracted from ECR Ion Source at VECC, Kolkata. The irradiation of Si (100) sample was done with ion beam falling at an angle of 60^o from surface normal. The fluence is varied from $1x10^{16}$ to $7x10^{17}$ atoms/cm^2.A maximum modulation depth of 12 nm could be achieved with the fluence of $7x10^{17}$ atoms/cm^2. Evolution of nano-pattern was studied using GI-SAXS, X-ray reflectivity, soft x-ray absorption spectroscopy and grazing incidence Small Angle X-ray Scattering.

Rippled Si surface was used to deposit Co thin film with controlled uniaxial magnetic anisotropy. In-situ MOKE and Resistivity measurements has been done in order to study the evolution of magnetic properties as a function of film thickness, and the modulation depth of ripples on the substrate.

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Dispersion of WO_3/WS_2 within the polymer matrix through ion beam

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ABSTRACT

We report here the synthesis of polymer nanocomposite films by a facile solution blending method for its possible application as supercapacitor materials in energy storage devices. Polymer nanocomposites are largely dependent upon the homogeneous dispersion of fillers within the polymer matrix. The dispersion of nanographite platelets (NGP), tungsten trioxide (WO_3) and tungsten disulphide (WS_2) nanoparticles in polymer matrix is a great challenge because of the inherent inert nature, poor wettability and easy agglomeration of fillers within the polymer matrix. In the present study, attempts have been made to use swift heavy ions (SHI) by irradiating the polymer nanocomposites films with 600 keV Ar^{+3} ions at a fluence of 1×10^{15} ions/cm^2. The XRD study shows the delamination and enhanced dispersion of fillers after ion irradiation compared to unirradiated films. Moreover FTIR, SEM, AFM and Raman techniques depict strong interfacial interaction of fillers and polymer matrix after ion irradiation. The study exhibits SHI as a unique method which satisfies the challenges associated with the dispersion of fillers within the polymer matrix for their enhanced performance towards supercapacitor application.

Modification of the nanocomposite films through Ar^{3+} ion irradiation

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ABSTRACT

Two – Dimensional Metal Dichalcogenide like Molybdenum Disulphide (MoS_2) are known to show unique physical and chemical properties. These properties make them suitable for various applications such as electrical, supercapacitors etc. In the present study, polymer nanocomposite films were prepared through solution blending technique using Molybdenum Disulphide (MoS_2) and Nanographite Platelets (NGPs) nanofillers. The as prepared films were irradiated with 600 KeV Ar3+ ions at a fluence of 1 x 10^{15} ions/cm^2. The effects of irradiation in polymers are correlated with the collisions of penetrating high energy ions with the target atoms which leads to the formation of defects. These defects change the structural and electrical transport properties of the materials. The structure and morphology of the films before and after Ar3+ ions irradiation were studied by using FTIR, XRD and SEM analysis .The XRD analysis indicates strong interfacial interaction of MoS_2 with both polymer and NGPs after irradiation, which is responsible for the decrease in crystallinity of the material and increase in exfoliation of NGPS. Moreover, the presence of a MoS_2 with a bandgap of ~1.3eV ensures an increase in semiconducting properties when it is combined with NGPs. The polymer nanocomposite films showed a remarkable increase in the electrical conductivity after ion beam irradiation as irradiation encourages the bonding between the metal and polymer. Further, significant changes in surface morphology were also observed after Ar3+ ions irradiation.

Nickel Ion Implanted PMMA/NGP Nanocomposites with Enhanced Electrical and Electrochemical Properties

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ABSTRACT

Swift heavy ion (SHI) irradiation is a special technique for inducing physical and chemical modifications in bulk materials. In the present work, the SHI has been used to prepare Polymethyl methacrylate/nanographite platlets/Nickel (PMMA/NGP/Ni) nanocomposites with homogeneously dispersed nanoparticles. PMMA/NGP nanocomposites have been synthesized by in situ polymerization followed by Ni ion implantation through SHI irradiation (Ni ion beam, 80 MeV) at a fluence of 1×10^{10} to 3×10^{12} ions/cm^2. The nanocomposite films were characterized by SEM, XRD and Raman Spectroscopy. The as prepared PMMA/NGP/Ni naocomposites were evaluated for their electrical and electrochemical properties. The high specific surface area and electrical conductivity of the irradiated PMMA/NGP/Ni nanocomposites enhances the capacitance and shows potential application for energy production and storage purpose.

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In-situ Soft X-ray Absorption Study of Ultrathin Fe Film on MgO

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ABSTRACT

Soft x-ray absorption is a powerful technique to study electronic state of elements, high sensitivity of the technique allows one to study even sub monolayers. In the present work in-situ Soft x-ray absorption studies have been done during deposition of iron films on MgO (Synchrotron source-RRCAT, Indore). Evolution of electronic structure with film thickness allows one to deduce selective information about the interfacial region. In two different experiments, iron films were deposited on MgO (001) substrate as well as on MgO film pre-deposited on Si substrate. Iron films were deposited using Magnetron sputtering. Base pressure in the chamber was 5 $x10^{-7}$ mbar. During deposition the pressure in the chamber raised to $1x10^{-5}$ mbar after each deposition vacuum was brought to 5 x 10^{-7} before opening the gate valve to connect the chamber with beamline. Soft x-ray absorption measurements were done across the L edge of iron and K edge of oxygen.

In case of iron film on MgO substrate, even at the lowest thickness of 3 Å, the absorption spectrum is typical metallic BCC iron. There is no significant change in the position as well as shape of the spectrum with increasing film thickness. These results suggest that at the interface of iron on MgO substrate no oxide layer is formed. On the other hand, behaviour of iron on MgO film is very different. The absorption spectrum of 1.2 Å and strong thick films matches very well with that of Fe_3O_4 [1]. It consists of two peaks separated by ~ 2 eV. With increasing film thickness, gradually the second peak is overlapping with the first peak of Fe_3O_4 and starts evolving. This peak corresponds to metallic iron. This clearly suggests that at the interface there is a few monolayers thick iron oxide film. Detailed analysis of the data is being done in order to get quantitative information about the thickness of oxide layer.

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Self diffusion of iron in nanocrystalline BCC iron film

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ABSTRACT

One important aspect in which nanocrystalline materials differ from the conventional polycrystalline systems is the increased volume fraction of grain boundary region, which makes nanocrystalline materials to exhibit, in general, an enhanced atomic diffusion. Since the structural stability of the system as well as a number of its physical and chemical properties depend upon atomic diffusion, understanding of the same in such systems is vital from both application as well as basic points of view. In the present work Nuclear Resonance Reflectivity (NRR) from isotopic multilayer of Fenat /Fe57 [1] has been used to study self diffusion of iron in nanocrystalline iron. Low annealing temperature and time have been used in order to avoid significant structural relaxation during annealing.

Isotopic multilayer structure: Substrate/ [Fenat (30Å)/ Fe57 (30 Å)] x10 was prepared using ion beam sputtering of targets of natural iron and Fe57 (98% enriched). X-ray diffraction showed that the film is nanocrystalline in nature with average crystallite size of about 10nm. Nuclear Resonance Reflectivity was measured at P01 beamline of PETRA-III, Hamburg.

X ray Reflectivity of the multilayer at 8 KeV x-ray energy shows only total thickness oscillations, since chemically the isotopic multilayer is single homogeneous film of iron. However due to scattering contrast between Fe56 and Fe57, Nuclear Resonance Reflectivity exhibits Bragg peak corresponding to the isotopic periodicity. With thermal annealing as interdiffusion in natural iron and Fe57 layer takes place, height of the Bragg peak decreases, yielding the diffusion length with an accuracy of 0.1nm [1]. Values of diffusivity obtained at different temperatures are used to determine the activation energy E for diffusion and the pre-exponent factor D_0 using the relation: $D(T)=D0\exp[-E/kBT]$.

It has been found empirically that values of E and D_0 are correlated with each other and this correlation is very different for crystalline and amorphous metals [2]. This difference essentially reflects the difference in the mechanism of diffusion in the two systems. One finds that the point corresponding to nanocrystalline iron lies on the correlation curve for amorphous alloys. Thus, mechanism of atomic diffusion in nanocrystalline iron is very similar to that in amorphous alloys. Some earlier studies have shown that as grain boundaries are structurally highly disordered, the mechanism of diffusion through grain boundary is very similar to that in amorphous alloys [3]. Thus present studies shows that atomic diffusion in nanocrystalline iron takes place predominantly through grain boundaries and the diffusive jumps involve collective movement of a group of atoms similar to that in amorphous alloys.

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DETECTION OF LEGIONELLA PNEUMOPHILA IN WATER SAMPLES AND APPLICATION OF NANOTECHNOLOGY IN PATHOGENIC FIELD

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ABSTRACT

Legionella Pneumophila is the rod shape, motile, thin, Gram-negative bacterium, and causative agent of Legionnaires' disease. They can be found and survive in any water systems. The most prevalent methods to detect this pathogen are through cultural or non-cultural methods according to microbiology to disinfect the drinking water and other water reservoirs. In this project, we have followed the cultural technique to detect L.P in three various water samples using BCYE as a medium with the help of specific growth factor (L-Cysteine). Different temperature and duration were considered for incubating the agar plates, until we found out the best precise temperature and time duration. All the samples proved growth of pathogens in the intended condition. The incubated samples were tested with control test, L. latex agglutination test, and biochemical test. Samples showed positive result in control test, it means BCYE is a suitable medium for growth of L.P. From agglutination test, we have declared that L. serotype presented in T1, while L. serotypes 2-15 presented in T3. There was no evidence of presence of any L. serogroups 1-15 reagents in T2 sample. According to biochemical test, L.P failed in growing in different 12 medium within 24 hr, while E.coli proved that has ability to grow on 6-7 various mediums within one day. Stain method for testing TCA and BPA reagents was done and results were confirmed by the microscope that implied TCA is a Gram-negative, while BPA is a Gram-positive reagent. Apart from this, we have studied several papers published by different researchers to prove that nanotechnology can enhance the quality and function of devices and providing new methods to detect the pathogens in least time. Moreover, bacteria such as Bacillus and E.coli are being used in biological approach to produce cost effective, non-toxic, and safe nanoparticles such as gold and silver. The samples are further irradiated with ion beam and the results are presented.

Keyword: L.P. (Legionella Pneumophila), microbiology, cultural method, agglutination test, biochemical test, stains method, and Nanotechnology

EVALUATION OF MWCNT AND MWCNT-Fe2O3 AS FLEXIBLE ELECTRODES FOR SUPERCAPACITORS

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ABSTRACT

With the increasing energy requirements of the world, it is inevitable to design new energy storage devices. Supercapacitors are energy storage devices that will help to bridge the gap between the batteries with low power density and capacitors with low energy density. A novel tape casting method is used to synthesize flexible electrodes which will be a huge benefit for the flexible electronics industry. The main objective of this project is to test nanomaterials, MWCNT (Multiwalled carbon nanotube) and MWCNT- Fe_2O_3 (Multiwalled Carbon nanotube-Iron oxide) 1:1 composite, as electrodes for supercapacitor to improve the capacitance of the supercapacitor. The energy storage mechanism in MWCNT is by electrical double layer capacitance (EDLC), while Fe_2O_3 mostly relies on pseudocapacitance (PC) to store charges. By combining the two materials, it is possible to combine the effects of EDLC and PC which will result in a dramatic increase in the specific capacitance. Electrochemical characterizations such as potential window determination, cyclic voltammetry (CV) and constant current charge discharge (CCCD) were carried out on both the electrodes using a three-electrode configuration in 2M KOH electrolyte with Hg/ HgO reference electrode. The maximum specific capacitance obtained from MWCNT electrode was 33.88 F/g at 1 A/g current density in the potential range -0.9 to 0 V. While for MWCNT:Fe_2O_3 (1:1) electrode, the specific capacitance was found to be 292.72 F/g at 1 A/g current density in the potential range -1.1 to 0 V. The samples are further exposed to ion beam and the results are presented.

Keywords: MWCNT, Fe2O3, electric double layer capacitance, pseudocapacitance, supercapacitor, cyclic voltammetry, constant current charge discharge

CHARACTERISTICS OF WATER BASED NANOFLUID & HEAT DISSIPATION BY ANALYTICAL & EXPERIMENTANTAL APPROACH

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ABSTRACT

Most IC engines are liquid cooled utilizing a fluid coolant passing through a heat exchanger cooled via air. It is noticed that conventional coolants have a lesser heat transfer rate when compared to nanofluids. Water as we all know is the most used coolant in automobile industry. It is used for cooling of the engine due to excess heat produced inside the engine which are caused due to reasons such as low coolant level , low supply of air from radiator fan or the radiator damage. In this setup a mixture of water based nanofluid with multi walled carbon nano tube particle between the range 0.1 to 0.8 volume percentage is used as the base fluid and various fluid & thermal properties were determined. The above setup which is constructed adopts gravity method for circulating nanoparticle mixed in water. This paper concludes that by mixing nanoparticles with water the overall heat dissipation is improved. The sample is further exposed to ion beam and the results are presented.

Keywords: Heat transfer rate, Multi walled carbon nanotubes, Nanofluid, Magnetic stirrer, Thermal conductivity.

A Systematic Analysis of Nanoclay Reinforced Epoxy Polymer Nanocomposites Based on Mechanical and Chemical Characteristics

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ABSTRACT

In this work, an analysis was carried out to inspect the effects of nanoclay fillers in epoxy resin with respect to tensile, flexural and impact properties. Further, the nanoclay was analysed based on the Fourier transform infrared spectroscopy characterisation for chemical analysis, scanning electron microscope characterisation for studying the morphological properties and X-ray diffraction characterisation for to know the dispersion pattern. The nanocomposites were prepared by adding Cloisite 25A nanoclay in various weight percentages with the polymer. From the test results, it was observed that most favorable elastic modulus and flexural modulus were obtained for higher nanoclay loading. Alternatively, the ultimate tensile strength and flexural strength were favorable for lower clay loadings. Likewise, impact strength had exhibited a greater resistance towards the impact damage for 2 wt.% nanoclay loading. Besides, an interpretation of microscope image disclosed that the appreciable surface property was attained for lower nanoclay loading. Chemical analysis of all clay/epoxy nanocomposites indicated that similar peaks were attained with minimum variations and evident that no chemical modification happened. The samples are further exposed to ion beam and the results are presented.

Keywords:

Nanoclay; Cloisite 25A; Mechanical properties; FTIR; XRD

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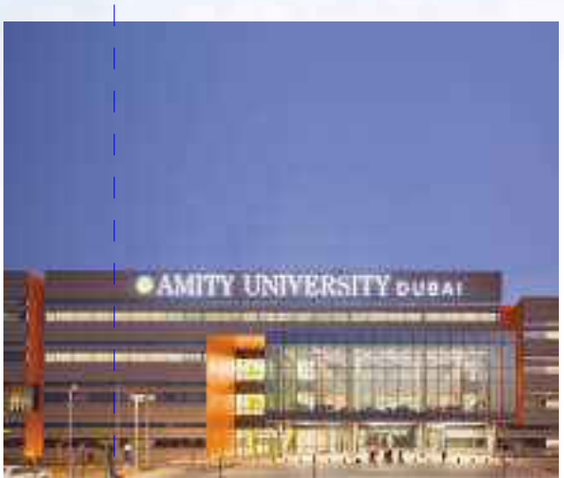

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