Prof. Mohammad Zulfequar
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&
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Multidisciplinary Centre for Advance Research and Studies (MCARS), JMI
Tel. Phone: +91 (11) 26981717 Ext. 1033
e-mail: mcars@jmi.ac.in

Designation : Professor

Teaching Experience :30 Years

(i). Jan 22, 1990 to Jan.22, 1995 worked as a Lecturer in Physics Department, Jamia Millia Islamia, New Delhi.
(ii). Jan.22, 1995 to Jan. 22, 2000 worked as a Sr. Lecturer in Physics Department, Jamia Millia Islamia, New Delhi.
(iii). Since Jan. 22, 2000 to Jan.21, 2008 worked as a Reader in Physics Department, Jamia Millia Islamia, New Delhi.
(iv). Since Jan. 22, 2008 working as a Professor in Physics Department, Jamia Millia Islamia, New Delhi

Research Experience :34 Years

(i) Worked as JRF and SRF in HBTI Kanpur for 3 years under CSIR Scheme "Electrical and Dielectric Properties of Hot Pressed AlN Ceramic".

(ii) Worked as a Project Scientist (DST Project) in Physics Department, IIT Kanpur under guidance of Prof. D.C. Khan. This project belongs to the "Experimental Studies on High T_c Superconductor" from Dec.1988 to Jan 1990.

Particulars of Guiding Research: See Annexure-1

(i). No. of candidates who have been awarded the Ph.D. : **28**
(ii). No. of candidates who have been submitted the Ph.D. : **0**

(iii). No. of candidates presently working for Ph.D. : **08**

(iv). No. of candidates worked/ working as **PDF/RA/SRA** : **06**

Publications: See Annexure-2

(i). Research Papers **:200 (International=196, National= 04)**

(ii). Conference/Workshop /Symposium **: 46**

(iii) Communicated **:02 List of Publications attached**

Area of Research **: Experimental Solid State Physics**

(i) **Amorphous Semiconductor**
(ii) **Ceramic**
(iii) **Conjugated polymers**
(iv**)** **Nano structural Materials**

Ph.D. Thesis Title **: *"Electrical & Dielectric Properties ofHot-Pressed Aluminum Nitride Ceramic"***

Research Project Completed :

(i) Major Research Project entitled *"Estimation of Density of Localized States in chalcogenide glasses from electrical properties"* funded by the University Grant Commission, New Delhi. (Cost Rs.4.30 Lacks) (1998-2001)

(ii) Minor Research Project entitled *"Dielectric Relaxation studies of chalcogenideglasses"* funded by the Jamia Millia Islamia, New Delhi. (Cost Rs.0.30 Lacks) (2002-2004)

(iii) Major Research Project entitled *"Dielectric Relaxation and high field conduction studies of chalcogenide glasses" funded* by the University Grant Commission, New Delhi. (Cost Rs.5.30 Lacks) (2003-2006)

(iv) Major Research Project entitled "*Effects of Swift Heavy Ion irradiation on conjugated polymers*" funded by the Nuclear Science Center, NewDelhi. (Cost Rs.2.25 Lacks) (2005-2009)

(v)Major Research Project entitled *"Design and Fabrication of Photon-Drag Detectors and Transversely Excited Carbon-dioxide Laser for their Evaluation"* funded by DRDO/LASTEC, New Delhi (Cost Rs.37.31 Lacks) (2006-2009)

(vi) Research Project entitled*"Laser irradiation and thermal annealing effects on optical constants of amorphous chalcogenide thin films for optical memory devices"* Ministry of Higher Education, King Abdul Aziz University, Jeddah, Kingdom of Saudi Arabia. (Reference No- 3-16/429) (Co-Investigator). (03-03-2009 to 02-12-2009)

(vii) *"Growth of single Wall Carbon Nanotubes for Semiconducting Applications"* funded by Department of Electronics and Information Technology (DeitY), Ministry of Communication and Information Technology, New Delhi. (Project cost: 380.76 Lakhs), from April 23, 2010 to April 22, 2015.

(Prof. M. Zulfequar, Chief Investigator, from January 01, 2014 to April 22, 2015) ,(Prof. M. Husain, Chief Investigator from April, 23, 2010 to 31st December, 2013 and Co-Investigator from January 01, 2014 to April 22, 2015)

Foreign Visits:

(i). ***PAKISTAN***

Participated in Nathiagali Summer College on Physics and Contemporary Needs (1991).

(ii). ***ITALY***

Participated in Workshop on Materials Science and Physics of Non-Conventional Energy Sources at I.C.T.P., Trieste (July. 1993).

(iii). ***ITALY***

Visited ICTP, Trieste as affiliate to carry out our own research work on Condensed Matter Physics at I.C.T.P., Trieste (Nov-Dec. 1996).

(iv) ***Kingdom of Saudi Arabia.***

Oral presentation in I**nternational Conference on Nanotechnology: Opportunities Challenges (ICON 008)," I**-V Characteristics of Multi-walled Carbon Nanotubes Synthesized using ECR-CVD" held at King Abdul-Aziz University, Center of Nanotechnology, Jeddah, Kingdom of Saudi Arabia., 17-19 June 2008.

(v) ***United Kingdom:***15 Dec 2014 to 20 Dec 2014; To attend for training of growth of SWCNT and Graphene using PECVD at AXITRON **Cambridge UK.**

Membership of Academic Societies:

(i). Indian Chapter of ICTP, IIT, New Delhi
(ii). Meteorological Society of India.
(iii). Semiconductor Society of India***(Executive Member*).**
(iv). Indian Science Congress
(v).Society for nano science and technology
(vi) Indian Association of Physics Teachers *(Life Member)*
(vii)Member, Society for Semiconductor Devices

Scholarship & Awards:

(i). Merit Scholarship at High School Level.
(ii) . Principal Award Scholarship at Intermediate Level.
(iii). JRF/SRF at Ph.D. Level.
(iv). Sultana Nahar Distinguished Teacher of the Year Award 2017-18, JMI

Administrative Responsibilities:

(i). Co-OrdinatorB.Sc. (Instrumentation) course Feb.-May 1997
(ii). Advisor, Jamia Physics Association, JMI (1995 to 2004).
(iii). Member, Purchase committee, Physics Department, JMI
(iv) **Asstt. Superintendent of Exam**, Faculty of Natural Science, JMI April-May, 2006, 2007,2010, 2011 and 2012.
(v) **Asstt. Superintendent of Exam**, M.Sc. (Physics) Exam., Physics Department, Faculty of Natural Science, JMI, April toMay,2008&2009
(vi) **Asstt. Superintendent of Exam**, M.Sc. (Physics) and M. Tech (Nanotechnology) End Semester Exam. Department of Physics, Dec.-2011
(vii) **Member,** Central Admission Co-ordination & Monitoring Committee (CACMC) Jamia Millia Islamia, for University admissions 2012
(viii) Member of Academic council, JMI, 2012-2015, 2020
(ix) **Head**, Department of Physics, JMI (August 2012 to Aug 2015)
(x) Member of Technical Purchase committee of Centre of Nanoscience and Nanotechnology, JMI
(xi) Officiating Director of Centre of Nanoscience and Nanotechnology, JMI
(xii) Member of **COS** of Center of Nanoscience and Nanotechnology, JMI
(xiii) Member of the Anjuman (Court) Jamia Millia Islamia, New Delhi
(xiv) Member of Central Purchase committee, JMI (2019)
(xv) **Hony. Director**, **Multidisciplinary Centre for Advanced Research & Studies (MCARS)JMI,** (Nov.2019-Contd.)

Workshop/Conference organized as a member/Organizing Secretary:

1. Second National Conference on Disordered Materials, February 25-26, 1991 Department of Physics, JMI, New Delhi-110025
2. National Seminar on Materials Research and Environmental Issues, Oct 23, 1997, Department of Physics, JMI, New Delhi-110025
3. Workshop on Nanomaterials, 1 November 2002, Department of Physics, JMI, New Delhi-110025
4. Workshop on Nanostructure. March 11, 2004 Department of Physics, Jamia Millia Islamia, New Delhi-110025
5. Thirteenth International Workshop on Physics of Semiconductor Devices. December 2005, NPL, New Delhi.
6. National Seminar on Condensed Matter, High Energy and Nuclear Physics, March 23-24,2009, Department of Physics, Jamia Millia Islamia, New Delhi-110025.
7. Fifteenth International Workshop on The Physics of Semiconductor Devices. December 15-19, 2009, Jamia Millia Islamia, New Delhi.
8. National Seminar on Condensed Matter, Nuclear Physics and High

Energy Physics, Feb., 18-19, 2011, Department of Physics, Jamia Millia Islamia, New Delhi- 110025

9. National Seminar on nanomaterials: Synthesis, Characterization and Applications,14 March 2015, Centre for Nanoscience and Nanotechnology, Jamia Millia Islamia, New Delhi

Reviewer of the International Journals:

(i) Journal of Materials Chemistry and Physics
(ii) Philosophical Magazine Letter
(iii) Journal of Applied Physics
(iv) Physica B

Other Contributions:

Developed **Materials Science Lab,** which includes the sophisticated equipment like *Scanning Electron Microscope* (SEM), RF Sputtering Unit, ECR Plasma Etching System, Differential Scanning Calorimeter (DSC), UV/VIS/NIR Spectrophotometer, Chemical Vapor Deposition (CVD) etc.

UGC Nominee (SAP programme): Department of Physics, MD University, Rohtak

Annexure-1

THESIS AWARDED

(i). Topic **:** Electrical, Optical and Dielectric Studies of Glassy Semiconducting Alloys.
Name of the Student : Mr. Mohd. Ilyas, *Year 1998*

(ii). Topic **:** Estimation of Density of Localized States in chalcogenide glasses from electrical properties.
Name of the Student **:** Mr. Mohd. Abdul. Majeed Khan, *Year 2003*

(iii). Topic **:**Phase change and crystallization study of chalcogenide glasses.
Name of the Student **:** Mr. Shamshad Ahmad Khan, *Year 2003*

(iv). Topic **:**Study of Optical parameters in chalcogenideGlasses.
Name of the Student **:**Mrs Preeti Devedi, Year 2004

(v) Topic **:** Structural studies on Ga_2Te_3 and related compounds.
Name of the Student **:**Mr.Wasim Javed, Year 2004

(vi). Topic **:** Spectroscopic studies of organic laser dyes in sol-gel glasses.

Name of the Student **:** Mr. Haider Abbas, Year 2007

(vii). Topic **:** Dielectric Relaxation and High field conduction study in chalcogenide glasses.
Name of the Student **:** Mr. Satish Kumar, Year 2007

(viii). Topic **:** Thermal andDielectric Properties of Amorphous Semiconductors.
Name of the Student **:** Mr. Nadeem Mohamed Awad Musahwar,Year 2009

(ix) Topic **:** Synthesis and Characterization of Nano-structures.
Name of the Student **:** Mr. Karunapati Tripathi, Year 2010

(x) Topic **:** Effects of Swift Heavy Ion irradiation on Conjugated polymers.
Name of the Student **:** Ms. G.B.V.S. Lakshmi, Year 2010

(xi) Topic **:**Electrical Conductivity and Dielectric properties of Silicon Nitride Ceramic.
Name of the Student **:** Mr. Imran Khan, Year 2011

(xii) Topic :Laser Preparation and Processing of Semiconductor Nanomaterial and Their Spectroscopic Characterization
Name of the Student **:**Mr Ausama I. Khudiar, Year 2011

(xiii) Topic : Study of Spectroscopic and optoelectronic Properties of Semiconductor and Their Semiempirical and ab initio Computations
Name of the Student **:**Mr Ziaul Raza Khan, Year 2011

(xiv) Topic : Synthesis and characterization of new biocidal coordination polymers containing transition metal ion.
Name of the Student **:** Ms. Sumaiya Hasnain ,Year 2011

(xv) Topic :.Thermal and High Field Conduction Studies in Chalcogenide Glasses
Name of the Student **:**Mr. Mohd. Nasir, Year 2012

(xvi) Topic **:** Design and fabrication of Photon Drag-Detector and TEA CO_2 laser as their evaluation and study the effect of laser irradiation on amorphous semiconductor.
Name of the Student **:** Mr. Adam Abdullah Bahishti, Year 2012

(xvii) Topic : Synthesis and Spectroscopic characterization of Thermoplastic Dispersed Polyaniline Nano-Composites.
Name of the Student **:**Ms Kiran Kumari, Year 2013

(xviii) Topic :Grouth and Characterization of Carbon Nanotube Using Catalysts.

Name of the Student **:**Mr.Avshish Kumar,Year 2014

(xix) Topic : Optical and photo-induced Studies on Thin films of Chalcogenide Glasses.

Name of the Student **:**Ms Neetu,Year 2014

(xx) Topic : Transport and Interface study of Hole Transporting Organic Semiconductors.

Name of the Student **:**Ms Omwati,Year 2014

(xxi) Topic : Study of Physical and Chemical Mechanism Responsible for Colossal Dielectric Phenomenon in Calcium Copper Titanate (CCTO).

Name of the Student **:**Mr Ranjeet Kumar,2014

(xxii) Topic :Electrical and structural Properties of Conjugated Polymers by RF Plasma Polymerization.

Name of the Student **:**Ms Shama Islam,2014

(xxiii) Topic Effect of Laser, Gamma-ray and swift heavy ion irradiation on compound semiconductors

Name of the Student :Mr. Shabir Ahmad Kumar (2017)

(xxiv) Topic Dielectric relaxation and super ohmic behavior of doped amorphous semiconductor

Name of the Student :Mr. Mohsin Ahmed Gannai, 2017

(xxv) Topic Synthesis of graphene using Chemical Vapor deposition method and its characterization

Name of the Student :Mr. Sunny Khan,2018

(xxvi) Topic Synthesis and Characterization of single wall carbon nanotubes and their sensor applications

Name of the Student :Mr. Mohd. Yaseen Lone, 2018

(xxvii) Topic Photo and Thermally Induced Effects in solution driven Chalcogenide Thin Films for Photonics Applications

Name of the Student :Mr. Prince 2019

(xxviii) Topic Synthesis and characterization of semiconductor quantum dots for its applications

Name of the Student :Mr. Zuber Mohd. Saddam Husain Khan, 2020

WORK UNDER PROGRESS

(i) Topic A Study of Physical Parameters andApplications of NanostructuresModified Chalcogenide
Name of the Student : Hana Khan

(ii) Topic Study of the Physical Properties of Nanostructured Chalcogenide Based Compound Semiconductors
Name of the Student :Mr.Raja Saifu Rehman

(iii) Topic Study of Thermal and Electrical Properties of Selenium based Quaternary Chalcogenide Glasses.
Name of the Student : Mr .Mohd Shoab.

(iv) Topic : Synthesis Characterization and Application of Carbon Nanotubes and Their Nanocomposites
Name of the Student : Shabina Saifi

(v) Topic : Synthesis of Semiconductor Nanomaterials and Their Applications
Name of the Student :Mr.Zubair Aslam

(vi) Topic : Optically Stimulated Luminescence Dosimetry for Tissue-Equivalent Systems
Name of the Student :Mr.Debashish Sen

(vii) Topic : Study of Topological Semiconducting materials
Name of the Student : Nargis Fatima

(viii) Topic : Study of Semiconducting Quantum Dot
Name of the Student : Faizan Beg

Post Doctorial Student:

(1)Name of the Candidate : Dr. Avshish Kumar

Name of Fellowship : Research Associate

Name of the funding agency: CSIR

Sanction no. : 9/466(0169)2K15-EMR-1

Duration : 3 Years (w.e.f October 01, 2015 to September 09, 2018)

Amount of Project : StipnedRs. 4,32,000/- per year + Conting. Rs. 20,000/- per Year

Name of the Mentor : Prof. M. Zulfequar

Name of the Department & University : Department of Physics, JamiaMilliaIslamia, New Delhi

Project Proposal: Synthesis and functionalization of single wall carbon nanotubes for targeted Sensor applications

(2) Name of the Candidate : **Dr. Shama Islam**

Name of Fellowship : **Senior Research Associate (Pool Scientist)**

Name of the funding agency: **CSIR**

Sanction no. : **Pool No. 9056-A**

Duration : 3 Years (w.e.f. 17th July 2019 to 17th July 2022)

Amount of Project : 21000/- basic + allowances + Rs.20000/- per annum (Contingency)

Name of the Mentor : Prof. M. Zulfequar

Name of the Department & University : Department of Physics, JamiaMilliaIslamia, New Delhi

Project Proposal : Selfpowered electronics by integration of photo capacitor based on polymer nanocomposites for both photoelectric conversion and energy storage

(3) Name of the Candidate : **Dr. Shumaila**

Name of Fellowship : **Post Doctorate Fellow**

Name of the funding agency: **UGC**

Sanction no. : F.151/201415/PDFWM201415OBUTT28617(SAII)

Duration : 5 years (w.e.f. Fab 02, 2015 to Fab 01, 2020)

Amount of Project : Flshp Rs. 38,800/- per month + Contin Rs. 50000 per year

Name of the Mentor : Prof. M. Zulfequar

Name of the Department & University : Department of Physics, JamiaMilliaIslamia, New Delhi

Project Proposal: Conducting Polymer Nanocomposites for Field Emission Devices: Synthesis and Characterization

(4) Name of the Candidate : **Dr. Shama Parveen**

Name of Fellowship : **Research Associate**

Name of the funding agency: **CSIR**

Sanction no. : **09/466(0194)2K18-EMR-I**

Duration : 3 Years (w.e.f. May 07, 2018 to May 06, 2021)

Amount of Project : Stipned Rs. 4,32,000/- + Conting. Rs. 20,000/- per year

Name of the Mentor : Prof. M. Zulfequar

Name of the Department & University : Department of Physics, Jamia Millia Islamia, New Delhi

Project Proposal : Polymer functionalized Carbon nanotubes for detection of heavy metal ions in Environment

(5) Name of the Candidate : **Dr. Sunny Khan**

Name of Fellowship : **Research Associate**

Name of the funding agency: **CSIR**

Sanction no. : **09/466(0218)2K19 EMR-I**

Duration : 3 Years (w.e.f. April 01, 2019 to contd.)

Amount of Project : Rs 6,99,360/- per annum (Salary), Rs.20000/- per annum (Contingency)

Name of the Mentor : Prof. M. Zulfequar

Name of the Department & University : Department of Physics, JamiaMilliaIslamia, New Delhi

Project Proposal: Fabrication and study of Graphene Based Super Capacitors for Enhanced Energy Storage

(6) Name of the Candidate : **Dr. Ashi Ikram**

Name of Fellowship : **Dr. DS Kothari postdoctoral fellowship**

Name of the funding agency: **UGC**

Sanction no. : **F.4-2/2006(BSR)/PH/19-20/0067 dated on 16 June 2020**

Duration : 3 Years (w.e.f. July 01, 2020 to contd.)

Amount of Project : Rs- 25,32,000/- (47,000+HRA for 1 yr ; 49,000+ HRA for 2 yr; 54,000+HRA for 3 yr along with 1,00,000/- contingency per annum)

Name of the Mentor : Prof. M. Zulfequar

Name of the Department & University : Department of Physics, Jamia Millia Islamia, New Delhi

Project Proposal : Incorporation of 1D Nano-architectures with CZTS Quantum Dots for Photoelectrochemical Hydrogen Production.

Annexure-2

LIST OF PUBLICATIONS OF DR. M. ZULFEQUAR

Journals

200. Study the electron field emission properties of plasma-based reduction of graphene oxide (GO): An ex-situ plasma approach.

Mohammad Moeen Hasan Raza, Sunny Khan, Shah M Aalam**,** Mohd Sadiq, Mohd Sarvar, **Mohammad Zulfequar**, Samina Husain, Javid Ali
Corban Trends (ELSEVIER) 5 (2021)100127- 1 to 13.

199. Poly(o-toluidine)/multiwalled carbon nanotubes-based nanocomposites: An efficient electrode material for supercapacitors.
Shama Islam, Poonam Sehrawat, Hana Khan, S.A. Hashmi, **M.Zulfequar**
Journal of Materials research (2021) DOI: 10:1557/s43578-021-00383-3.

198. Tunable optical bandgap in PVA/Ge10As40Se50 chalcogenide glass (ChG) nanocomposites free standing films.
Hana Khan, Prabhat K. Dwivedi, Mushahid Husain, **Mohammad Zulfequar**
Optik (ELSEVIER) **245** (2021) 167677.

197. Solution processing of chalcogenide glasses: A Facile path towards functional integration.
Hana Khan, Prabhat K. Dwivedi, Mushahid Husain, **M.Zulfequar**
Optical Materials (ELSEVIER) **119** (2021) 111332.

196. Surface modification via silver nanoparticles attachment: An ex-situ approach for enhancing the electron field emission properties of CNT field emitters
Mohammad Moeen Hasan Raza, Mohd Sadiq, Sunny Khan, Mohd Sarvar, Shama Parveen, Shah M Aalam**, Mohammad Zulfequa**, Samina Husain, Javid Ali
Materials Today: Proceedings **47** (2021) 1542–1549

195. Investigations on Structural, Optical Properties, Electrical Properties and Electrochemical Stability Window of the Reduced Graphene Oxides Incorporated Blend Polymer Nano-Composite Films
Mohd Sadiq, Mohammad MoeenHasan Raza, **Mohammad Zulfequar,** and Javid Ali
Journal of Nanoscience and Nanotechnology Vol. **21**,(2021) 1–15,

194. Sodium Ion-Conducting Polyvinylpyrrolidone (PVP)/Polyvinyl Alcohol (PVA) Blend Electrolyte Films
Mohd Sadiq, Mohammad Moeen Hasan Raza, Tahir Murtaza,
Mohammad Zulfequar, and Javid Ali
Journal of Electronic MaterialsVol. **50**, No. 2, (2021),403-418

193. Studies on flexible and highly stretchable sodium ion conducting blend polymer electrolytes with enhanced structural, thermal, optical, and electrochemical properties
Mohd Sadiq, Mohammad Moeen Hasan Raza, Sujeet Kumar Chaurasia,
Mohammad Zulfequar, and Javid Ali
J Mater Sci: Mater Electron (2021) **32**:19390–19411

192. A single step in-situ process for improvement in electron emission properties of surface-modified carbon nanotubes (CNTs): Titanium dioxide nanoparticles attachment
Mohammad M.H. Raza , Mohd Sadiq , Sunny Khan , **Mohammad Zulfequar** , Mushahid Husain , Samina Husain , Javid Ali
Diamond & Related Materials **110** (2020) 108139

191. Enhancement of Electron Emission Properties of Carbon Nanotubes by the Decoration with Low Work Function Metal Oxide Nanoparticles
Mohammad M. H. Raza, Sunny Khan, Mohd Sadiq, **Mohammad Zulfequar,** Mushahid Husain, and Javid Ali
Journal of Nanoscience and Nanotechnology Vol. **20** (2020)1–6

190. Trace level toxic ammonia gas sensing ofsingle-walled carbon nanotubes wrappedpolyaniline nanofibers
Nagma Ansari, Mohd Yaseen Lone, Shumaila, Javid Ali, **Mohammad Zulfequar**, Mushahid Husain,S. S Islam, and Samina Husain
J. Appl. Phys. **127**, (2020) 044902-1 to 16

189. Bandgap tunability endowed by isovalent Sulphur doping in SeTeglassy films: Correlation with Kastner's and single oscillator models
Raja Saifu Rahman, Mohd Shoab , Zubair M.S.H. Khan , Zubair Aslam, Kandasami Asokan,**Mohammad Zulfequar**
Journal of Alloys and Compounds **835** (2020) 155441-49

188. Facile synthesis of highly conducting polypyrrole and reduced graphene oxide nanocomposites for low-turn-on electron field emitters
Shumaila , Sunny Khan , Zubair M.S.H. Khan , M. Husain , **M. Zulfequar**
Journal of Physics and Chemistry of Solids **14**(2020)109522-109530

187. Effect of Annealing Temperature on Optical and StructuralProperties of Solution Processed As_2S_3 Chalcogenide Glass Films
Hana Khana, Shama Islama, Prabhat K. Dwivedi, Nita Dilawar, Mushahid Husain, **M. Zulfequar;**
Materials Today: Proceedings **21** (2020) 2072–2078

186. Effect of Bi Additive on Optical and Electrical Properties of Quaternary Chalcogenide In3Te7BixSe90-x Thin Films.
S. S. Ashraf and **M. Zulfequar**
Journal of Ovonic Research Vol. **15**, No. 6, November - December 2019, p. 393 - 400

185. Bismuth Additive Non-Isothermal Crystallization Kinetics of In3Te7BixSe90-x
S. S. Ashraf and **M. Zulfequar**
Chalcogenide Letters Vol. **16**, No. 12, December 2019, p. 603 – 614

184. Interface modification for enhancing the conduction mechanisms in 2,2',7,7'-tetrakis(N,N-diphenylamine)-9,9'-spirobifluorene (Spiro-TAD) Nano layers for optoelectronic applications.
Omwati Rana, Ritu Srivastava, M.N.Kamalasanan, M.Husain, **M.Zulfequar**
International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-6S, March 2019.

183. Structural effect of SWCNTs grown by PECVD towards NH3 gas sensing and field emission properties.
Mohd Yaseen Lone, Avshish Kumar, Nagma Ansari, Samina Husain, **Mohammad Zulfequar**, Ravi Chand Singh, Mushahid Husain
Material Research Bulletin **119** (2019) 110532.

182. Hydrothermal treatment of red lentils for the synthesis of fluorescent carbon quantum dots and its application for sensing Fe3+
Zubair M.S.H khan, Raja Saifu Rahman, Shama Islam, **M.Zulfequar**
Optical Materials (Elsevier) **91** (2019) 386-395.

181. Fabrication of sensitive SWCNT sensor for trace level detection of reducing and oxidizing gases (NH_3 and NO_2) at room temperature
Mohd Yaseen Lone, Avshish Kumar, Samina Husain, Ravi Chand Singh **Mohammad Zulfequar**, Mushahid Husain
Physica E: Low dimensional Systems and Nanostructures **108** (2019) 206-214

180. Enhanced electrical conductivity in solution processed carbon nanotubes incorporated As_2S_3 glass films
Hana Khan, Prabhat K. Dwivedi, Mushahid Husain, **M.Zulfequar**
Journal of Material Science: Materials in Electronics **29** (2018) 12993-13004

179. Improved giant dielectric properties in microwave flash combustion derived and microwave sintered $CaCu_3 Ti_4O_{12}$ ceramics.
Ranjit Kumar, **M. Zulfequar**, T.D Senguttuvan
Journal of Electroceramic**42** (2019) 41-46.

178. Non-Isothermal Crystallization Kinetics of $In_4Se_{96-x}S_x$ Chalcogenide Glasses using Differiential Scanning Calorimetry.
S.S.Ashraf, **M. Zulfequar**, M.Uddin
Chalcogenide Letters **15(4)** (2018) 227-235.

177. Enhancement of sensor response of as fabricated SWCNT sensor with gold Nanoparticles.
Mohd Yaseen lone, Avshish kumar, Nagma Ansari, Samina Husain, **Mohammad Zulfequar**, Ravi Chand Singh, Mushahid Husain
Sensors and Actuators A **274** (2018) 85-93

176. CdSe quantum dots using selenourea as selenium source in polymer matrix.
Zubair M.S.H khan, Hana Khan, **M.Zulfequar**
J Mater Sci: Mater Electron (springer) **28** (2017) 14638-14645

175. Electrical and optical properties of solution phase deposited As_2S_3 and As_2Se_3 chalcogenide thin films: A comparative study with thermally deposited films.
Prince, Radhakant Singh, **M. Zulfequar**, A. Kumar, Prabhat K. Dwivedi
Journal of Non-Crystalline Solids **476** (2017) 46-51

174. Solution phase driven As_2S_3chalcogenide films: Optical and picoseconds nonlinear optical properties
Radhakant Singh, Prince, **M. Zulfequar**, S. Venugopal Rao, Prabhat K. Dwivedi
Journal of Non Linear Optical Physics and Materials **26** (2017) 1750038 (16 pages)

173. First order phase transformation and structural studies in $Se_{85}In_{15-x}Zn_x$ chalcogenide glasses
Archana Srivastava, S. N. Tiwari, A. N. Upadhyay, **M. Zulfequar** and Shamshad A. Khan
Journal of Thermal Analysis and Calorimetry **129** (2017)1435-1444

172. Influence of Thermal Annealing on Structural and Optical Properties of $Se_{85}In_{12}Bi_3$ Thin Chalcogenide films
Ravi P. Tripathi, **M. Zulfequar**, Shamshad A. Khan
Materials Focus **6** (2017) 1-5

171. Growth of Carbon Nanotubes by PECVD and its Applications: A Review
Mohd. Yaseen Lone, Avshish Kumar, Samina Husain, **Mohammad Zulfequar** and Mushahid Husain
Current Nanoscience **13** (2017) 1-11

170. Oxygen and nitrogen doping in single wall carbon nanotubes : An efficient stable field emitter
Avshish Kumar, Shama Parveen, Samina Husain, **M. Zulfequar**, Harsh, Mushahid Husain
Journal of Alloys and Compounds **711** (2017), 85-93

169. Synthesis, Characterization and Properties of MgB2 Doped Polyaniline
Shumaila, **M. Zulfequar**, M. Husain
Journal of Modern Materials **4** (2017), 1-9

168 Study of thiol capped CdSe quantum dots using SeO2 precursor for selenium Source
Zubair M.S.H. Khan, Shamshad A. Khan, **M. Zulfequar**
Materials Science in Semiconductor Processing **57** (2017) 190–196

167. Low temperature synthesis and field emission characteristics of single to few layered graphene grown using PECVD .
Avshish Kumar, Sunny Khan, **M. Zulfequar**, Harsh, Mushahid Husain
Applied Surface Science **402** (2017) 161–167

166. Growth of single wall carbon nanotubes using PECVD technique: Anefficient chemiresistor gas sensor.
Mohd Yaseen Lone, Avshish Kumar, Samina Husain, **M. Zulfequar**, Harsh, Mushahid Husain
Physica E **87** (2017) 261–265

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InternationalNathiagaliSummerCollege on Physics and Contemporary Needs, Islamabad (Pakistan), 04-18 July 1991.

10. Participated in International Congress on Ultrasonic, ICU, National Physics Laboratory, New Delhi, 12-14 Dec, 1990.

11. Participated in Second National Conference on Disordered Materials, Department of Physics, Jamia Millia Islamia, New Delhi, Feb. 25-26, 1991.

12. Participated in National Seminar on Advances in Physics of Materials, Department of Physics , Harcourt Butler Technological Institute, Kanpur, 21-23 Dec. 1991 .

13. Participated in 'Research Workshop on Condensed Matter Physics' InternationalCenter for Theoretical Physics, Truest, Italy , 21-30 Aug. 1993

14. Participated in "Workshop on Material Science and Physics of Non-Conventional Energy Sources". InternationalCenter for Theoretical Physics, Trieste, Italy , 30 Aug.- Sep.17, 1993.

15. Participated in Indo-Italian Workshop on Renewable energy Technology, IIT, New Delhi, April. 20- 22, 1994.

16. Participated in Indo-Italian Workshop on Synchrotron Radiation Applications, IIT, New Delhi, Feb. 17- 19, 1995.

17. Participated in **Orientation Program** organized by IGNOU, New Delhi, Sept. 29-30, 1995.

18. Participated in **"Workshop on Physics Laboratory Education",** At IUC, DAFE, Indore, (Nov. 06-24, 1995)

19. Visited **InternationalCenter For Theoretical Physics, Italy , as an Affiliate** to carry out Research in condensed Matter Physics, 17 Nov.-13 Dec.1996.

20. *Optical Properties of a-$Se_{80-x}Ga_{20}Te_x$ Thin Films.*
3rd International Conference and Intensive Tutorial Course on Semiconductor Materials & Technology, Department of Electronic Sciences, South Campus, University of Delhi, Delhi, Dec. 19-21, 1996.

21. Participated in National Seminar on Recent Trend in Nuclear, Particle and

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22. Participated in the National Seminar on Materials Research and Environmental Issues, Department of Physics, Jamia Millia Islamia, New Delhi, Oct. 23, 1997.

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25. Participated in the Seminar on Science & Technology in 21st century (ST2000), jointly organized by Faculty of Engg. & Technology and Faculty of Natural Sciences, Jamia Millia Islamia, New Delhi (Feb. 25-26, 1998).

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28. *A study of the density of localized states in a-$Se_{100-x}Bi_x$.*
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29. (i). Crystallization Kinetics in a-$Se_{100-x}Bi_x$ Alloys (x=0,5 &10).
(ii). Electrical conductivity and Determination of Density of States in a-$(Ga_5Se_{95})_{100-x}Te_x$ Thin Films.
International Workshop on Physics of Semiconductors Devices, held at IIT New Delhi (Dec. 14-18, 1999), Organised by Solid State Physics laboratory.

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(ii)Optical & Electrical properties of Bi_x Se_{100-x}

Presented in National Conference on Semiconductor Materials & Semiconductor Technologies in Electronics Research(Nov. 8-10, 2000), Department of Electronics & Communication Engineering, G.B.Pant University, Pantnagar.

31. *A study of the density of localized states in a-Se_{78-x} $Te_{22.}$ $Bi_{x.}$*
Presented in **Indo-Japanese Workshop** on Micro System Technology (Nov. 23-25 ,2000), at DelhiUniversity, Delhi , Organized by Solid State Physics laboratory, Delhi, Delhi University Delhi &Toyoshashi University, Japan.

32. *(I) Optical and Electrical properties of a-Ga_5 $Se_{95-x}Sb_{x.}$* alloys.
(ii)*A Study of Transient Photoconductivity in a-$Ga_{20}Se_{80-x}Bi_{x.}$ Semiconductong alloys.*
Presented in **International Conference on Advance Materials(ICAM-2000)** (Dec. 26-28 ,2000), at Department of Physics, Ch. Charan Singh University, Meerut (India).

33. Participated in the **88th Session of the Indian Science Congress** Held at ICAR, New Delhi (Jan.,3-7 2001).

34. Participated in the **International Conference on Time & Frequency (ICTF),** (Feb.,6-7,2001) and **3rd International Conference on Metrology in New Millennium & Global Trade (MMGT-2001),** (Feb.,8-10,2001), Organized by Metrology Socity Of India, New Delhi &National Physical Laboratory ,New Delhi .

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38. *Thermal Properties of a- Se100-xBix glasses..*
BSME-ASME International Conference on Thermal Engg., Dhaka, Bangladesh. (31 December to 02 Jan. 2002) Page. 690.

39. Participated in *Workshop on nanomaterials* , Organized by Department of Physics, Jamia Millia Islamia, New Delhi and the Society for Semiconductor devices, November 1,2002.

40. Participated in *Quantum Theory : Perspectives and Challenges* , Organized by Department of Physics, Jamia Millia Islamia, New Delhi on March, 7,2003.

41. *(i). Kinetics Study of a-$Se_{80}Te_{20-x}Pb_x$ Using Non-Isothermal Crystallization.*
(ii). High field conduction in a- $Bi_{0.5}Se_{99.5-x}Zn_x$ Film.
(iii). Effect of Ag impurity electrical and Dielectric properties of Se-Te System.
Proceedings of the Twelfth **International Workshop** on Physics of Semiconductors Devices, held at IIT Chenni (Dec. 16-21,2003).

42. Participated in *Workshop on Nanostructure*, Organized by Department of Physics, Jamia Millia Islamia, New Delhi on March, 11, 2004.

43. Participated in "National Conference *on Nanomaterials & Applications"* , Organized by Amity Institute of Technology, Noida on May, 27-28, 2005.

44. *(i). Differential scanning calorimetry study of $Se_{100-x}Bi_x$ glasses*
*M. A. Majeed Khan, **M. Zulfequar**, M. Husain*
*T*hirteen **International Workshop** on Physics of Semiconductors Devices, held at NPL New Delhi, 2 (2005) 1449-1452

(ii). Dielectric Properies of Se-S glassy alloys
*Nadeem Musahwar**, M. Zulfequar**, M. Husain*
*T*hirteen **International Workshop** on Physics of Semiconductors Devices, held at NPL New Delhi, 2 (2005) 1453-1456

(iii). Dielectric relaxation studies in a- Se-Te-Ga system
*Satish Kumar**, M. Zulfequar**, M. Husain*
*T*hirteen **International Workshop** on Physics of Semiconductors Devices, held at NPL New Delhi, 2 (2005) 1457-1460.

(iv). Synthesis of carbon nanotubes by ECR plasma assisted CVD

Monika Aggarwal, Samina Khan, M. Zulfequar, M. Husain
*T*hirteen **International Workshop** on Physics of Semiconductors Devices, held at NPL New Delhi, 1 (2005) 487-491

(v). Synthesis and characterization of Te doped polyaniline
Samarana Kazim, Vazid Ali, **M. Zulfequar**, M. Husain
Thirteen **International Workshop** on Physics of Semiconductors Devices, held at NPL New Delhi, 2 (2005) 948-951

(vi) Electrical Conductivity and Dielectric properties of sulfamic acid doped polyaniline
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*T*hirteen **International Workshop** on Physics of Semiconductors Devices, held at NPL New Delhi, 2 (2005) 952-955
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45. Poster presentation entitled "XRD and FTIR studies of p-toluene sulphonic acid doped
poly(m-toluidine) and poly(m-toluidine)-PVC blends"
G.B.V.S. Lakshmi, Vazid Ali, Azher M. Siddiqui and **M. Zulfequar**
"International Conference on Electroactive Polymers – 2007" organized in Goa, India.

46. Poster presentation in "Natural Science Info Fest – 2007" organized in Jamia Millia Islamia, New Delhi.

47. Poster presentation in Recent Trends in Nanotecnology, 29-31 March, 2007,SGSITS, Indore
"Synthesis and characterization of Multiwalled Carbon Nanotube film by ECR-CVD".

47. Poster presentation in National Seminar on Electroceramics "*Effect of Te on Electrical Conductivity of Silicon Nitride Ceramics*", 5-6 November 2007, Sonipat organized by DRDO.

48. Poster presentation in Fourteenth **International Workshop** on Physics of Semiconductors Devices, "*Synthesis and Characterization of ZnO Nanostructures* " (919-920) held at IIT Mumbai, 16-20 December 2007.

49. 60 MeV Si5+ ION IRRADIATION EFFECTS ON POLY (m-TOLUIDINE) –PVC BLENDS, G. B. V. S. Lakshmi, Vazid Ali, Azher M. Sidddiqui, Pawan K Kulriya, M. Husain and M. Zulfequar, Accepted for presentation in "The POLYCHAR 16 - World Forum on Advanced Materials" to be held from 17-23rd February 2008 in Lucknow, India.

50. Oral presentation in **International Conference on Nanotechnology :**Opportunities Challenges(ICON 008), "I-V Characteristics of Multi-

walled Carbon Nanotubes Syntheszedusing ECR-CVD " **held at King Abdul aziz University**, Center of Nanotechnology, Jeddah, Kingdom of Saudi Arabia., 17-19 June 2008.

51. Participated in "National seminar on Ferroelectrics and Dielectrics-2008", Electrical and Structural properties of Sintered Silicon Nitride ceramics with MgO and Y_2O_3 additives' organized by Thapar University Patiala (Punjab) and DRDO, November 6-8, 2008.

52. Poster presentation in Fifteenth International Workshop on The Physics of Semiconductor Devices. December 15-19, 2009, Jamia Millia Islamia, New Delhi

(i) Synthesis and characterization of CdS Semiconductor thin Films having Nanometer
Grain Size, Ziaul Raza Khan, M.Zulfequar and Mohd.Shahid Khan.

(ii) Synthesis and Spectroscopic characterization of ZnO doped Polyaniline,MonikaChahar,Vazid Ali, Sushil kumar, G.B.V.S.Lakshmi, M.Zulfequar and M.Husain

(iii) DC conductivity and spectroscopic Characterization of Binary Dopent ($ZrOCl_2$/Agl) Doped Polyaniline, Kiran Kumari, Vazid Ali, Sushil kumar, G.B.V.S.Lakshmi, and M.Zulfequar.

(iv) Electrical properties of Sintered Silicon Nitride Ceramics with different Additives, Imran Khan and M.Zulfequar.

(v) Synthesis and Characterization of Polyaniline Thin Films by RF-Plasma Polymerization, G.B.V.S.Lakshmi, Anju Dhillon, D.K.Avasthi, Azher M. Siddiqui and M.Zulfequar.

(vi) SHI Irradiation Effects on PmT-PVC Blends.G.B.V.S.Lakshmi,Azher M. Siddiqui,Pawan K. Kulriya, Vazid Ali and M.Zulfequar.

(vii) Optical and Structure Study of CdSe Thin Film, AusamaI.Khudiar , M.Zulfequar and Zahid H. Khan.

(viii) Optical and surface Characterization of Nano-$Se_{70}Te_{30-X}Zn_X$ Alloy System.
Karunapatitripathi, S.S.Mehdi, M.Husain and M.Zulfequar.

53. Participated in National Seminar on Condensed Matter, Nuclear and High Energy Physics, Department of Physics, Jamia Millia Islamia,New Delhi,Feb. 18-19, 2011.

54. Participated in Seminar on Progress in Physics of Materials and Theoretical Physics, Organized by DRS program,Department of Physics, Jamia Millia Islamia, New Delhi, Feb. 03, 2012.

55. Welcome address in Abdus Salam Memorial Lecture, at adepartment of Physics, JMI ,30 Jan, 2013

56. Chaired the session in National conference on "Advanced trends in nanoscience and nanotechnology (ATNN-2013), Department of Applied Sciences and Humanities, Faculty of engineering and technology, Jamia Millia Islamia, New Delhi. 25th Feb 2013.

57. Participated in science academies lecture workshop on Nanoscience and nanotechnology organized by the department of Chemistry, Jamia Millia Islamia, New Delhi. 1-2 March 2013

58. Chaired the session in National Seminar on Physics and Technology of Sensers,Centre for Interdisciplinary Research in Basic Sciences, JMI, 11-13,March 2013

59. Raman Characteristics of Vertically Aligned Single Wall Carbon Nanotubes Grown by Plasma Enhanced Chemical Vapor Deposition System,

60. Avshish Kumar, Samina Husain, Shama Parveen, Javid Ali, **M. Zulfequar**, Harsh, M.Husian, presented poster presentation in "17th International Workshop on the Physics of Semiconductor Devices 2013, at Amity University, Noida, From 10-14 December 2013

61. Engineering the Optical Properties of insitu Polymerized poly (o-toluidine/V2O5) Composites"
Shama Islam, G.B.V.S. Lakshmi, M. Zulfequar,
M. Husain and Azher M. Siddiqui
Physics of Semiconductor Devices, DOI: 10.1007/978-3-319-03002-9_234
Environmental Science and Engineering, Springer International Publishing Switzerland 2014.

62. Dc conductivity and High Field Behavior of Se100-xTex Alloy
Mohsin Ganaie, Shabir Kumar, Adam A. Bahishti, M. Zulfequar
Physics of Semiconductor Devices DOI: 10.1007/978-3-319-03002-9_159,
Environmental Science and Engineering, Springer International Publishing Switzerland 2014

63. Study of Optical Parameters of the Thin Films of Se100-x Hgx with Laser Irradiation
Shabir Ahmad, Mohsin Ganaie, Nasir, Neetu, Shahid Khan, M. Zulfequar

Physics of Semiconductor Devices, DOI: 10.1007/978-3-319-03002-9_219, Environmental Science and Engineering, Springer International Publishing Switzerland 2014

64. Welcome address in Abdus Salam Memorial Lecture, at a department of Physics, JMI ,17 Feb., 2014
65. Welcome address in Abdus Salam Memorial Lecture, at a department of Physics, JMI ,11 Feb., 2015
66. Delivered a talk on"Lasser Effect on Amorphous Semiconductor" dated 06/08/2015 at Alflaha university solid state lightning

67. Synthesis And Characterization Of CdSe Quantum Dots Dispersed In PVA Matrix by Chemical Route .
Zubair M.S.H. Khan, Mohsin Ganaie, Shamshad A. Khan, M. Husain, M.Zulfequar
DAE Solid State Physics Symposium 2015
AIP Conf. Proc. 1731, 050069-1–050069-3; doi: 10.1063/1.4947723

69. Chaired the session in International Conference on Nanobiotechnology, Centre for Interdisciplinary Research in Basic Sciences, JMI, New Delhi, 05-06, Feb.2018

70. Chaired the session in International Conference on Advanced Materials, Centre for Nanoscience and Nanotechnology, JMI, New Delhi, 06, March .2019.

71. Structural, thermal and optical properties of magnesium ion conducting biopolymer electrolytes for supercapacitor applications.
Mohd Sadiq, S.K. Chaurasia, Anjani Kr Singh, Raghvendra Pandey, Hari Shankar Yadav,M.M. Hasan Raza, Yogesh Kumar, P.K. Singh, M. Zulfequar, Javid Ali
Materials Today: Proceedings https://doi.org/10.1016/j.matpr.2020.10.957

72. Dielectric properties and ac conductivity behavior of rGO incorporatedPVP-PVA blended polymer nanocomposites films
Mohd Sadiq, M.M. Hasan Raza, Anjani Kumar Singh, Sujeet Kumar Chaurasia, Mohammad Zulfequar, Anil Arya, Javid Ali
Materials Today: Proceedings :https://doi.org/10.1016/j.matpr.2020.11.169

Summary of research projects

Title: **Effects of SHI Irradiation on conjugated polymers**
Sponsoring Agency: Inter University Accelerator Centre, New Delhi
Amount: Rs. 2,83,980
Duration: 2005 to 2009

Under the project entitled "**Effects of SHI Irradiation on conjugated polymers**" the following work has been carried out.

Samples prepared:

1. Poly (o-toluidine) powder
2. Poly (m-toluidine) powder
3. poly (o-toluidine) – polyvinylchloride blends

4. poly (m-toluidine) – polyvinylchloride blends
5. Poly(3-methyl thiophene)

The polymer powders of PoT, PmT and poly(3-methyl thiophene) were prepared by chemical oxidation polymerization method and PoT, PmT were doped with p-toluene sulphonic acid at different concentrations (2,4,6,8 and 10% (w/w)). The polymer powders were then blended with PVC to achieve thin films. The powders and blends were characterized by using DC conductivity measurement, X-Ray Diffraction, FTIR and UV-Visible studies. After characterization the blends were irradiated by 60 MeV C^{5+} ions, 60 MeV Si^{5+} and again characterized by the above techniques. After irradiation with C^{5+} ions the optical band gap decreases and DC conductivity decreases with decrease in crystallinity in Pot-PVC blends. Whereas, Si^{5+} ion irradiation leads increase in the crystallinity and decrease in optical band gap. Depending on electronic energy loss (S_e) value the crystallinity and optical band gap changes in different way.

Poly(3-methyl thiophene) powder was dissolved in chloroform and the films are prepared on glass and silicon substrates and irradiated with Si^{5+} ions. The optical band gap found to decrease after irradiation, DC conductivity found to increase and crystallinity found to decrease. The residual gas analysis has been carried out on the all above samples and found the evolution of H, C, N, CH_4, C_2H_6 and C_3H_8 gasses from PoT and PmT blend films. So the changes in optical, structural and conductivity properties are attributed to the evolution of gasses during irradiation leading to chain scissoring, bond breaking and new bond formation in conducting polymers. These results were published in 6 International Journals.

Title: **Estimation of Density of Localized State in Chalcogenide Glasses from Electrical Properties**
Sponsoring Agency: UGC, New Delhi
Amount: 4.30 Lacks
Duration: 1998-2001

The density of such localized states in the mobility gap controls many physical properties of amorphous semiconductors. Moreover, when the transition p to n type is lot of change in the density of states. Much attention has not been paid this aspect. Therefore, it is mater of great interest to estimate and study the density of states in glassy amorphous materials. There are several methods to estimate the density of states near the Fermi level. We purpose the estimation of density of states using Mott parameter and space charge limited conduction. In the present research work, we propose the following studies:

(i) To prepare some glassy amorphous materials.

(ii) To characterized these glassy amorphous materials.

(iii) To study the temperature dependence of dc conductivity.

(iv) The density of localized states near the Fermi level have been calculated by Mott parameters for various samples.

(v) The field dependence of the conductivity will be measured at different temperatures on bulk samples as well as on vacuum evaporated thin films of chalcogenide glasses having different electrode separation. Thickness dependence of I-V characteristics of the samples confirms the presence of space charge limited conduction (SCLC). Using the theory of SCLC, the density of localized states near the Fermi level have been calculated various samples.

(vi) Impurity effects in chalcogenide glasses may have importance in fabricating glassy semiconductors. The effect of metallic impurity on electrical properties will also be studied.

Keeping in view of, we worked on amorphous semiconductor and their alloys. The following systems have been studied in the present research work:

(i) a-$Se_{100-x}Sb_x$ (where x = 0, 0.5, 2.5, 5 and 10)

(ii) a-$Se_{100-x}Bi_x$ (where x = 0, 0.5, 2.5 and 5)

(iii) a-$Se_{78-x}Te_{22}Bi_x$(where x = 0, 0.5, 2 and 4)

(i) a-$Bi_{0.5}Se_{99.5-x}Zn_x$ (where x = 0, 0.1, 0.2, 0.5 and 1)

(v) a-$Se_{80}In_{20-x}Pb_x$ (where x = 2, 4, 6 and 10)

(vi) a-$Ga_5Se_{95-x}Sb_x$ (where x = 0, 1, 5 and 10)

(vii) a-$Se_{80}Te_{20-x}Pb_x$ (where x = 0, 2, 6 and 10)

Melt quenching method has been adopted to prepare the amorphous material.
The d. c. conduction is very important for chalcogenide glasses because it provides useful information's about the transport mechanism in chalcogenide glasses.

Title: **Designing and fabrication of Photon drag detector and TEA CO_2 laser as their evaluation.**
Sponsoring Agency: DRDO-LASTECH, New Delhi
Amount: Rs.37.31 Lacks
Duration: 29 September 2006 to 29 September 2009

Under this project, designing and fabrication of germanium photon drag-detector and TEA CO_2 laser has been done successfully and summarized below-

(A) Designing and Fabrication of Photon Drag-Detectors

While studying the responsivity of the Ge photon drag detector it was found that the Fresnel reflection loss at the incident end of the germanium bar and the multiple reflections in the bar reduce the value of the fraction of the incident laser radiation which actually travels in the germanium bar. If the exit end of the detector is cut at a critical angle (14.5^o), then 64 % of incident laser radiation can travel in the Ge bar. To increasing the responsivity of detector choice of length and resistivity of the germanium was an important design parameter.

In view of the above, two type of photon drag detectors have been designed and fabricated with following specifications.

(a) Resistivity and dimension of the Ge bar choosen as-

(i) ***Type A detector:*** 1.0 Ω-cm, p-type, 2mm × 2mm × 20mm

(ii) ***Type B detector***: 2.5 Ω-cm, p-type, 2.5mm × 2.5mm × 30mm

(b) Responsivity and response time of the detectors for CO_2 laser is as follows:

(i) ***Type A detector***: 674 mV/MW, nanosecond/ sub nano-second

(ii) ***Type B detector:*** 872 mV/MW, nanosecond/ sub nano-second

(c) Damage Threshold Intensity: 20 MW/cm_2

(B) Designing and Fabrication of TEA CO_2 Laser

Design and fabrication of laser cavity is an important aspect of a laser oscillator. To obtain low divergence, a plano-concave configuration has been chosen. A quartz mirror with thick coating of aluminium has been used for fully reflecting mirror which provides a specular reflectance adequate for a high gain laser. A partially Aluminium coated flat germanium mirror has been used to get laser output. Instead of brewsterized ends, adjustable laser mirrors in vacuum tight holders has been used. Linear pin-rod configuration has been used for electrical excitation in which cathode consist of a string of about 116 pins, 7.5 mm apart each being loaded with a 1.0 K Ωcarbon composition resistor (1 Watt). The anode is a sand blasted copper tube of 7 mm diameter. The pin to anode separation is about 3 cm. The current excitation pulses are obtained by discharging a 0.02 μF capacitor of 10 nH with the help of a spark gap through the laser electrodes using variable high voltage DC (0-30 kV) supply. The capacitor can be charged to voltages upto 30 kV, and on its discharge, the exciting pulses have a peak current of upto 5 A per pin. The exciting pulses have duration of about 1 μs. The optimum pressure of CO2 gas for maximum gain is found to be 35 Torr whether He is present or not. For highest gain partial pressure of CO2 = 35 Torr, N2 = 20 Torr and He = 30 Torr are about the optimum. The peak gain in CO2 at 25 Torr and N2 at 25 Torr is found to be maximum. This is quite encouraging if one wishes to avoid Helium in this binary mixture of equal ratio.

Title: **Synthesis and characterization of Single wall carbon nanotubes for Semiconducting Applications**

Funding Agency: Department of Electronics & Information Technology (DeitY), Ministry of Communication & Information Technology,New Delhi, Sanction No. 20(10)/2007-NANO
Amount: Rs. 380.76 Lakh
Duration: 23.04.2010 – 21.04.2015

The main objective of the project was to synthesize and characterize single wall carbon nanotube (SWNTs) using Plasma Enhanced Chemical Vapor Deposition (PECVD) technique and to study their characteristics for semiconducing applications. The main objective of the project was successfully achieved.We have successfully grown SWCNTs of different diameter ranging from 1 nm to 3 nm using Iron as well as other catalystsand purity close to 100% by varying growth and pretreatment temperatures, source gas flow rate, reactor chamber pressure etc.In this project, The I-V characteristics of single wall carbon nanotubes have been studied for various device applications. The SWCNTs have also been studied for sensor applications particularly for NH_3 and NO_2 gas. The effect of NH_3& NO_2 gas on the resistance of SWCNTs was measured on the samples prepared for the I-V measurements. The change in resistance as a function of time was observed using I-V measurement system. The drain and transfer characteristics of CNT-FET were also studied with different channel lengths. Effect of the gate voltage control over the channel conductance was observed as evident from the transfer characteristics of the CNT-FET.

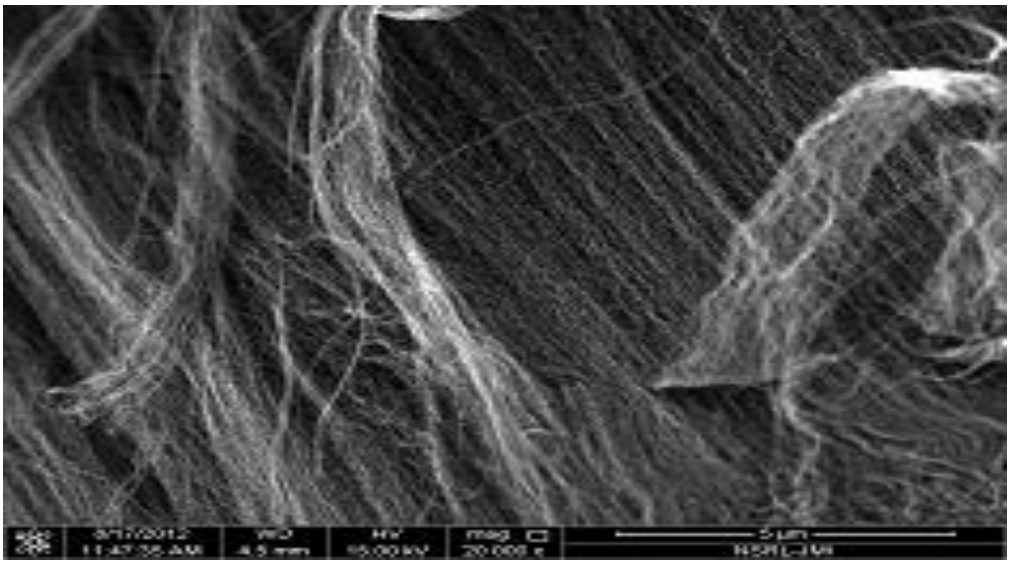


Fig. Single wall carbon nanotubes

Research Interest

Preparation and Characterization of the Amorphous Semiconductors

We are also studying the electrical, dielectric, optical and thermal properties of amorphous semiconductors as they have drawn great attention due to their extensive use in the solid-state devices. One of the main applications of the chalcogenide glasses is in Xerography where selenium is used as one of the chalcogen elements. The shortcoming of the pure glassy selenium for use in the photographic drums are such as its short life time and low sensitivity which can overcome by the use of certain additives such as Ge, Te, Bi, In, and Sb. The binary alloy is of great interest owing to their greater hardness, higher sensitivity, higher crystallinity and small ageing effect in comparison to pure amorphous selenium.

Thin film preparation

Quenching technique has been adopted to prepare glassy alloys. Thin films of the glassy alloys were prepared by vacuum evaporation technique in a vacuum of ~10^{-6} torr.

Electrical Transport Studies

In electrical properties, we have studied the temperature dependence of dark conductivity, photoconductivity and thermoelectric power of thin films of a-Se-Te-In, Se-Ge-In, Ga-Se-Ag, Se-Te-Ga, Ga-Se-Bi and Ga-Se-Sb etc. On the basis of these results, we have explained the conduction mechanism in these glasses. On electrical transport, we have also published a number of research papers in various international journals.

Optical properties

In recent years, Optical memory effects in amorphous semiconductor films have been investigated and utilized for various device applications. These have distinct advantage viz. large packing density, mass replication, fast data rate, high signal to noise ratio and high immunity to defects. Glassy chalcogenide semiconductors have great varieties of band gaps and are transparent in IR region. In optical studies, we have measured the optical band gap and optical constants of thin films of a Ga-Se-Te, Ga-Se-Sb, Ga-Se-Bi, Ga-Se etc. The results show that the optical band gap decreases with increase in concentration in all the samples. The spectral dependence of the refractive index and

extinction coefficient shows that the refractive index (n) decreases and the coefficient of extinction (k) increases with photon energy. The electronegativity for all samples of the present system has also been calculated. It is also observed that the electronegativity decreases with the decrease in the optical band gap for all the samples of the present system. We are also studying the materials optical properties, which are useful for photovoltaic applications. Photovoltaics are one of the most fascinating ways for direct solar energy conversion. Thin films solar cells give hope to meet the cost goals, which are necessary to provide the needs for energy production by photovoltaics.

Dielectric properties

In dielectric properties, the temperature and frequency dependence of dielectric constant and dielectric losses are studied in the bulk glassy samples of Ga –Se, Ga-Te, etc. in the temperature and frequency range of (300-360 k) and (0.12khz-100khz) respectively. A strong dielectric dispersion has been observed when Ga is added to a-Se in the entire temperature range. The dc conductivity has also been measured to see the effect of Ga on dc conduction losses, which are found to be prominent. The results are interpreted in terms of dc conduction losses and Maxwell Wagner type losses.

Thermal Properties

Thermal Studies a glass can be performed in several different ways. In calorimetric measurements, two basic methods can be used; isothermal and non-isothermal. In the isothermal method the sample is brought quickly to a temperature above glass transition temperature (T_g) and heat evolved during the crystallization process at a constant temperature is recorded as a function of time. In the non-isothermal method, the sample is heated at a fixed rate and heat evolved is recorded as a function of temperature. At present, the group is concerned with the study of crystallization kinetics of amorphous semiconductors and evaluation of the activation energy for crystal growth by non-isothermal technique using Differential Scanning Calorimeter.

Synthesis and characterization of conducting polymers

Conducting polymers have many applications in electronic, optical and optoelectronic devices. Polyaniline, Poly(o-toluidine), poly(m-toluidine), poly(3-methyl thiophene) and poly(o/m-toluidine)-Polyvinylchloride blends have been prepared by chemical

polymerization methods. The samples have been characterized by FTIR, XRD, UV-Visible and dc conductivity measurements. The samples have been irradiated by **Swift Heavy Ions** and the effects were studied. We have also synthesized polyaniline and poly(3-methyl thiophene) thin films by RF-Plasma polymerization method.

FTIR studies

FTIR spectra show the formation of the polymers by chemical polymerization method. The spectra have been taken in the range 400 to 4000 cm^{-1} wave number range. The lower wave number bands represent the finger print of various the polymers. The formation of polymers and the changes occur due to irradiation are studied by taking FTIR spectra.

XRD studies

The polymers under study are semi-crystalline in nature. The structural properties of these polymers have been studied by XRD. From XRD the percentage crystallinity has been measured. The changes in structure after irradiations are also studied.

UV-Visible studies

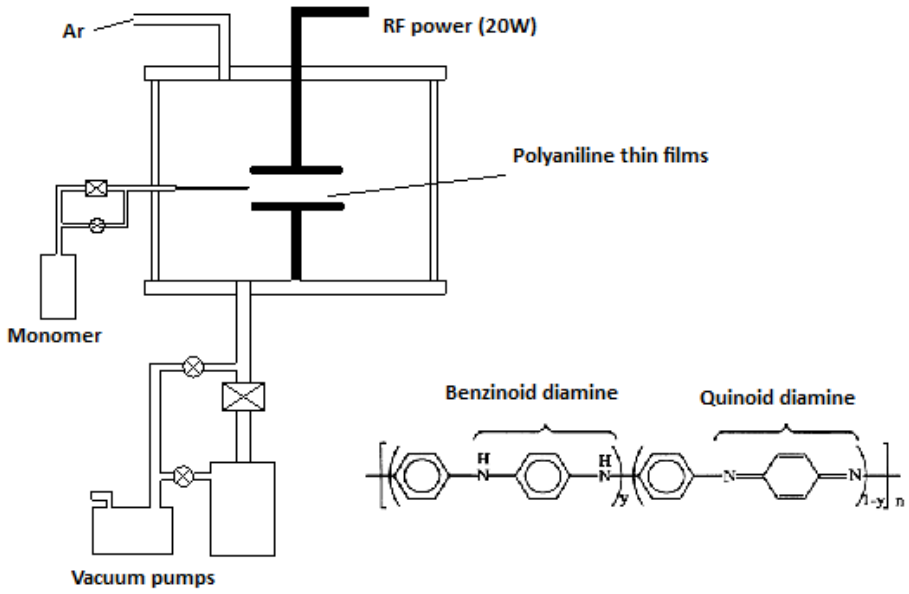
The UV-Visible absorption spectra have been carried out in the wavelength range 190-900 nm. From UV-Visible studies various optical properties of polymers as optical band gap, extinction co-efficient and the absorption co-efficient have been studied. Measurement of these properties is important to use these materials in optical devices. The changes due to irradiation in optical properties have also been studied.

DC-Conductivity measurements

The dc-conductivity of bulk and thin film samples has been studied in the lab using specially designed metallic sample holders under vacuum of $\sim 10^{-3}$ torr. The dc conductivity changes after doping and irradiation of these polymers. It increase with doping concentration and it varies with SHI irradiation. The change is different when the samples irradiated with different ions. It depends on the energy, mass and current of the ion beam used for irradiation.

Preparation of polyeniline thin films by RF-Plasma polymerization

Suitable modifications are done in a RF sputtering set up to facilitate synthesis of polyaniline thin film by RF- plasma polymerization process. The films prepared are highly cross-linked, amorphous in nature and have band gap of 2.07eV. SEM images show the uniformity in film morphology. The refractive index of the films is determined to be 1.11 and dielectric constant is 1.12 at a wavelength 620nm in the visible region.



Contd…

ECR Plasma Etching System(Developed by our group)

In the early years of IC fabrication, wet etching had no competition as an etching technique for pattern transfer and selective etching. However, reproducible controllable transfer of patterns in 1-2 m m range and below is difficult using wet etching. That is because wet etching cannot etch vertically and highly directional and highly anisotropic etching is crucial for reduced geometry. Therefore, dry etching technique is gaining a resurgence of interest over wet etching. Electron cyclotron resonance (ECR) discharges offer a number of advantages for dry etching of III-V group semiconductor materials. Since the electrical and optical properties of these materials are easily degraded by excessive ion bombardment or preferential loss of one of the lattice constituents, ideally one would wish to use discharges with low ion energies while retaining useful etch rates. Moreover, since device dimensions are now often at the 1 m m level or below it is necessary to have highly anisotropic etching, even small amounts of undercut become a significant function of the feature size at this level. Electron Cyclotron Resonance etching technique is one that provides less damage on the surface of the material with anisotropic etching. ECR etching process is of great importance for its excellent properties like high degree of ionization, high densities of ions (>10^{12} ions/cm^3), radicals and excited particles and low contamination because no electrodes are needed. ECR technique has the advantages of producing low ion energies in comparison to other dry etching techniques.

ECR plasma etching system has been developed and is shown schematically in the figure 1.

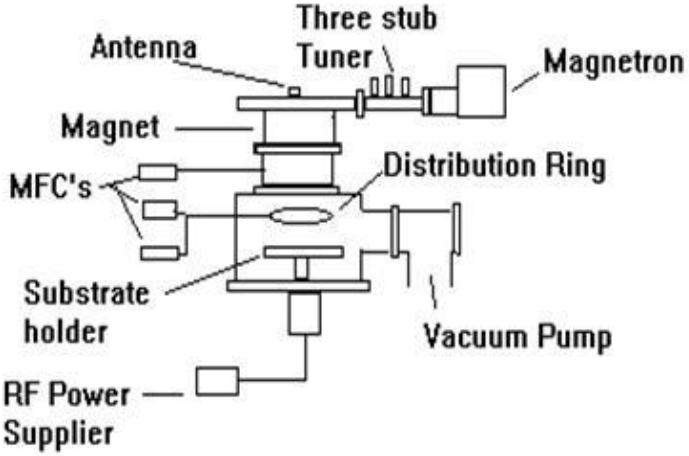


Fig.1 ECR Etching System

Advanced Ceramic Materials

Aluminium nitride (AlN) ceramic has drawn great attention of scientists and engineers because of its excellent thermal and mechanical properties. The kinetics of densification and mechanical properties of this material have been studied in detail and it is now well established that AlN has very good thermalshock resistance along with very high oxidation resistance. This material can, therefore, be used as components in heat engines operating at very high temperatures.

Temperature dependence of electrical conductivity and dielectric measurement have been studied for hot-pressed AlN ceramic having different volume percentage of porosity (0.2, 4.0, 9.0 and 15%) in the temperature range (500 K to 950 K). It has been observed that electrical conductivity decreases by two orders of magnitude as the volume percentage of porosity increases from 0.2 to 15%. Temperature dependence of electrical conductivity and dielectric measurement have also been studied in hot-pressed samples of AlN with additives of CaO, MgO, BeO and Y_2O_3 in high temperature range (500 K to 950 K). The increase in dc conductivity after putting these additives is responsible for the larger values of ε‘and tanδ which is consistent with space charge polarization mechanism.Electrical Conductivity and dielectric properties of Silicon NitrideCeramics reports the effects of different additives (different oxides like Y_2O_3, MgO, V_2O_5 and ZnO and chalcogens such that Te, and Se) on the structural and electrical and dielectric properties of sintered Si_3N_4 based composites.

Nanomaterials:

The group is working on synthesis and characterization of nanomaterials. Here main focus is on ZnO nanostructures, chalcogenide nanoparticles and multiwall carbon nanotubes. The ZnO nanostructures have been synthesized by thermal Evaporation system and by sol gel techniques. The chalcogenide nanostructures have also been synthesized by the Thermal Evaporation system at different gas pressure. The grown nanostructures are characterized by XRD, SEM and UV-visible. We are also synthesizing the multiwallcarbon nanotubes by CVD method. In CVD method, we are using ECR-CVD system to grow the multi wall carbon nanotubes. Then Grown CNTs are characterized by different systems like, Scanning Electron Microscope, Transmission Electron Microscope and Scanning Probe Microscope.