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Teaching Experience : 23 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 : 27 Years

- (i) Worked as JRF and SRF in HBTI Kanpur for 3 year 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. : **21**
- (ii). No. of candidates who have been submitted the Ph.D. : **01**
- (iii). No. of candidates presently working for Ph.D. : **05**

Publications: See Annexure-2

- (i). Research Papers : **148 (International=145, National= 03)**
- (ii). Conference/Workshop /Symposium : **43**
- (iii) Communicated : **04 List of Publications attached**

Area of Research : **Experimental Solid State Physics**
(i) **Amorphous Semiconductor**
(ii) **Ceramic**
(iii) **Conjugated polymers**
(iv) **NanoStructural Materials**

Ph.D. Thesis Title : ***“Electrical & Dielectric Properties of Hot-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 chalcogenide glasses”* 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, New Delhi. (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)

Research Project Undertaken: “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 **International Conference on Nanotechnology :Opportunities Challenges(ICON 008)**, “I-V Characteristics of Multi-walled Carbon Nanotubes Synthesized using ECR-CVD ” held at King Abdulaziz University, Center of Nanotechnology, Jeddah, Kingdom of Saudi Arabia., 17-19 June 2008.

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.

Administrative Responsibilities :

- (i). Co-ordinator B.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
- (v) Asstt. Superintendent of Exam, Faculty of Natural Science, JMI April-June, 2007
- (vi) Asstt. Superintendent of Exam, Faculty of Natural Science, JMI (Compartment),Nov-Dec, 2007
- (vii) **Asstt. Superintendent of Exam**,M.Sc(Physics) Exam.,Physics Department, Faculty of Natural Science, JMI ,April-May, 2008
- (viii) **Asstt. Superintendent of Exam**,M.Sc(Physics) Exam.,Physics Department, Faculty of Natural Science, JMI ,April-May, 2009
- (ix) **Asstt. Superintendent of Exam**, Faculty of Natural Science, JMI April-May, 2010
- (x) **Asstt. Superintendent of Exam**, Faculty of Natural Science, JMI April-May, 2011
- (xi) **Asstt. Superintendent of Exam**, M.Sc(Physics) and M.Tech (Nanotechnology) End Semester Exam. Department of Physics, Dec.-2011
- (xii) **Asstt. Superintendent of Exam**, Faculty of Natural Science, JMI April-May, 2012
- (xiii) **Member**, Central Admission Co-ordination & Monitoring Committee (CACMC) Jamia Millia Islamia, for University admissions 2012
- (xiv) Member of Academic council, JMI since August 2012
- (xv) **Head**, Department of Physics, JMI (Since August 2012)
- (xvi) Member of Technical Purchase committee of Centre of Nanoscience And Nanotechnology, JMI
- (xvii) Officiating Director of Centre of Nanoscience And Nanotechnology,JMI
- (xviii) Member of **COS** of Center of Nanoscience And Nanotechnology, JMI
- (xix) Member of the Anjuman (Court) Jamia Millia islamia, New Delhi

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

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 chalcogenide Glasses.
Name of the Student : Mrs Preeti Devedi, Year 2004
- (v) **Topic** : Structural studies on Ga₂Te₃ 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 and Dielectric 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 CO₂ 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** :Growth 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

THESIS SUBMITTED

- (i) **Topic** :Electrical and structural Properties of Conjugated Polymers by RF Plasma Polymerization.
Name of the Student :Ms Shama Islam, 2014

WORK UNDER PROGRESS

- (i) **Topic** :Optical Line of Sight Communication Studies under different media and its Application for Remote Detection.
Name of the Student :Ms Shammi Wadhwa
- (ii) **Topic** Effect of Laser,Gamma-ray and swift heavy ion irradiation on compound semiconductors
Name of the Student :Mr. Shabir Ahmad Kumar
- (iii) **Topic** Dielectric relaxation and super ohmic behavior of doped amorphous semiconductor
Name of the Student :Mr. Mohsin Ahmed
- (iv) **Topic** Photo and Thermally Induced Effects in solution driven Chalcogenide Thin Films for Photonics Applications
Name of the Student :Mr. Prince
- (v) **Topic** Synthesis and characterization of semiconductor quantum dots for solar cell application
Name of the Student :Mr. Zuber Mohd. Saddam Husain Khan

Annexure-2

List of publications of Professor Mohammad Zulfequar

Journals

148. Dopant Effect and Characterization of Poly (O-Toluidine)/Vanadium Pentoxide Composites Prepared by in Situ Polymerization Process
Shama Islam, Mohsin Ganaie, Shabir Ahmad, Azher M. Siddiqui and **M. Zulfequar**
International Journal of Physics and Astronomy June 2014, Vol. 2, No. 2, pp. 105-122.
147. Study of Effect of Solar Light Irradiation on Structural, Optical and Electrical Properties of CdSe Thin Films
Shabir Ahmad, Mohsin Ganaie, Shama Islam, Mohd. Shahid Khan, K. Asokan and **M.Zulfequar**
International Journal of Physics and Astronomy June 2014, Vol. 2, No. 2, pp. 79-92.

146. Electrical Conductivity and Dielectric Properties of $\text{Se}_{100-x}\text{Te}_x$ Alloy
Mohsin Ganaie¹, Shabir Ahmad, Shama Islam and **M. Zulfequar**
International Journal of Physics and Astronomy June 2014, Vol. 2, No. 2, pp.51-64
145. Effect of laser and visible light Irradiation on structural and optical properties of thin films of amorphous selenium and selenium mercury (80:20 composition)
Shabir Ahmad, Mohsin Ganaie, M. Shahid Khan, and **M.Zulfequar**
Adv.Mat.Lett. 5 (9) (2014) 511-519
144. Effect of oxygen plasma on field emission characteristics of single-wall carbon nanotubes grown by plasma enhanced chemical vapour deposition system,
Avshish Kumar, Shama Parveen, Samina Husain, Javid Ali, **M. Zulfequar**, Harsh, M. Husain,
Journal of Applied Physics **115**, (2014) 084308-6.
143. Photoconductivity of $\text{Se}_{90-x}\text{Te}_{10}\text{Zn}_x$ thin films
Neeetu & M.Zulfequar
Indain Journal of Pure & Applied Physics **52** (2014) 53-59
142. Synthesis, DC conductivity and dielectric properties of rf-plasma polymerized poly (3- methyl thiophene) thin film.
Shama Islam, **M. Zulfequar** and Azher M. Siddiqui,
Int. J. Adv. Res. Sci. and Technol. Volume 2, issue 3, (2013), 150-154.
141. Effect of Cadmium concentration and laser irradiation on photoconductivity of $\text{Cd}_x\text{Se}_{100-x}$ thin films
Ausama I. Khudiar, **M.Zulfequar**, Zahid H. Khan
Materials Science in Semiconductor Processing **16** (2013) 1791-1796
140. Effect of sulfur additive on the density of localized states in nanostructures chalcogenide $\text{Se}_{95-x}\text{S}_x\text{Zn}_5$
Mohd. Nasir, **M.Zulfequar**
Journal of Physics and Chemistry of Solids **74** (2013) 1527-1532
139. Synthesis, Electrical Conductivity, and Dielectric Behaviour of Polyaniline/ V_2O_5 Composites Shama Islam, G.B.V.S. Lakshmi, Azher M.Siddiqui, M.Husain and **M. Zulfequar**
International Journal of Polymer Science Volume2013, Article ID 307525, 7 pages

138. Synthesis, DC conductivity and dielectric properties of rf-plasma polymerized poly (3-methyl thiopene) thin films”
Shama Islam, **M.Zulfequar** and Azher M.Siddiqui.
Int. J. Adv. Res. Sci. and Technol. Volume 2, issue 3, 2013,pp 150-154.
137. Influence of Laser-irradiation on structural and optical properties of phase change $\text{Ga}_{25}\text{Se}_{75-x}\text{Te}_x$ thin films
F.A. Al-Agel, Shamshad A Khan, E.A. Al-Arfaj, F. M. Al-Marzouki, A A Al-Ghamdi, Zishan H Khan, **M. Zulfequar**
Materials Letters 92 (2013)424-426
136. Characterization of Phase change $\text{Ga}_{15}\text{Se}_{77}\text{Ag}_8$ chalcogenide thin films by laser-irradiation
M.A. Alvi, **M. Zulfequar**, A.A Al-Ghamdi
Journal of Alloys and compounds 550 (2013) 413-437
135. A low-cost chemical Route for high Dielectric constant Plate-Shaped Nanocrystalline $\text{CaCu}_3\text{Ti}_4\text{O}_{12}$
Ranjit Kumar, **M. Zulfequar**, V.N. Singh, Sukhvir Singh, and T.D Senguttuvan
Advanced Science Letters 5(2012) 1-5.
134. Modification of metal-organic interface using F4 – TCNQ for enhanced hole injection properties in optoelectronic devices
O. rana, R. Srivastva, G. Chauhan, **M. Zulfequar**, M. Husain, P.C. srivastva and M. N. kamalasanan.
Phys status solidi A 209, No 12, 2539-2545 (2012)
133. Microwave sintering of dielectric $\text{Ca Cu}_3\text{Ti}_4\text{O}_{12}$: An interfacial conductance and dipole relaxation effect
Ranjit Kumar, **M. Zulfequar**, V.N Singh, J.S. Tawale, T.D. Senguttuvan
Journal of Alloys and compound 541 (2012) 428-432
132. Estimation the Density of Localized State Glassy $\text{Se}_{100-x}\text{Zn}_x$ Thin Films by using Space charge Limited Conduction Measurement
Mohd. Nasir, **M.Zulfequar**
New Journal of Glass and Ceramics 2(2012) 91-97
131. The study of Optical parameters and DC conductivity of $\text{Se}_{100-x}\text{Hg}_x$ thin films
Neetu Chaudhary, Adam A Bahishti, **M Zulfequar**
Physica B 407 (2012) 3868-3871
130. Photoconductivity of $\text{Se}_{85-x}\text{Te}_{15}\text{Hg}_x$ thin films
Neetu Chaudhary, Adam A Bahishti, **M Zulfequar**
Physica B 407 (2012) 2267-2271

129. Determination of Kinnetics parameters of $\text{Se}_{100-x}\text{Zn}_x$ glassy alloys by using an Isothermal methods.
M.Nasir and **M.Zulfequar**
International Journal of Material Physics **3(2012)** 19-29.
128. Charge transport studies in thermally evaporated 2,2',7,7'-tetrakis-(N,N-di-4-methoxyphenyl amino)-9,9'-spirobifluorene (spiro-MeOTAD) thin film
Omwati Rana, Ritu srivastva, Rakhi Grover, **M Zulfequar**, M. Husain, M N Kamalasanan
Synthetic Metals,161(**2011**) 828-832
127. Charge transport study of 2,2',7,7'-tetrakis-(N,N-di-4-methoxyphenyl amino)-9,9'- spirobifluorene using impedance spectroscopy.
Omwati Rana, Ritu srivastva, Rakhi Grover,Gayatri Chauhan, S S Bawa, **M Zulfequar**, M. Husain and M N Kamalasanan
Japanese Journal of Applied Physics 50(**2011**) (in Press)
126. impedance spectroscopic studies of Sol-Gel Derived Nanocrystalline $\text{CaCu}_3\text{Ti}_4\text{O}_{12}$
Ranjit kumar, **M. Zulfequar**, Harjeet Kaur, V. N Singh, and T D Senguttuvan
Advanced science engineering and medicine Vol 3, 1-5, **2011**
125. DC Conductivity and spectroscopic Characterization of Poly (o-toludine) Doped with Binary Dopant $\text{ZrOCl}_2/\text{AgI}$
Kiran Kumari, Vazid Ali, Gita Rani, Sushil Kumar, G.B.V.S. Lakshmi, **M.Zulfequar**
Material Sciences and Application, **2(2011)** 1049-1057
124. Structural and Electrical Characterization of Sintered Silicon Nitride Ceramic.
Imran Khan, **M.Zulfequar**
Materials Sciences and application **2 (2011)** 738-747
123. Chemical Synthesis of CdS nanoparticles and their optical and dielectric studies
Ziaul Raza Khan, **M Zulfequar**, Mohd. Shahid Khan
J Material Science **46 (2011)**, 5412-5416
122. Optical and Structural Properties of ZnO Thin Films fabricated by Sol-Gel Method.
Ziaul Raza Khan, M.Shoeb Khan, **Mohammad Zulfequar**,M.Shahid Khan
Materials Sciences and Applications, **2 (2011)** 340-345.
121. Adsorption properties of thermally stable and biologically active polyurea: its synthesis and spectral aspects
Sumaiya Hasnain, **M. Zulfequar** and Nahid Nishat
Polymers advanced technologies (**2011**) **Accepted**

120. Metal containing polyurethanes from tetradetate Schiff bases: synthesis, characterization, and biocidal activities
Sumaiya Hasnain, **M. Zulfequar** and Nahid Nishat
Journal of Coordination Chemistry **64**(6) (2011), 952-964
119. Structural, optical and gas evolution studies of 60 MeV Si^{5+} ion-irradiated PoT-PVC blends.
G. B.V.S. Lakshmi, D.K. Avesthi, Jai Prakash Azher M. Siddiqui, Vajid Ali and **M. Zulfequar**
Advanced Materials Letters **2**(2) (2011) 125-130.
118. Effect of laser irradiation on optical properties of a- $\text{Se}_{100-x}\text{Te}_x$.
Adam A. Bahisisti M. Husain and **M. Zulfequar**.
Radiation Effects and Defects in Solids **166**(7) (2011) 529-536
117. Thermal Properties of $\text{Se}_{100-x}\text{Zn}_x$ Glassy System
Mohd Nasir, Mohd Abdul Majeed Khan, Mushahid Hussain, **Mohammad Zulfequar**,
Materials Sciences and Applications, **2**, (2011) 289-298.
116. Structural, optical and electrical properties of 60 MeV C^{5+} ion-irradiated poly (3-methiophene) films.
G. B. V. S. Lakshmi, Azher M. Siddiqui and **M. Zulfequar**
Radiation Effects and Defects in Solids **166**(6) (2011) 427-435.
115. Annealing and laser irradiation effects on optical constants of $\text{Ga}_{15}\text{Se}_{85}$ and $\text{Ga}_{15}\text{Se}_{83}\text{In}_2$ chalcogenide thin films.
A.A. Al-Ghamdi, Shamshad A. Khan, S. Al-Heniti, F.A. Al-Agel, **M. Zulfequar**
Current Applied Physics (2010) -In Press
114. Laser wavelength effect on structural and optical properties of $\text{Cd}_{34}\text{Se}_{66}$ nanocrystalline thin film.
Ausama I. Khudiar, **M. Zulfequar**, Zahid H. Khan
Journal of Non-Crystalline Solids **357** (2011) 1264-1269
103. Synthesis and characterization of Se doped polyaniline,
A. Shumaila, G. B. V. S. Lakshmi, Masood Alam, Azher M. Siddiqui, **M. Zulfequar** and M. Husain, Current Applied Physics: **11** (2) (2011) 217-222
112. Synthesis, spectra, and antibacterial screening studies of chelating polymers of bisphenol-A-formaldehyde resin bearing barbituric acid
Nahid Nishat, **M. Zulfequar**, Asma and Sunaiya Hasnain
Journal of Coordination Chemistry **63**(7) (2010), 1273-1281

111. Effect of thickness on structural and optical properties of thermally evaporated Cadmium Sulfide polycrystalline thin films
Ziaul Raza Khan, **M Zulfequar**, Mohd. Shahid Khan
Chalcogenide Letters **7** (6) (**2010**), 431-438
110. Optical and structural properties of thermally evaporated Cadmium Sulphide thin films on Silicon (100) wafers
Ziaul Raza Khan, **M Zulfequar**, Mohd. Shahid Khan
Material Science and Engineering B **174** (2010) 145-149
109. Electrical and Dielectric Properties of MgO-Y₂O₃-Si₃N₄ Sintered Ceramics.
Imran Khan, Nadeem Musahwar, **Mohammad Zulfequar**
Ceramics-Silikaty **54**(3) (2010)263-268.
108. Influence of Pb doping on the structural, optical and electrical properties of nanocomposite Se-Te thin films.
M.A.Majeed Khan, M.Wasi Khan, Mansour Alhoshan, M.S.AlSalhi, A.S.Aldwayyan and **M.Zulfequar**
Journal of Alloys and Compounds **503** (2) (2010), 397-401
107. Structural, optical and electrical characterization of Selenium sulphide nanostructural thin film.
M.A.Majeed Khan, M.Wasi Khan, Mansour Alhoshan, M.S.AlSalhi, A.S.Aldwayyan and **M.Zulfequar**
Materials Letters **64** (17) (2010), 1929-1932
106. Effects of Si⁵⁺ ion irradiation on Poly(3-methyl thiophene) films,
G. B. V. S. Lakshmi, Azher M. Siddiqui and **M. Zulfequar**,
International journal of polymeric **59** (2010) 970-980.
105. Kinetics of non-isothermal crystallization of ternary Se₈₀Te_{20-x}Zn_x glasses,
Anis Ahmad, Shamshad A Khan, A.A.Al-Ghamdi, Faisal A. Al-agel, Kriti Sinha, **M. Zulfequar**, and M. Husain,
Journal of Alloys and Compounds **497**(2010) 215-220.
104. Effects of laser irradiation on optical properties of amorphous and annealed Ga₁₅ Se₈₁In₄ and Ga₁₅Se₇₉In₆ chalcogenide thin films, A.A.Al-Ghamdi, Shamshad A Khan, S.Al-Heniti, F. A. Al-Agel, T.Al-Harbi, and **M. Zulfequar**,
Journal of Alloys and Compounds **505** (2010) 229-234.
103. Nd: YAG Laser-Induced effects on the Structural and optical properties of Nanostructured CdS thin film,
Ausama I. Khudiar, Siddhartha, **M. Zulfequar**, and Zahid H. Khan,
Chalcogenide letters **7**(5)(2010) 291-298.

102. Nano and Microstructures of Selenium Oxide by thermal Evaporation, Karunapati Tripathi, M. Husain and **M. Zulfequar** Chalcogenide letters 6(9)(2009) 517-522.
101. Synthesis and characterization of thin films of poly (3-methyl thiophene) by rf-plasma polymerization and characterization of polyaniline, G. B. V. S. Lakshmi, Anju Dhillon, D.K. Avasthi, Azher M. Siddiqui, **M. Zulfequar**, Materials letters **64 (2010)** 1672-1673.
100. Electrical transport mechanism in a-Se₉₅M₅ films(M=Ga,Sb,Bi) M. A. Majeed Khan, Sushil Kumar, M. Wasi Khan, M. Husain and **M. Zulfequar**, Materials Research Bulletin 45(2010) 727-732.
99. Structural Characterization and Anomalous Dielectric Behaviour of (Si₃N₄)_x (V₂O₅)_{100-x} Ceramics Imran Khan and **M. Zulfequar** Physica B 405(2) (2010) 579-585
98. Electrical transport and optical properties of Zn doped Bi-Se chalcogenide glasses M. A. Majeed Khan, M. Wasi Khan, M. Husain and **M. Zulfequar**, Journal of Alloys and Compounds 486(1-2) (2009) 876-880.
97. Effect of laser irradiation on thermal and optical properties of selenium-tellurium alloy, Adam A. Bahisti, M. A. Majeed Khan, B. S. Patel, F. S. Al-Hazmi and **M. Zulfequar** Journal of Non-Crystalline Solids **355 (2009)** 2314-2317.
96. Rf-plasma polymerization and characterization of polyaniline, G. B. V. S. Lakshmi, Anju Dhillon, Azher M. Siddiqui, **M. Zulfequar** and D. K. Avasthi, European Polymer Journal **45 (2009)** 2873-2877.
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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 **International Center 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 Condensed Matter Physics, Department of Physics, Jamia Millia Islamia, New Delhi, March 06-07, 1997.
22. Participated in the National Seminar on Materials Research and Environmental Issues, Department of Physics, Jamia Millia Islamia, New Delhi, Oct. 23, 1997.
23. (i). *Calculation of Number of Electrons Participating in Plasmon Oscillations Using Chemical Shift of the X-ray Absorption Edges Data.*
(ii). *X-ray K-absorption edge of Glassy Semiconducting Ga-Se Alloys.*
VIth National Seminar on X-ray Spectroscopy and allied Areas, Govt. P.G. Arts and Science College, Ratlam (MP) (Nov. 17-19, 1997).
24. (i). *Compositional dependence optical studies of a-Se-Ga-Sb thin films.*
(ii). *Thermal Studies of a- $Se_{80-x}Ga_{20}Te_x$ Thin Film.*
(iii). *Electrical and Dielectric Studies of a- Ga_xSe_{100-x} Alloys.*
International Workshop on Physics of Semiconductors Devices, held at New Delhi (Dec. 16-21, 1997).

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).
26. Dielectric studies in a-(Se₇₀Te₃₀)_{100-x}(Se₉₈Bi₂)_x system
Regional Workshop on Characterization of semiconductor Nano- structures and their Applications to Opto-electronic Devices.(Dec.01-04,1998), Department of Electronic Sciences, University of Delhi (South Campus) New Delhi-110021.
27. *Estimation of Density of States of a-Ga-Se Alloy.*
Presented in National Seminar on Physics of Materials for Electronic and Optoelectronic Devices (March 08-10, 1999), Department of Physics, JNV University, Jodhpur.
28. *A study of the density of localized states in a-Se_{100-x}Bi_x.*
Presented in National Conference on Semiconductor Materials & Recent Technologies (Nov. 1 -3, 1999), Department of Physics, G.B.Pant University, Pantnagar.
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-(Ga₅Se₉₅)_{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.
30. (i)*Optical properties of Glassy Ga₁₀Te_{90-x}Sb_x*
(ii)*Optical & Electrical properties of Bi_xSe_{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}Te₂₂Bi_x.*
Presented in **Indo-Japanese Workshop** on Micro System Technology (Nov. 23-25 ,2000), at Delhi University, Delhi , Organized by Solid State Physics laboratory, Delhi, Delhi University Delhi & Toyoshashi University, Japan.
32. (I) *Optical and Electrical properties of a-Ga₅Se_{95-x}Sb_x alloys.*
(ii)*A Study of Transient Photoconductivity in a-Ga₂₀Se_{80-x}Bi_x Semiconducting 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 Society Of India, New Delhi & National Physical Laboratory ,New Delhi .
35. *Thermal properties of a- $Se_{100-x}Bi_x$ Glasses.*
 Proceeding of BSME-ASME International Conference on Thermal Engg., Dhaka, Page No. 565-570, 2001.
36. (i)*Crystallization kinetics in a- $Ga_5Se_{95-x}Sb_x$ by Differential Scanning Calorimetry.*
 Proceeding of the Sixth Asian Thermophysical Properties Conference (ATPC-2001), Guwahati University, Guwahati, Assam., Vol. II, Page No. 478-483, Oct. 08-11 2001
- (ii)*Estimation of Density of Localized State of a- $Se_{78-x}Te_{22}Bi_x$ using Electrical Prperties*
 Proceeding of the Sixth Asian Thermophysical Properties Conference (ATPC-2001), Guwahati University, Guwahati, Assam., Vol. I, Page No. 138-143, Oct. 08-11 2001
- (iii)*Electrical Properties of a- $(Se_{70}Te_{30})_{100-x}(Se_{98}Bi_2)_x$ alloys.*
 Proceeding of the Sixth Asian Thermophysical Properties Conference (ATPC-2001), Guwahati University, Guwahati, Assam., Vol. II, Page No. 744-749, Oct. 08-11, 2001
37. *Optical Study of a- $Ge_5Se_{95-x}Te_x$:Effect of Crystallization.*
 Proceeding of the XIth International Workshop on The Physics of Semiconductor Devices SSPL, New Delhi, India, Vol. II, Page No. 1300-1303, Dec.,11-15, 2001
38. *Thermal Properties of a- $Se_{100-x}Bi_x$ 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 Chennai (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
Thirteen **International Workshop** on Physics of Semiconductors Devices, held at NPL New Delhi, 2 (2005) 1449-1452
- (ii). *Dielectric Properties of Se-S glassy alloys*
Nadeem Musahwar, **M. Zulfequar**, M. Husain
Thirteen **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
Thirteen **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
Thirteen **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
Sadia Ameen, Vazid Ali, **M. Zulfequar**, M. Husain
Thirteen **International Workshop** on Physics of Semiconductors Devices, held at NPL New Delhi, 2 (2005) 952-955
Proceedings of the 13th **International Workshop** on Physics of Semiconductors Devices,
held at NPL New Delhi (Dec. 13-17, 2005)
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 Nanotechnology, 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. Siddiqui, 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 Synthesized using 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 Y₂O₃ 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, Monika Chahar, Vazid Ali, Sushil kumar, G.B.V.S.Lakshmi, M.Zulfequar and M.Husain

- (iii) DC conductivity and spectroscopic Characterization of Binary Dopant (ZrOCl₂/AgI) 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, Ausama I. Khudiar , M.Zulfequar and Zahid H. Khan.
 - (viii) Optical and surface Characterization of Nano-Se₇₀Te₃₀-XZnX Alloy System. Karunapati tripathi, 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 a department 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 Sensors, 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, **Avshish Kumar**, Samina Husain, Shama Parveen, Javid Ali, M. Zulfequar, Harsh, M.Husain, presented poster presentation in “17th International

Workshop on the Physics of Semiconductor Devices 2013, at Amity University, Noida, From 10-14 December 2013

60. 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.
61. Dc conductivity and High Field Behavior of Se_{100-x}Tex 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
62. Study of Optical Parameters of the Thin Films of Se_{100-x} Hg_x 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
63. Welcome address in Abdus Salam Memorial Lecture, at a department of Physics, JMI , 17 Feb., 2014

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- $\text{Se}_{100-x}\text{Sb}_x$ (where $x = 0, 0.5, 2.5, 5$ and 10)
- (ii) a- $\text{Se}_{100-x}\text{Bi}_x$ (where $x = 0, 0.5, 2.5$ and 5)
- (iii) a- $\text{Se}_{78-x}\text{Te}_{22}\text{Bi}_x$ (where $x = 0, 0.5, 2$ and 4)
- (i) a- $\text{Bi}_{0.5}\text{Se}_{99.5-x}\text{Zn}_x$ (where $x = 0, 0.1, 0.2, 0.5$ and 1)
- (v) a- $\text{Se}_{80}\text{In}_{20-x}\text{Pb}_x$ (where $x = 2, 4, 6$ and 10)
- (vi) a- $\text{Ga}_5\text{Se}_{95-x}\text{Sb}_x$ (where $x = 0, 1, 5$ and 10)
- (vii) a- $\text{Se}_{80}\text{Te}_{20-x}\text{Pb}_x$ (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°), 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 \times 2mm \times 20mm
 - (ii) **Type B detector:** 2.5 Ω -cm, p-type, 2.5mm \times 2.5mm \times 30mm
- (b) Responsivity and response time of the detectors for CO₂ 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/cm²

(B) Designing and Fabrication of TEA CO₂ 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 Ω carbon 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 μ F 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 μ s. 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.

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 $\sim 10^{-6}$ 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

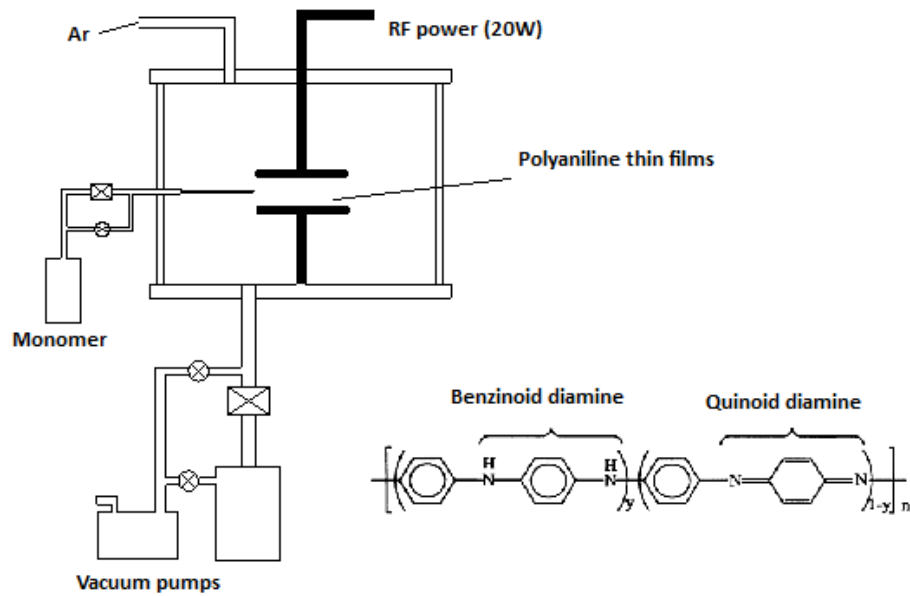
The UV-Visible absorption spectra have been carried out in the wavelength range 190-900 nm. From UV-Visible studies various optical properties of polymers as optical band gap, extinction co-efficient and the absorption co-efficient have been studied. Measurement of these properties is important to use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



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/cm³), 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.

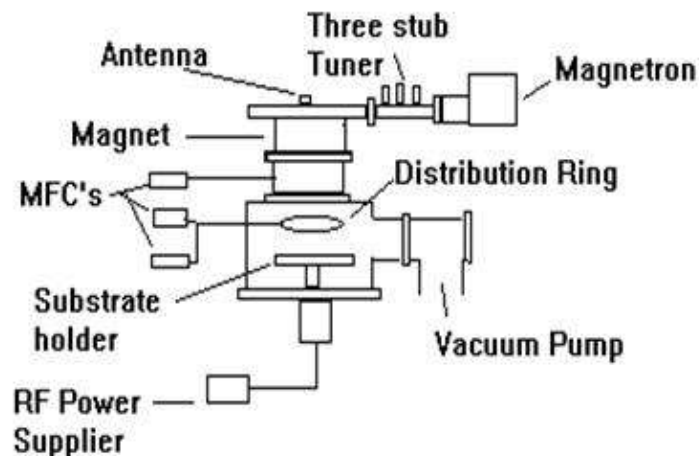


Fig.1 ECR Etching System

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 thermal shock 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 Y₂O₃ 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 $\tan\delta$ which is consistent with space charge polarization mechanism. Electrical Conductivity and dielectric properties of Silicon Nitride Ceramics reports the effects of different additives (different oxides like Y₂O₃, MgO, V₂O₅ and ZnO and chalcogens such that Te, and Se) on the structural and electrical and dielectric properties of sintered Si₃N₄ 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 multiwall carbon 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.