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Born: 27th June 1978
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Husband's name: Prof. Prasanta Sanyal

EDUCATION

- **PhD in Materials Science (Polymer science and Engineering) from Materials Science Centre, Indian Institute of Technology Kharagpur, India** in **2004-2007, Title of the thesis:** 'Effect of fluorination and oxy-fluorination of Kevlar fiber on the properties of short fiber reinforced polymer composites and its mold flow simulation study'.

- **Bachelor of Education from Institute of Education (Post Graduate) for women, Chendernagore, Hooghly, University of Burdwan, India in 2002-2003.**

- **Master of Science in Chemistry (Inorganic special) from Department of Chemistry, University of Burdwan, India in 1999-2001, M. Sc. Project title:** 'Metal Mediated C-N Coupling Reaction, A Case of Platinum (II) complexes of arylazopyridines'.

- **Bachelor of Science in Chemistry (Hons) with Physics, Mathematics and Bengali as Compulsory language from Department of Chemistry, Chandernagore Govt. College, University of Burdwan, India in 1996-1999.**

AWARDS

- **July, 2013-January,2017** **Fast Track Young Scientist, DST (Department of Science and Technology, India),** "Development of Graphene-Polynorbornene Novel Composite Materials for Aircraft Application" Indian Institute Science Education and Research Kolkata, India, **Highlighted in the Research Highlight in SERB Young Scientist Scheme, START-UP RESEARCH GRANT, Engineering Sciences, Page no. 69.**
- **2009** **Post Doctoral Research Fellow,**"Reinforcements of Polyolefins" Nanyang Technological University (NTU), Singapore
- **2008-2009** **CSIR-Research Associate,** "Development of Carbon Nanotubes-Polymer Nanocomposites", Indian Institute of Technology Kharagpur, India.
- **2007-2008** **Research Associate,** DRDO sponsored project, "Development of Novel Polyphosphazene Based High Performance Polymeric Composites for Wide Temperature Range Application", Indian Institute of Technology Kharagpur, India.

ACADEMIC ACHIEVEMENTS:

- National Scholarship (Govt. of India) 2001
- Graduate Aptitude Test in Engineering (GATE) – 2004.
- Recipient of the award of fellowship by Department of Science and Technology, Government of India for Ph.D (IIT, Kharagpur).
- Research Associateship by Defence Research and Development Oganization, Government of India, (IIT, Kharagpur)
- Research Associateship by Council of Scientific and Industrial Research, Government of India, (IIT, Kharagpur)
- Research Fellowship by School of Materials Science and Engineering, Nanyang Technological University, Singapore.
- Fast Track Young Scientist by Department of Science and Technology, India (Indian Institute of Science Education and Research Kolkata), **Highlighted in the Research Highlight in SERB Young Scientist Scheme, START-UP RESEARCH GRANT, Engineering Sciences, Page no. 69.**

TECHNICAL EXPERTISE

Polymer Modification & Processing:

- **Polymer Composites**

  Ethylene Polypropylne copolymer (EP)/ unmodified, fluorinated and oxy-fluorinated Kevlar fiber
  Syndiotactic polystyrene s-PS)/ unmodified, fluorinated and oxy-fluorinated Kevlar fiber
  Polyetherimide (PEI) /Liquid crystalline Polymer (LCP) /Multi-walled Carbon nanotube (MWCNT)
  Polycarbonate (PC) / Liquid crystalline Polymer (LCP) /Multi-walled Carbon nanotube (MWCNT)
  Polyethylene (PE) / Glass fiber and thermoplastic elastomers
  Polynorbornene/Graphene Composites

- **Polymer Blends**

  Polycarbonate (PC) / Liquid crystalline Polymer (LCP)/ unmodified, fluorinated and oxy-fluorinated Kevlar fiber
  Nylon 6,6/ Liquid crystalline Polymer (LCP) and Polyphosphazene
  Synditactic polystyrene (s-PS)/ Liquid crystalline Polymer (LCP) and Silicone Rubber
  Polyetherimide (PEI)/Liquid crystalline Polymer (LCP) and Polyphosphazene
  Polyetheretherketone (PEEK)/Liquid crystalline Polymer (LCP) and Poly phosphazene
  Polyethersulfone (PES)/Liquid crystalline Polymer (LCP) and Polyphosphazene

- **Surface Modification**

  Surface modification of various micro and nanofillers such as

i) Kevlar fiber by direct fluorination and oxy-fluorination
ii) Multi-walled carbon nanotubes by carboxylation and amide modification
iii) Graphene by oxidation, carboxylation and amidation.

LABORATORY EXPERIENCE:

- **Melt Mixing**
  - Brabender plastic corder
  - Sigma high temperature internal mixer
  - Open two roll mixing mill
  - Twin-screw extruder (19mm, 25 L/D)
  - Compression Press
  - Injection molding
- **Synthesis of monomers and polymers**
  - Synthesis of norbornene monomers
  - Polymerization of norbornenes by ROMP technique

- **Polymer Testing & Characterization**
  - Handling and maintaining various instruments related to chemistry and polymer science and engineering as followed:

Tensile Testing (UTM), XRD (X-ray Difractometer), DTA-TGA Thermogravimetric Analysis), DSC (Differential Scanning Calorimetric) study, DMTA (Dynamic Mechanical Thermal Analysis), FTIR (Fourier Transform Infrared Spectroscopy) , SEM (Scanning Electron Microscopy), FESEM (Field Emission Scanning Electron Microscopy), TEM (Transmission Electron Microscopy), AFM Atomic Force Microscopy), TMA (Thermal Mechanical Analysis), Optical microscopy, Capillary Rheometer, Melt Flow Rate (MFR),Thermal conductivity (Holomax, C-Matic), Curing Study (Monsanto Rheometer), Gel Permeation Chromatography (GPC), Raman Spectroscopy.

LIST OF PUBLICATION:

In International Journals:

1) **Mukherjee. M.,** Mukherjee. S., Kumar. R., Shunmugam R**.** Improved thermal and mechanical properties of polynorbornene upon covalent attachment with graphene sheets, ***Polymer.*** **2017, 123, 321-333** (Citation = 6)

2) **Mukherjee. M.,** Gonivada. M. N., Venu. P., Kanjilal. P., Shunmugam. R. Unique Nanotubes from Polynorbornene Derived Graphene Sheets, ***RSC Advances*. 2016, 6, 40691-40697** (Citation = 4)

3) Pal. K., **Mukherjee. M**., Frackowiak. S., Kozlowski. M., Das. C.K. Improvement of the physico-mechanical properties and stability of waste polypropylene in the presence of wood flour and (maleic anhydride)-grafted polypropylene, ***J. Vinyl. Addit.Technol.*** **2014, 20 (1), 24-30**. (Citation = 6)

4) **Mukherjee. M.,** Bose. S., Nayak. G. C., Das. C. K. A study on the properties of PC/LCP/MWCNT with and without compatibilizers, ***J. Polym. Res***. **2010, 17(2), 265-272.** (Citation = 17)

5) Bose. S**., Mukherjee. M.,** Pal. K., Nayak. G, Das. C. K. Development of Core-Shell structure aided by SiC-coated MWNT in ABS/ LCP blend, ***Polymer. Adv. Tech***. **2010, 21(4), 272-278**. (Citation = 7)

6) **Mukherjee. M**., Das. T., Rajasekar. R., Bose. S., Kumar. S., Das. C.K. Improvement of the properties of PC/LCP blends in the presence of carbon nanotubes, ***Compos. Part A-Appl s***. **2009, 40(8), 1291-1298**. (Citation = 31)

7) **Mukherjee. M.**, Nayak. G. C., Bose. S., Das. C. K., Improvement of the properties of PC/LCP/MWCNT with or without silane coupling agents, ***Polym-Plast. Technol**. **Eng.*** **2009, 48(11), 1107–1112**. (Citation = 16)

8) Bose. S., **Mukherjee. M.**, Das. C. K., Ranjan. A., Saxena. A. K. Effect of Modified MWCNT and Polyphosphazene Elastomer on the properties of PES/LCP blend System, ***J. Nanosci. Nanotechnol.*** **2009, 9 (11), 6569-6578**. (Citation = 11)

9) Bose. S., **Mukherjee. M.**, Das. C. K., Saxena. A. K. Effect of polyphosphazene elastomer on the compatibility and properties of PES/TLCP composites, ***Polym. Compos.*** **2009, 31(3), 543 -552**. (Citation = 15)

10) Bose. S., **Mukherjee. M**., Das. C. K. Silicone rubber compatibilized Syndiotactic polystyrene and Thermotropic Liquid Crystalline Polymer (Vectra A950) blend, ***Polym-Plast. Technol. Eng.*** **2009, 48(2), 158-163**. (Citation = 11)

11) **Mukherjee. M**., Das. T., Das. C. K., Kharitonov. A. P., Banik. K, Chung. T. N., Mennig. G. Simulation of Fibrillation of PC/LCP/Kevlar Blends and Its Chracterizations, ***Macromolecular Symposia***, **2009, 277(1), 24-35**. (Citation = 1)

12) Bose. S., **Mukherjee. M**., Rath. T., Das. C. K., Effect of polyphosphazene elastomer on the properties of blend of Nylon 6, 6 and a Thermotropic Liquid Crystalline Polymer (Vectra A950), ***J. Reinf. Plast. Compos.*** **2009, 28(2), 157-166**. (Citation = 9)

13) Roy. S., Sahoo. N. G., **Mukherjee. M.**, Das. C. K., Chan. S. H., Li. Lin. Improvement of Thermal and Mechanical Properties of PEI/LCP Blends in the Presence of Functionalized Carbon Nanotubes, ***J. Nanosci. Nanotechnol.*** **2009, 9(3), 1928-1934.** (Citation = 8)

14) **Mukherjee. M.**, Kumar. S., Bose. S., Das. C. K., Kharitonov. A. P., Study on the Mechanical Rheological and Morphological Properties of Short Kevlar Fiber/s-PS Composites, ***Polym-Plast Technol**. **Eng***. **2008, 47(6), 623-629**. (Citation = 11)

15) **Mukherjee. M.**, Das. C. K., Kharitonov. A. P. Effect of Compatibilizer on the Properties of Fluorinated and Oxy-fluorinated Short Kevlar fiber Reinforced Ethylene Propylene Matrix Composites, ***J. Reinf. Plast. Comp.*** **2008, 27(5), 523-539**. (Citation = 7)

16) Rath. T., Kumar. S., Mahaling R. N., **Mukherjee. M.**, Das. C. K., Pandey. K. N., Saxena. A. K., Flexible composite of PEEK and liquid crystalline polymer in presence of polyphosphazene, ***J. Appl. Polym. Sci***. **2007, 104(6), 3758-3765**. (Citation = 19)

17) **Mukherjee. M.,** Das. C. K., Kharitonov A. P. Fluorinated and oxy-fluorinated short Kevlar fiber-reinforced ethylene propylene polymer, ***Polym.Compos.*** **2006, 27(2), 205-212**. (Citation = 51)

18) **Mukherjee, M.**, Das. C. K., Kharitonov. A. P., Banik. K., Mennig. G., Chung. T. N. Properties of Syndiotactic Polystyrene Composites with Surface Modified Short Kevlar Fiber, ***Mat. Sci. Eng A- Struct*. 2006, A441 (1-2), 206-214**. (Citation = 54)

19) **Mukherjee. M.,** Das. C. K., Kharitonov A. P. Influence of fluorinated and oxy-fluorinated short Kevlar fiber loading on the properties of ethylene propylene matrix composites, ***Mater. Manuf. Process*. 2006, 21(8), 892-898**. (Citation = 5)

20) Rath. T., Kumar. S., Mahaling. R. N., **Mukherjee. M.**, Das. C. K., Pandey. K. N., Saxena. A. K., The flexible PEI composites, ***Polym. Compos*. 2006, 27(5), 533-538**. (Citation = 10)

Papers presented in national and international conferences:

1) Polynorbornene Grafted Graphene as Hybrid Functional Materials, **M. Mukherjee**, M. N. Gonivada, R. Shunmugam, Macro-2015, IACS, Kolkata, India.
2) Recycling of Waste PP by Wood Flour and MAH-g-PP", K. Pal, **M. Mukherjee**, S. Bose, R. Rajasekar, S. Frackowiak, M. Kozlowski, C. K. Das, "International Conference on Hi-Tech Materials (ICHTM-09), Kharagpur, February 11-13, 2009.
3) Development of Core-Shell structure aided by SiC-coated MWNT in ABS/ LCP blend, S. Bose, **M. Mukherjee,** K. Pal, G. C. Nayak, C. K. Das, Kharagpur, International Conference on Hi-Tech Materials (ICHTM-09), February 11-13, 2009.
4) Effect of type of Kevlar fiber on the properties and flow behavior of s-PS/Kevlar composites, **M. Mukherjee,** R. Rajasekar, K. Pal, C. K. Das, T. N. Chung, G. Mennig, PPS-25, '09, Goa, India.
5) Process-Morphology Interrelation Using Hot-Tool Welding of Thermoplastic Nanocomposites, **M. Mukherjee**, C. K. Das, S. Friedrich, M. Gehde, ICHTM'09, Indian Institute of Technology, Kharagpur, India.
6) Simulation of fibrillation of the PC/LCP/Kevlar blends, **M. Mukherjee**, C. K. Das, A P. Kharitonov, K. Banik, G. Mennig, T.N. Chung, Polychar-16, '08, Lucknow, India.
7) Improvement of the Properties of PC/LCP Blends in the Presence of Carbon Nanotubes, **M. Mukherjee**, T. Das, R. Rajasekar, C. K. Das, Chemical Congress '08, Nepal.
8) Simulation of the Fiber Orientation of Kevlar in s-PS/ Kevlar Composites-Effect of Fluorination and oxy-fluorination of Kevlar Fiber on the Properties and Processibility, **M. Mukherjee**, C. K. Das, A. P. Kharitonov, K. Banik, G. Mennig, T. N. Chung, ICPP '07, Beijing, China.
9) Effect of compatibilizers on the properties of short Kevlar fiber reinforced EP Polymer, **M. Mukherjee**, A. P. Kharitonov, C. K. Das, ETPST'05, Indian Institute of Technology, Kharagpur, India.
10) Effect of fluorination and oxy- fluorination on short Kevlar fiber reinforced EP Composites, **M. Mukherjee**, A. P. Kharitonov and C. K. Das, 19th rubber conference, IRMRA'05, Mumbai, India.

Book Chapter

Handbook of Vinyl Polymers: Radical Polymerization, Process, and Technology, Second Edition
Chapter 15: Fiber Filled Vinyl Polymer Composites, pp. 456-495, Publisher CRC, USA
M. mukherjee, T. Das, C. K. Das

Papers Reviewed

International Journal –Composites Part A: Applied Science and Manufacturing
Journal of Polymer Research
Journal of Membrane Science
Journal of Applied Polymer Science
Journal of Materials Science and Chemical Engineering
Journal of Macromolecular Science, Part A: Pure and Applied Chemistry

Research Experience

- Investigated the effect of direct fluorination and oxy-fluorination on the properties of short fiber reinforced polymer composites. Kevlar fiber as reinforcement and various types of thermoplastic matrix like ethylene propylene copolymer (EP), syndiotactic polystyrene (s-PS) and poly carbonate (PC) were taken for this research purpose. The compatibilizing effect of various compatibilizers in EP/Kevlar system has investigated.

- Investigated fiber orientation in fluorinated and oxy-fluorinated Kevlar/ Syndiotactic (s-PS), Polycarbonate (PC) composites under different processing condition. Correlation of various physico-chemical properties with the fiber orientation of the said composites has been explored. Simulation of fiber orientation has been done using Mold Flow Simulation Technique.

- Developed processing technique of high viscous polymers such as Poly(etherimide) (PEI), Poly (ether ether ketone) (PEEK), Poly((ether sulfone) (PES), Syndiotactic Polystyrene (s-PS), Nylon 6,6 by introducing Liquid Crystalline Polymers (LCP, Vectra A and C).

- Fabricated flexible polymer composites using various elastomers such as polyphosphazene and silicone rubbers.

- Investigated the effect of functionalized carbon nannotubes (f-MWCNTs) in the PC/LCP, PEI/LCP blends. Better dispersion of f-MWCNTs has been achieved by using different compatibilizers to achieve better thermal, mechanical and crystalline properties of the resulting composites.

- Developed the core-shell morphology of Silicone carbide coated MWCNTs in Acrylonitrile butadiene styrene rubber (ABS)/LCP blends.

- Synthesized norbornene based monomers and polymers and evaluated the morphology of the graphene aided polynorbornenes along with various physico-chemical characterizations.

Work Summary

The project was conceived with the aim of improving mechanical properties, thermal stability, dynamic mechanical properties of polymer composites for aerospace and microelectronics and defense applications. The matrix materials studied were Ethylene propylene copolymer (EP) for easy availability, syndiotactic polystyrene (s-PS) and Polycarbonate (PC) for high temperature applications. Kevlar fiber was used with dual aim for use as reinforcement. Kevlar fibers were sourced from Du Pont, USA (Grade- 1100 dtex). In the present work, EP /unmodified, fluorinated and oxy-fluorinated Kevlar fiber composites were developed through melt process using brabender mixer and then compression molded for property evaluation. s-PS/ unmodified, fluorinated and oxy-fluorinated Kevlar and Polycarbonate/unmodified, fluorinated and oxy-fluorinated Kevlar fiber composites were prepared using twin-screw extruder and then molded in a injection molding mechne.

Thermal properties were characterized using DSC and TGA, while morphologies and phase analysis of the composites were studied by SEM and AFM. The effect of unmodified, fluorinated and oxy-fluorinated Kevlar fiber on crystallanity of EP, s-PS and PC was also studied using X-ray diffraction.

In case of EP/ Kevlar composites, it was observed that the addition of fluorinated and oxy-fluorinated Kevlar fiber into the EP matrix appreciably increased the thermal stability, storage modulus as well as crystallinity. This enhancement is noticeable incase of oxy-fluorinated Kevlar/ EP composites. Mechanical properties also improved very much incase of treated composites. These results were corroborated with that of the SEM study. These improved properties of treated composites can be ascribed as the better adhesion taken place at the fiber/matrix interface caused by the introduction of functional groups on to the Kevlar surface by surface fluorination and oxy-fluorination (Paper published in Polymer Composites).

In second phase of work MA-g-PP was blended with EP/unmodified and modified Kevlar composites with the hypothesis that compatibilizer generates more functional groups onto the matrix surface giving rise to better adhesion onto the matrix as well as fiber surface. In our study, improved thermal, dynamic mechanical crystalline as well as rheological properties as a result of better adhesion between the fiber and matrix at the interface were observed. The compatibilizing effect is much more pronounced in case of oxy-fluorinated Kevlar /EP composites in comparison to the untreated and fluorinated Kevlar/EP composites at higher compatibilizer content (Paper published in Journal of reinforced Plastics and Composites, in press).

The effects of surface modified Kevlar fibers, fiber loading and the resultant crystalline, thermal, dynamic mechanical and morphological properties of Kevlar fiber and thermoplastic ethylene- propylene polymer composites have also been discussed here. Incorporation of surface modified Kevlar fibers enhances the crystallization of the matrix through heterogeneous nucleation compared to unmodified Kevlar fiber. Modified Kevlar fiber reinforcement significantly improved thermal stability of the composites as evidenced by thermo gravimetric analysis. Dynamic mechanical analysis shows that an increase in the storage modulus is more pronounced in case of surface modified Kevlar fibers. The physico-chemical properties also improved with high fiber content in the composites (Paper published in Materials and Manufacturing Processes).

In case of s-PS/ unmodified and modified Kevlar composites crystallinty was measured by X-ray study. The crystallization temperature shifts to a higher value in case of unmodified and fluorinated Kevlar fiber reinforced composites in comparison to the oxy-fluorinated one. Kevlar fibers enhance the crystallization of the matrix through heterogeneous nucleation. Modified Kevlar fiber reinforcement significantly improved the thermal stability of the composites as evidenced by the Thermogrvametric analysis (TGA). Dynamic Mechanical Analysis and Differential Scanning Calorimetry show the shift of T_g to slightly higher value in case of modified Kevlar fiber reinforced s-PS in comparison to the unmodified derivative. This is because of the more fiber/matrix interaction in case of modified Kevlar fiber/s-PS (Paper published in Materials Science and Engineering A and Polymer Plastics Technology and Engineering, in Press).

In the second phase of work with s-PS/Kevlar system, the composites were melt blended in a twin-screw extruder and the injection molded under different processing parameters. Various physicochemical properties were studied and the effect of molding parameters on these properties has been thoroughly investigated. These properties have been corroborated with the fiber orientation pattern in the composites using mold flow simulation study. Modified polymer composites exhibit better thermal as well as crystalline properties in comparison to the unmodified composite as evidenced from differential calorimetric study and X-ray diffraction study due to better adhesion between fiber and the matrix at the interface. Thermal and crystalline properties of the composites remarkably vary with the processing parameters. There is an optimum condition under which composites along with the virgin polymer possess superior crystalline and thermal properties. The variation of magnitude of the orientation tensor with the normalized thickness has been reported, which clearly depicted that fiber orientation varies very significantly with the processing parameters in the skin as well as in the core region. SEM micrographs show more surface adhesion in case of modified Kevlar/s-PS composites (Paper under review, Plastic Rubber and Composites).

During my research period, I have also studied the effect of surface medication of the Kevlar fiber by direct fluorination and oxy-fluorination into the PC/liquid crystalline polymer blends. Liquid crystalline polymers were investigated as possible reinforcements to improve thermal, mechanical and morphological properties of PC matrix. On the other hand Kevlar fiber also acts as reinforcements in the PC/LCP systems. Surface modification of Kevlar fiber by fluorination and oxy-fluorination further augments the thermal, dynamic mechanical and crystalline properties of the concerned blends. Mold flow simulation technique was used to evaluate the fiber orientation of the composites under different processing parameters. Mold flow simulation technique revealed that fiber orientation is different in the skin region as compared to the core region and also it varied under different processing parameters (Paper published in Macromolecular Symposia).

My research work also included the enhancement of flexibility of PEI, PEEK, Nylon 6,6 and thermotropic liquid crystalline polymer blends in presence of polyphosphazene Being an inorganic elastomer, polyphosphazene offered significant enhancement of flexibility and enhanced compatibility between the PEI, PEEK, Nylon and PES and thermotropic liquid crystalline polymers. (Papers published in Polymer Composites (2), Journal of Applied Polymer Science, Journal of reinforced Plastics and Composites, and paper under review in Plastic Rubber and Composites.).

Effect of Silicone rubber as an effective compatibilizer and elastomer in s-PS and LCP blends has been revealed in my research work (paper published in Polymer-Palstics Technology and Engineering).

My research work also encompassed the effectiveness of MWCNTs in various thermoplastics (PEI, PC, and PES) and LCP systems by means of enhanced thermal and mechanical properties (Papers published in Composites part A, Journal of Nanoscience and Nanotechnology (3), Journal of polymer Research, Polymer Plastics Technology and Engineering). Addition of SiC coated MWCNT enhanced the thermal and mechanical properties giving rise to core-shell morphology in Acrylonitrile butadiene styrenic rubber (ABS) and LCP blend (Papers published in Polymers for Advanced Technology).

As a DST Fast Track Fellow, I successfully synthesized norbornene based monomers and polymerized the as-synthesized monomer by Ring Opening Metathesis Polymerization. Then developed the novel composite materials with synthesized polymer and functionalized Graphene oxide (Paper published in RSC Advances). Self assembly of the nanoaggregates was studied thoroughly in different organic solvents. Nice tubular aggregates were found in THF, which can be evaluated as carriers of GN dopant in solar cells. Further, superior mechanical and thermal properties were achieved with excellent solubility in case of graphene derived polyorbornene systems (manuscript is under preparation). Noncovalent attachment of graphene in polynorbornes was also explored by π-π stacking. Spherical morphology was noticed, which can be explored in photovoltaic cells and solar cells.

RESEARCH STATEMENT

My research interest encompasses fabrication and detailed study of the micro, nano polymeric composites and their applicability in the defence, microelectronics, aerospace and day to day life. The main component of my research work is to enhance the compatibility between the reinforcements and various polymeric matrices by surface modification of the reinforcing materials or by using effective compatibilizers into the resulting composites. This modification resulted hybrid composites of improved mechanical, electrical, thermal and crystalline properties. The compatibility of the constitute materials was demonstrated by the various morphological studies. These studies include spectral analysis (Fourier Transform Infrared Spectroscopic Study), Scanning Electron Microscopic studies, and Transmission Electron Microscopic studies. Hence it is very important to integrate all the data obtained from different studies to achieve hybrid composites of improved properties as compared to virgin polymeric materials for the application of various fields in recent scenario. Hence, my research planning in near future is to obtain novel polymeric hybrids of high performance application using different micro and nano-reinforcements applicable in defence, microelectronics, nano-electronics, aerospace, photolithography and also commodity applications. In the long run I want to contribute in various multi disciplinary projects dealing with the development of micro and nano-composites of biocompatibility which can be used in different medical applications such as bone transplantation, artificial muscle design etc. I am keen to develop polymers of photo activity so that it can be used in photolithography for generating semiconductor circuits for IC, logic gates and PCB for sensors and biosensors. I am interested to collaborate with the experts in the relevant fields from different part of the world and build up a well equipped laboratory in your premiere institute in cooperation of the fellow colleagues.