Dr. Narayan Chandra Das

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ACADEMIC QUALIFICATION

S.No.	Degree	Year	Subject	University/Institution
1.	B. Sc.	1992	Chemistry (Major)	Calcutta University
2.	B. Tech.	1996	Polymer Science and Technology	Calcutta University
3.	M. Tech.	1998	Rubber Technology	IIT, Kharagpur
4.	Ph. D.	2002	Rubber Technology	IIT, Kharagpur

WORK EXPERIENCE

S.No.	Positions held	Name of the Institute	From	To
1.	Lecturer	Thaper University, Punjab, India	02/05/2001	22/04/2002
2.	Post-doctoral	K U Leuven, Belgium	22/04/2002	17/07/2002
3.	Part time lecturer	Hiroshima University, Japan	22/07/2002	21/07/2004
4.	Postdoctoral Researcher	Michigan Technological University, USA	05/05/2005	14/08/2006
5.	Research Associate	SUNY Binghamton, New York, USA	15/08/2006	04/02/2009
6.	Research Professor	Indiana University, Bloomington, USA	05/02/2009	24/06/2013
7.	Visiting Professor	IIT Kharagpur, India	07/07/2013	04/02/2015
8.	Associate Professor	IIT Kharagpur, India	05/02/2015	21/12/2022
9.	Professor	IIT Kharagpur, India	22/12/2022	Till to date

PROFESSIONAL RECOGNITION/ AWARD/ PRIZE/FELLOWSHIP RECEIVED

S.No	Name of Award	Awarding Agency	Year
1.	Early career award	SERB, DST, India	2016
2.	Faculty Excellence Award	IIT Kharagpur	2019
3.	Top cited author award	Institute of Physics (IOP)	2019
4.	Top Cited author award (Two)	Royal Society of Chemistry (RSC)	2019
5.	Faculty Researchers World Top 2% Scientists	Stanford University, USA	2019
6.	Top Cited Author Award	American Chemical Society (ACS), USA	2022
7.	Faculty Excellence Award	IIT Kharagpur	2022

PhD THESIS AND SUPERVISORS

Conductive polymer and polymer composites for microwave and electronics applications:
Supervisors: Prof. T. K. Chaki, Rubber Technology Centre, and Prof. A. Chakraborty, Electronics and Electrical Communication Engineering, Indian Institute of Technology Kharagpur; Year award: 2002

CURRENT RESEARCH INTERESTS

Polymer and conductive polymer nanocomposites; thermoplastics elastomers for specialty applications; smart fabrics for EMI shielding, and energy applications; graphene & decorated graphene; carbon dots for sensors and bio-imaging conductive hydrogel; antipathogen coating materials; recycle of waste rubber; green rubber composites; rheology and processing of polymer and polymer blends.

PROFESSIONAL RESEARCH AND WORKING EXPERIENCE

Indian Institute of Technology, Kharagpur. July 2013 – till to date
Rubber Technology Centre,

- Recycle of waste rubber and plastics: production of carbon black and extraction of oil.
- Synthesis graphene, nanoparticles decorated graphene and rGO and their characterization.
- Thermoplastics elastomers nanocomposites for membrane, food packaging and microwave (EMI) applications.
- Smart conductive textile materials, antipathogen and anti-fouling coated fabric materials.
- Green synthesis and characterization of carbon dots: sensor and medical applications.
- Hydrogel and conductive hydrogel for drug delivery
- Small angle X-ray/neutron scattering (SAXS/SANS) studies on polymeric, biomaterials and nano materials.

Indiana University, Bloomington, USA. Feb. 2009 – Jun. 2013
Centre for the Exploration of Energy and Matter,

- Small angle X-ray and neutron scattering (SAXS& SANS) studies of polymer nanocomposites, micelles and biomolecules.
- Oriented polymer crystallization template into vertically aligned carbon nanotubes arrays.

University of New York, Binghamton, USA Sept. 2006 - Jan. 2009
Department of Mechanical Engineering

- Synthesis, processing and applications of carbon nanotubes (CNTs), metal oxide nanoparticles, and nanorods; explore the self-assembly of nano-objects in polymers.
- Homogeneous and self-seeding crystallization of polymer and polymer blends.

Michigan Technological University, USA May 2005 – Aug. 2006
Materials Science and Engineering

- Study the phase separation behavior and crystallization of polymer blends using SANS and USANS, optical microscopy and AFM. Investigate the time evolution of morphology and structures development in the blends.
- Rheology and morphology of conjugated polymers in solutions and melt.

Hiroshima University, Japan July 2002 – July 2004
Soft Materials Physics Group, Faculty of Integrates Arts and Sciences

- Investigation of early stage crystallization of polyolefin by time-resolved simultaneous synchrotron radiation small angle X-ray scattering (SAXS).

Katholieke University Leuven, Belgium April 2002 – July 2002
Department of Chemical Engineering

- Investigated on microstructure development and morphology of immiscible polymer blends during processing from rheological properties using different techniques like dynamic stress control Rheometer (DSR), Rheometer RMS800, Rheometer Ares-9, Rheo-optics and SALS etc.

Thapar University, India June 2001 – April 2002
Department of Chemical Engineering

- Development of a high voltage lighting arrestors compounds based on ethylene propylene diene (EPDM) and silicone rubber blends

EXPERIMENTAL AND ANALYSIS EXPERTISE

Small angle neutron scattering (SANS) and ultra small angle neutron scattering (USANS), synchrotron radiation and laboratory facilities X-ray scattering [small and wide angle X-ray scattering (SAXS & WAXS).

TEACHING EXPERIENCE (Present and Past**)**

a) Teaching at IIT Kharagpur, India

Polymer Rheology and Processing, Rubber compounding and Reinforcing Materials, Tyre Technology, Rubber Products and Manufacturing Technology, Adhesion Science and Technology, Physical Testing of Rubbers. Science and Technology-Rubber and Rubber-like Materials, Characterization of Rubber and Rubber like Materials,

b) Taught at Indiana University, USA

P537: Scattering theory and applications: A course on X-ray/neutron scattering of soft condensed matter, including polymer composites, polymer crystallization, polymer rheology, polymer structure and dynamics, and nano porous materials

MEMBERSHIP AND PROFESSIONAL SOCIETY ACTIVITIES

American Chemical Society, American Chemical Society- Rubber Division.

RESEARCH ACTIVITIES

i. Project (ongoing & completed)

S. No	Title	Cost (Lakh)	Start Date	End Date	Role as PI/Co-PI	Agency
1.	Formation of double percolated conductive network (DCPN) and segregated structure with ultra-low carbon nanostructure filler content in thermoplastics elastomers vulcanizates (TPVs) with improved electrically conductivity and enhanced electromagnetic interference (EMI) shielding effectiveness	54.23	04-03-22	03-3-25	PI	SERB-DST, India
2.	Development of superior wear resistance and recyclable polymer and ceramic reinforced polymer composite for mill liner applications	33.26	22-11-23	21-11-26	PI	Bradken, Australia.
2.	Formation of double network structure (DNS) in elastomer with improved mechanical and dynamic mechanical	51.37	01-01-21	31-12-24	Co-PI	SERB-DST, India
3.	Training and skill development and its evaluation for IRI members	7.22	01-01-21	31-12-23	PI	IRI, Kolkata
4.	Green synthesis and characterization of biocompatible multi-color luminescent carbon dots for bioimaging and/or sensing applications	41.48	17-01-20	16-01-23	PI	MHRD-STARS

5.	Surface Engineering of Textiles and Soft/Hard Substrates by Impregnation of Metallic Nano-particles Decorated Graphene - An Economical Method to Combat Covid-19 Pandemic	7.00	16-06-20	09-06-22	Co-PI	IITKgp
6.	Invention of smart process technology for production of valuable products including oil and carbon black from waste tire	87.99	15-01-19	14-01-22	PI	MHRD-IMPRINT-II
7.	Functional polymers via ultrasound assisted polymerization; a green technology	48.26	15-03-19	14-03-22	Co-PI	SPARC, MHRD
8.	Radiation processable hybrid polymer nanocomposites multilayer films for food packaging materials processable hybrid polymer nanocomposites multilayer films for food packaging materials	26.58	01-04-18	31-03-21	PI	BRNS, DAE, India
9.	Advanced high strength conjugated polymer based conductive fibers as a smart textile materials for space applications	26.76	25-04-16	24-04-19	PI	ISRO, India
10.	Development of light weight thermally & electrically conductive high performance microwave radiation absorbing nanowires/polymer nanocomposites materials	27.91	05-08-16	19-12-19	PI	SERB-DST, India
11.	Development of carbon driven light weight and flexible conductive rubber/rubber-like conductive composites for electromagnetic field (EMF) radiation shielding materials from mobile tower and commonly used handset	25.08	27-05-14	26-05-17	PI	ISIRD, IIT Kharagpur

ii. Ph.D/M.Tech Thesis supervision

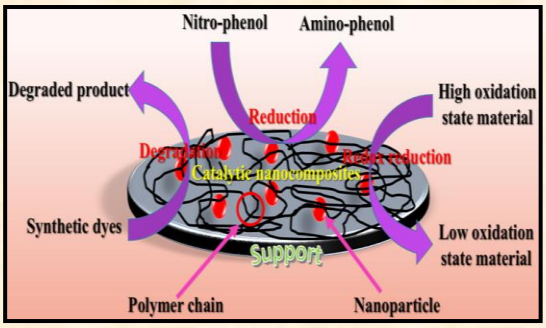
Students	**Completed (13)**		**Ongoing (16)**	
	Single	**Joint**	**Single**	**joint**
Ph.D.	9	5	5	10
M. Tech/M.S	22		2	

iii. Number of publications:

Publications	**Total**
International journals	180
Book Chapters	19
Proceeding in Symp. & Conferences	59
Book Editing	1
Patent	1 (filed)

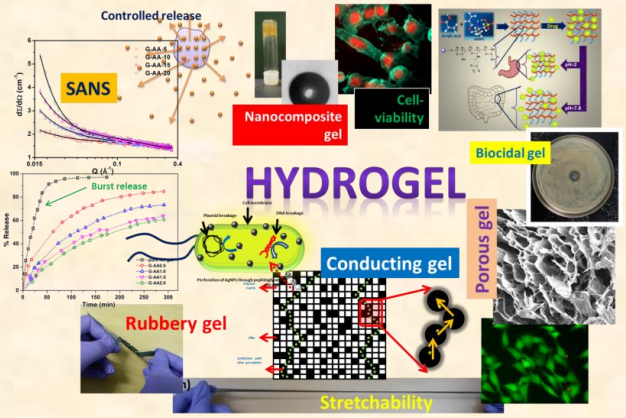
RESEARCH ACTIVITIES

Catlytic degradtion of aromatic pollutants by polymer stabilized nobel metal nanoparticles decorated



Recently the catalysis science and technology is essential as energy and environmental problems come in to the daylight of society. Knowing surprising catalytic activity of noble metal nanoparticles researchers are motivated to tune sizes of the nanoparticles from its precursors via various chemical in a simple facile ecofriendly way. One of the major problems associated with these noble metal nanoparticles is aggregation which is less active towards catalytic application. So, synthesis of fine tuning decorated stabilized nanoparticles on different supports is now challenging task to researchers. Tuning size of noble metal nanoparticles by polymer has gain interest due to not only advantage of *in-situ* generation nanoparticles from its salt by reduction but also provide stabilization to nanoparticle over supports. These nanoparticles decorated catalytic nanocomposites is employed as catalytic supports for reduction of nitro-phenols, degradation of synthetic dyes and redox reduction of inorganic compounds from its higher oxidation state to lower. Hence, the fabrication of heterogeneous catalytic nanocomposites via facile cost effective ecofriendly way, which shows high catalytic activity, is the primary aim of our research.

Hydrogel & Conductive: drug delivery

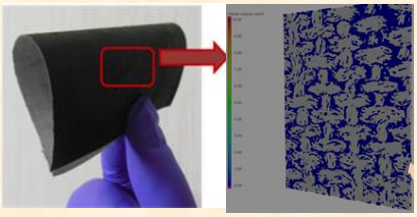


The starting of the path for hydrogels were initiated dates back at 1960 when Otto Wichterle (Austria-Hungary) and Draboslav Lim (Czechoslovakia) innovated contact lens. After the extensive research has been done through the world. Inspiring from the multifunctional activity and tremendous synthetic tenability, our laboratory synthesizes various types of hydrogels. Traditionally hydrogels are a cluster of macromolecules/supramolecules which have propensity to swell in water. As of specialty we developed semi-interpenetrating polymeric network based hydrogels (semi-IPNS) for various applications. The main focuses on the semi-IPN type hydrogel is due to their high elastic response, superior gel strength, fine tuning in the water imbibition and inter texture/morphology, loading of several analytes, ease of fabrications of hydrogel monoliths and as an obvious demand on non-cytotoxicity nature. The main applications which we study in our lab are controlled release od drugs, fertilizer delivery, Nano composite incorporated hydrogels, toxic pollutant removal, biocompatibility, super stretchablity, biodegradable vectors for analytes, analyte diffusion modeling, catalytic activity, conducting hydrogel and antibacterial behaviors and so on.

Smart conductive fabrics

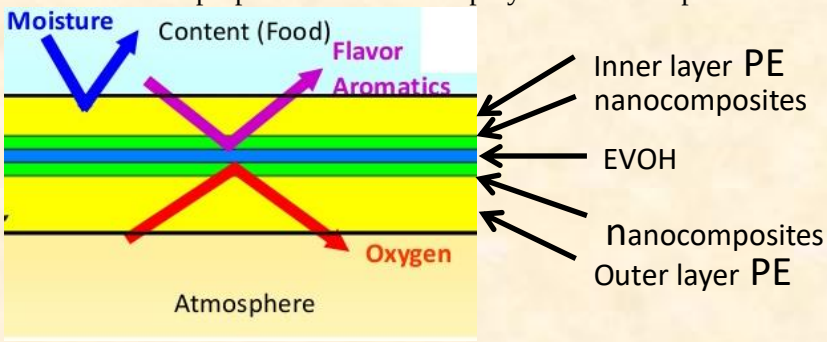
Textiles are mainly insulating material, by making the conductive textiles with the help of conductive materials such filler opened up new field of research area which are already being started from the end of twentieth century. Enhancement of electrical as well as textile properties is a challenging work because there is a huge difference in physical properties of conductive filler and textile. Textiles are inherently very soft and flexible with

moderate mechanical properties in between metals and polymeric materials. So, making the conductive textiles without losing its inherent properties is a huge challenge. Moreover, with technological advantages and new application areas, creating noble demands for flexible conductive textiles for the electro-textiles (or e-textiles) or new field of interest e.g. medical textiles, sensors, EMI shielding fabric etc.



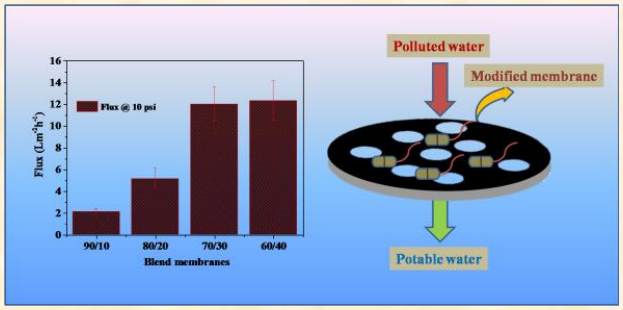
Nanocomposites for food packaging

Polymer nanocomposite has attracted most attention in the food packaging industry. The high point of multidisciplinary research is required in polymer nanocomposite in food packaging to overcome the barriers like safety, technology, regulation, standardization, trained workforce, and technology transfer in order to achieve the benefit for commercial products in the global market. Polymer nanocomposite food packaging material with antimicrobial properties is particularly useful because of the high surface-to-volume ratio of nanofillers. Also, this property enhances surface reactivity of the nanosized antimicrobial agents compared to bulk counterpart, making them able to inactivate or kill microorganisms. The performance properties such as mechanical, barrier, optical, thermal, biodegradation, antimicrobial, and other functional properties are found in polymer nanocomposites for the packaging applications.

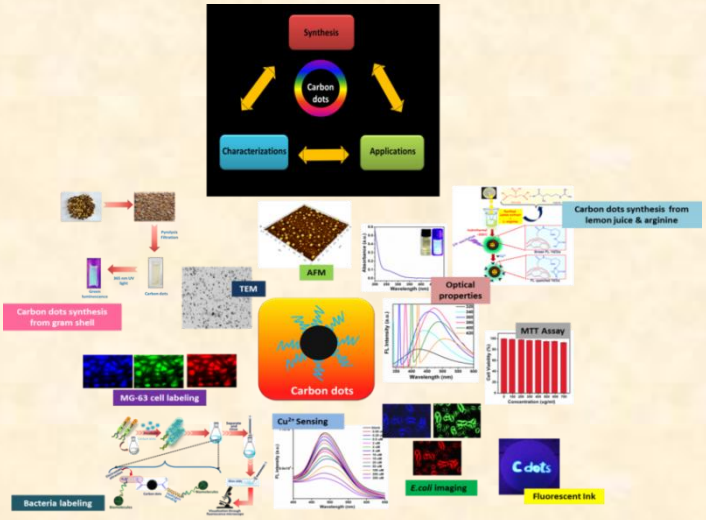


Polymeric materials for membrane

Globally, diarrhea is one of the leading causes of increased mortality among all ages, especially in India it contributes 13% of the child death under the five years of age and is the third leading cause of the childhood mortality. This condition arises from inaccessibility to the clean water. Globally access to the clean water is limited, and almost 1.2 billion people are live in the areas of physical water scarcity, and 500 million people are approaching this situation. In this scenario, water purification by polymer-based membranes is increased research interest. Polymer membrane such as PVDF is prone to bacterial fouling and research on mitigation of fouling is significantly addressed. Recently, research on graphene and other inorganic material based membrane is emerging as a low-cost membrane option with high separation efficiency as well as high permeate flux when it is suitably modified. We focus on developing the low-cost pressure driven membranes with high separation efficiency as well as improved service life.

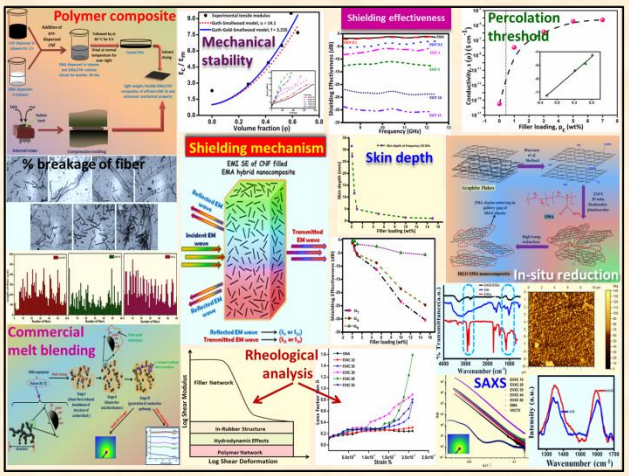


Carbon dot: Sensor, catalysis, biomedical applications



The recent era has witnessed the fast development of innovative nanotechnology in diverse region including biomedical, biological, and pharmaceutical applications. Carbon nanomaterials, including fullerenes, carbon nanotubes, graphene have gained remarkable attention owing to their unique properties and potential applications, including electrode materials, catalysis, adsorption, and gas storage among others. More recently, luminescent carbon dots, a newcomer in the domain of nanolights and nanomaterials have been studied extensively since past few years due to their excellent features. Carbon dots were discovered serendipitously by researchers purifying single-walled carbon nanotubes fabricated by arc-discharge methods. Regarding their size, excitation dependent photoluminescence (PL) character, easy of processing and easy water dispersability, carbon dots are drawing considerable attention in sensor design, cell tracking or fluorescence based live cell assays, medical diagnosis, photocatalysis, and also being potential building blocks for nanodevices. In our laboratory, we synthesize carbon dots from natural source by simple techniques. Such green approaches have more acceptance because of their low cost productive techniques, fast synthesis, high yield, and less hazardous in purification. Our research also includes application of these carbon dots in sensor and biomedical field.

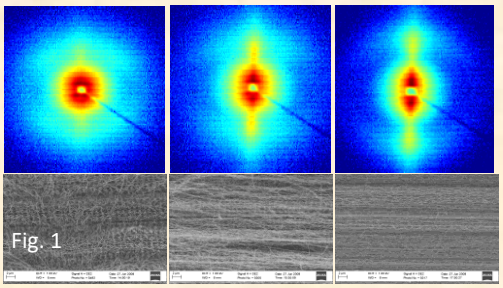
Microwave absorbing materials



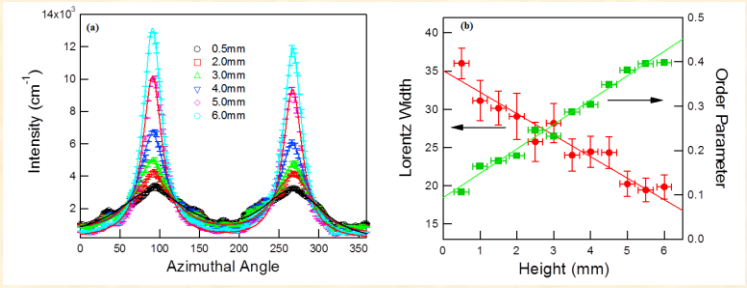
Rapid procreation and implementation of electronic appliances and telecommunication technology emerges a new hazard known as electromagnetic interferences (EMI) which affect human life, electronic devices and medical instruments.

For effective shielding, material should contain either mobile charge carriers or electric and magnetic dipoles to interact with electric and magnetic vectors of electromagnetic radiation for resisting electromagnetic energy from any external sources. From a long period of time, metals have been used as EMI shielding materials but upcoming trend shifts towards polymer nanocomposites because of their light weight, noncorrosive nature and low price. Although polymer nanocomposites, containing carbonaceous fillers, have drawn great interest in the present science and technological field for their improved electronic and shielding effectiveness (SE) but still now they have suffered through processing difficulties, poor dispersion, high production cost. Since, properties of composites depend on several factors, such as, nature of polymer and filler, mixing technique, time and uniform dispersion of filler in polymer. Henceforth, our aim is to explore a new commercial method to develop cost effective, light weight, flexible polymeric composites with improved EMI shielding effectiveness altogether moderate mechanical and thermal stability at very low electrical percolation threshold.

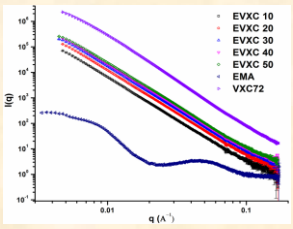
Structural Analysis of Materials using SAXS



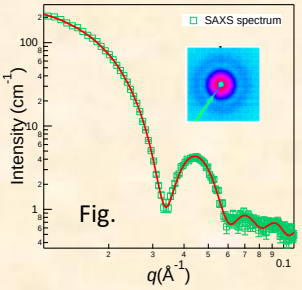
Small-angle scattering (SAS), either X-ray or neutron (SAXS or SANS) unveils invaluable information about the nanoscale size and structural profile in the bulk of systems. As such SAS has been applied to topics in materials science including ranging from soft materials, phase behavior of polymer blends, molecular self-assemblies, structure, size and size distribution of nanomaterials, size and structural characterization of micelles, gels, protein and virus, etc. One major advantage is the ability to determine a statistic ally significant bulk average particle size in the nanoscale of the order 1nm to over 100 nm with very small quantity (~60 μL) sample for the SAXS experiment. A vast number of scatters, e.g. over 10^5 can be probed in a single experiment with SAS whereas imaging such a number using microscopy would be inconceivable, even with the aid of image analysis software. Moreover, SAS can visualise the internal structure, such internal pore structure of porous materials.



This talk will be included to basic principle of SAS. We also review the recent works on characterization of polymeric materials using both X-ray and neutron scattering.



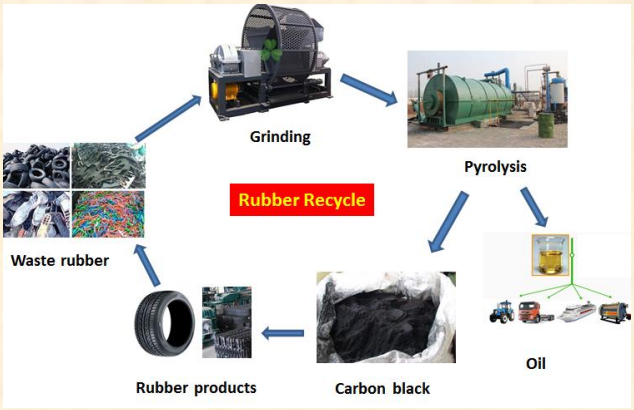
1. We will see how SAXS techniques are used to study anisotropic characteristic and structure of any materials, e.g. aligned nanotube (Fig. 1(top). Quantitative analysis of the SAXS spectrum provides differential structural parameters such as degree of alignment, inner and outer diameter of CNT. Etc Fig, 1 (bottom).



2. The application of SAS to investigate the phase behavior and crystallization of polymer. 3. The size and structure development of biomolecules like capsid protein or virus and so on will be discussed. Fig. 2 shows typical SAXS spectrum of BMV virus. Analysis gives a clear indication of size, size distribution of protein and RNA packing and their structure in the BMV and so on.

3. Filler distribution in the polymer nanocomposites can also be investigated using SAXS. Fig. 3 shows an example of SAXS. Quantitative analysis of the spectrum can be applied to get distribution characteristics of nanofillers in the polymer composites.

Recycle of Rubber waste: Recovery of carbon black and extraction of oil



The tire waste is an enormous global problem because of their non-biodegradability, their flammability and their chemical composition that leads to leaching of toxic substances into the ground on dumping and hazardous fumes on incineration. Since they are hefty and made of multiple materials, scrap tires present distinct challenges in recycling and disposal. Tires

generally do not decay nearly as quickly as other waste in the landfill due to vulcanization of rubber in presence of sulphur; because of this, other material around the tire will decompose and cause the tire to rise to the surface of the landfill. We are working to invent a technology to get more advanced tire oil and carbon black with zero emission and with overcoming present drawbacks. Different recycling routes, like pyrolysis, super critical fluid extraction, devulcanization and combination of these three techniques will be investigated to convert them into oil, carbon black and other valuable products. The techniques will be optimized to pilot plant by considering yield of products, quality of products, production cost and safety parameters, global environmental emission and targeting to the ZERO EMISSION AND ZERO WASTE

AKNOWLEDGEMENT

Funding Agency

Science and Engineering Research Board (SERB)
Department of Science and Technology (DST)
Govt. of India

BOARD OF RESEARCH IN NUCLEAR SCIENCES (BRNS)
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सत्यमेव जयते
Government of India
Ministry of Human Resource Development

INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR
भारतीय प्रौद्योगिकी संस्थान खड़गपुर
1951
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STARS
SCHEME FOR TRANSFORMATIONAL AND ADVANCED RESEARCH IN SCIENCES

BRADKEN

PUBLICATIONS (International)

1. A. Katheria, P. Das, J. Nayak, B. Roy, A. Pal, S. Biswas, **N. C. Das**, "*MXene and F_3O_4 decorated g-C3N4 incorporated high flexible hybrid polymer composite for enhanced electrical conductivity, EMI shielding and thermal conductivity*", Next Materials, 6, 100292 (2025).
2. A. Pal, J. Nayak, B. Roy, S. Maiti, S. N. Chowdhury, P. Das, A. Katheria, S. K. Ray, S. Chattopadhyaya, **N. C. Das**, "*Dual crosslinked interpenetrating polymer network-based porous hydrogel membrane for solid-state supercapacitors applications*", Polymer, 308, 127408 (2024).
3. M. Shee, S. L. Banerjee, A. Dey, I. D. Jana, P. Basak, M. Mandal, A. Mondal, A. K. Das, **N. C. Das**, "*pH-induced fluorescent active sodium alginate-based ionically conjugated and REDOX responsive multi-functional microgels for the anticancer drug delivery*", International Journal of Pharmaceutics, 662, 124490 (2024).
4. S. Subhadarshini, N. K. Peyada, D. K. Goswami, **N. C. Das**, " *Review of battery-type transition metal (Cu, Co, and Ni) oxide based electrodes: from fundamental science to fabrication of a hybrid supercapacitor device*", Energy & Fuel, 38 (13), 11455-11493 (2024).
5. A. Katheria, P. Das, H. Singh, J. Nayak, S. Paul, S. Biswas, **N. C. Das**, "*Highly flexible EMA/Fe_3O_4@gg-C_3N_4 composite for thermal control and EMI shielding application*", Colloids and Surfaces A: Physicochemical and Engineering Aspects, 700, 134756 (2024).
6. S. K. Ghosh, **N. C. Das**, "*Effect of graphene nanoplatelets and nano zinc oxide on gas barrier and antibacterial properties of thermoplastics nanocomposite*", Polymer Engineering & Science (2024).
7. S. K. Ghosh, S. Paul, T. Ghosh, **N. C. Das**, "*Design of interconnected graphene loaded thermoplastic elastomeric blend composites films for minimizing electromagnetic radiation and efficient heat management*", Polymer for Advanced Technologies, 35 (7), e6510 (2024).
8. S. Nath Choudhury, J. Nayak, P. Das, A. Pal, A. Katheria, P. Banerji, **N. C. Das**, "*Enhancing electrical characteristics and electromagnetic interference shielding effectiveness in thermoplastic elastomeric polymer blends by utilizing the selective distribution of carbon black*", Functional Composite Materials, 5 (4), 1-14, 2024.
9. A. Katheria, P. Das, A. Bhagat, J. Nayak, S. Paul, **N. C. Das**, "*Fe_3O_4@g-C_3N_4 and MWCNT embedded highly flexible polymeric hybrid composite for simultaneous thermal control and suppressing microwave radiation*", J. Alloys and Compounds, 988, 174287 (2024).
10. S. Paul, J. Jeethirajan, A. Giri, S. K. Ghosh, M. Rahaman, K. Naskar, N.C. Das, "*Optimization of scrap tire devulcanization process using Taguchi and Dear Method in a supercritical fluid extraction pilot scale setup*", Chemical Engineering and Processing-Process Intensification, 198, 109738 (2024).
11. P. Das, A. Katheria, J. Nayak, A. Pal, B. Roy, S. Paul, S. Biswas, **N. C. Das**, "*Stretchable and lightweight 2D MXene-based eleastomeric composites foam for suppressing electromagnetic interference*", Journal of Alloys and Compounds, 976, 173011 (2024).
12. T. Ghosh, S. Nandi, A. Girigoswami, S. K. Bhattacharyya, S. K. Ghosh, M. Mandal, U. K. Ghorai, P. Banerji, **N. C. Das**, "*Carbon dots for multiuse platform: intracullar pH sending and complementary intensified T1-T2 dual imaging contrast nanopores*", ACS Biomaterials & Engineering, 10 (2), 1112-1127 (2024).
13. S. Das, P. Das, D. Das, **N. C. Das**, "*A review of emerging bio-based constitutents for natural fiber polymer composites*", Journal of the Textile Institute (2024).

14. S. K. Ghosh, **N. C. Das**, "*Recent advances in Nanocly and graphene based thermoplastics nanocomposites for packaging applications*", Packaging Technology and Science, 37 (6), 503-531, 2024.

15. S. K. Bhattacharyya, D. Biswas, N. Pandey, S. Nandi, A. Ghorai, G. Mukherjee, M. Mondal, **N. C. Das**, S. Banerjee, "*Synthesis of 1, 2, 3-triazole link 5 fluorouracil-carbon dots-folate conjugates for target specific anticancer activity and cell imaging applications*", Nano-Structures & Nano-object, 38, 101160 (2024).

16. K. Nath, S. K. Ghosh, P. Das, A. Katheria, **N. C. Das**, "*Synthesis of ionic liquid modified 1-D nanomaterials and its strategical distribution into the biodegradable binary polymer matrix to get reduced electrical percolation threshold and electromagnetic interference shielding effectiveness*", Journal of Applied Polymer Science, 141(5), e54897 (2024).

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3. K. Nath, S. Ghosh, S. K. Ghosh, P. Das, **N. C. Das**, "*Facile preparation of ligh-weight biodegradable and electrically conductive polymer based nanocomposites for superior electromagnetic interference shielding effectiveness*", POLY-CHAR 2023, Auckland, New Zealand, January 22-26, 2023.

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5. **N. C. Das**, "*Small angle X-ray scattering technique for characterization of rubber compounds in tyre and non-tyre applications*", International Rubber Conference (IRC) 2022, Bengaluru, Karnataka, November 23-26, 2022 (**Invited Lecture**).

6. **N. C. Das**, "*Polymeric nanocomposites for radiation shielding: a major challenge to control environmental pollution and health hazards*", International Conference on Macromolecule (ICM-2021), Kottayam, Kerala, India, September 10-12, 2021 (**Plenary Lecture**).

7. **N. C. Das**, **"***Tyre Technology: Basic component, manufacturing, design & development*", Refresher Course in Chemistry, UGC-Human Resource Development Centre, Kumaun University, Nainital, February 15-28, 2021 (**Invited lecture**).

8. **N. C. Das**, "*Small angle Scattering (X-ray & Neutron) for characterization of nano-structure materials and soft materials*", Refresher Course in Chemistry, UGC-Human Resource Development Centre, Kumaun University, Nainital, February 15-28, 2021 (**Invited lecture**).

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