Kaushal Kishore Memorial Award Lectures 2022

AWARD LECTURE 1

Synthetic Strategies to Attain Polymer Functionalized Particles & Catalytic Porous Polymer Particles

by

Prof. Leena Nebhani
IIT, New Delhi, India

Date: December 11, 2023 | Time: 9.45 am

Venue : MACRO-2023 at Bhupen Hazarika Auditorium IIT, Guwahati

AWARD LECTURE 2

Functional Peptide-Polymer Conjugates for Stereoselective Enhancement of Chiroptical Properties

by

Prof. Ashish Pal
INST Mohali, Punjab

Date: December 11, 2023 | Time: 10.15 am

Venue: MACRO-2023 at Bhupen Hazarika Auditorium IIT Guwahati

Organized by:

The Society for Polymer Science, India

AWARD LECTURE 1

Abstract

New strategies and techniques have been developed for the synthesis and structural tailoring of polymer functionalized particles. Nitrone is a versatile compound widely used in organic synthesis for diverse reactions leading to complex molecules. The nitrone functionalities are also proven efficient in polymer grafting techniques such as enhanced spincapturing polymerization (ESCP) and nitrone mediated radical coupling reactions[1]. We have grafted nitrone functionality over green silica derived from rice husk ash via co-condensation, and the potential of polymer grafting via ESCP using styrene and 1,3-dipolar cycloaddition using polystyrene macromonomer has been investigated[2].

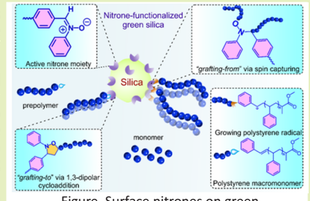

Figure. Surface nitrones on green silica for innovative polymer grafting[2].

The immobilization of catalytic moieties as heterogeneous support is expected to be one of the most effective ways for the preparation of well-defined heterogeneous catalytic systems providing economic and environmental importance. We are working on porous micro particles prepared by copolymerizing 2-(methyl(pyridine-4-yl)amino) ethyl methacrylate based monomer with divinyl benzene, where the former acts as a catalytic moiety. Initially, the solvent system has been optimized for the Baylis–Hillman reaction between 4-nitrobenzaldehyde and acrylonitrile using porous as well as non porous micro particles comprising approximately 70% of the catalytic moiety[3].

The molecular design flexibility of polybenzoxazine is currently being utilized by our research group to achieve a rational network that is suited for several intended applications. However, the permanent covalent cross links responsible for the interesting properties of thermo sets hinder its reprocess ability generating huge waste. Our research team is addressing this issue as well by incorporating dynamic covalent chemistry, such as imine, disulfide, etc. into the crosslinked network of polybenzoxazines, thereby producing a vitrimer for self-healing adhesives, coatings, and recyclable fibre reinforced composites. The modularity of various phenols and amines enables the design of functionalized monomer units with variable properties, including network flexibility, thermal and mechanical strength, optimal viscosity, dynamic linkages, and reprocessability. Carbonization is yet another feasible route for the reutilization of thermosets[4] which has motivated us to validate the heteroatom-enriched network of polybenzoxazine as a viable candidate for deriving inherently doped carbon structures suitable for energy storage applications.

References

[1] J. Laun, W. Marchal, V. Trouillet, A. Welle, A. Hardy, M. K. Van Bael, C. Barner-Kowollik and T. Junkers, Langmuir 2018, 34, 32443255.
[2] L. Hakkim N. and L. Nebhani, Polym. Chem. 2023, 14, 4547-4559
[3] A. Kumar, D. Kuckling, L. Nebhani, *ACS Appl. Polym. Mater.* 2022, 4, **12**, 8996–9005
[4] I. Tiwari, P. Sharma, and L. Nebhani, *Materials Today Chemistry* 2022, **23**, 100734–2126.

About the speaker

Dr.Leena Nebhani studied Chemistry at the University of Rajasthan and Polymer Science and Technology at the Indian Institute of Technology Delhi, India. She completed PhD in Polymer Chemistry in 2010 from the Karlsruhe Institute of Technology (KIT), Germany.She has received several awards and scholarships during her studies, including a DAAD scholarship to undertake M.Tech thesis at the Technical University Dresden, Germany, and a Faculty of Engineering Scholarship from the University of New South Wales, Sydney, Australia. After the completion of PhD, she worked as a Senior Scientist from 2011 to 2015 at the Goodyear Tire & Rubber Company, USA. In 2015, Dr. Nebhani joined the Indian Institute of Technology Delhi (IITD) as an Assistant Professor where she has been promoted to Associate Professor in 2020. She received a Faculty Research Award in the Early Career Category (2020)from the Indian Institute of Technology Delhi. Dr. Nebhani has recently received "Teaching Excellence Award" from the Indian Institute of Technology Delhi.She serves as an Academic Editor at PLOS One since August 2018. She is an expert committee member in several panels at the Department of Science and Engineering, Science and Engineering Research Board as well as served as a reviewer for several international peer-reviewed high impact journals, for example, Journal of Materials Chemistry B, ACS Sustainable Chemistry & Engineering, Polymer Chemistry, etc. Since she joined IITD, she has been a frequent visiting academic at Australian Universities, including the University of New South Wales and the University of Sydney. She has been collaborating with eminent researchers based in India, USA, Germany, Australia, and Taiwan.

AWARD LECTURE 2

Abstract

Homogeneously ordered macroscopic assemblies of chiral π-conjugated polymers into adaptive morphologies offer many opportunities in chiral photonics.The amplification of the chiroptical properties of such materials are naturally inspired by the spontaneous chiral symmetry breaking followed by chiral assymmetry transfer mediated by the self-assembly into higher order structures.The nanoscale engineering of such helical materials with controllable geometrical parameters provide access to enhanced chiroptical effect in the desired visible to near infrared range. Peptides offer a greener and easily functionalisable alternative as chiral precursors, with pure enantiomers being available commercially.

Herein, we report diacetylene-peptide based chiral bolaamphiphiles that undergo topochemical polymerization to furnish chiral polydiacetylenes. The π-π^* electronic transition of the alternate ene-yne conjugated backbone renders interesting optical response, high non-linear optical susceptibility and high structural anisotropy. Placing chiral polydiacetylene enantiomers in a confined system can give insights on the more superior role of either chiral end groups interaction or hydrogen bonding interactions, resulting in self-sorting of homochiral domains or co-assembly of heterochiral domains in the resulting composite. Tendency to self-sort or co-assemble also depends on the hard-soft segment ratio in the enantiomers. The chiroptical properties of these diacetylene systems can be further enhanced by mesophase formation upon annealing and plasmonic doping.Chiral plasmonic systems offer a unique way of chiroptic enhancement, enabling these molecular systems to act as Circular dichroism (CD), Circular Polarized Lumiscence (CPL) based sensors for biomolecule detection and molecular recognition. Alongside, development of these systems will also give more insights on chirality genesis and fabrication in naturally chiral biosystems.

References

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[2] Maulik, A.; Miglani, C.; Mavlankar, N. A.; Joseph, J. P.; Chandran, V. C.; Pal, A.; *New J. Chem.*, **2023**, *47*, 1657-1665.
[3] Joseph, J. P.; Miglani, C.; Maulik, A.; Abraham, S. R.; Dutta, A.; Baev, A.; Prasad, P. N.; Pal, A.; *Angew. Chem. Int. Ed.*, **2023**, *62*,e2023067.

About the speaker

Dr. Asish Pal, is presently working as Scientist-F (Professor) at Institute of Nano Science & Technology, Mohali, Punjab. He has obtained his PhD in Soft nanomaterials and hydrogels from Dept. of Organic Chemistry, Indian Institute of Science, Bangalore with Prof. Santanu Bhattacharyain 2009 and continued his postdoctoral work in Eindhoven University of Technology with Rint P. Sijbesma and University of Groningen with Sijbren Otto in the Netherlands. During his abroad stint, he worked mainly in the field of supramolecular polymer for tissue regeneration, and dynamic combinatorial library of self-replicating peptides.

He started his independent research career with INST in 2015 and started working on biomimetic materials based on his keen interest to learn from nature. His research interests include Self-assembled Peptide and Polymeric Biomaterials, Dynamic Combinatorial Chemistry and self-replication, Self-healing and Functional Nanomaterials, Bio-nanocomposite for tissue engineering, Drug and Agrochemical delivery. He has secured several grants from multiples funding agencies such as DST-SERB, DBT-BIRAC and UGC-DAE.He has published in more than ~45 high impact factor journals in the relevant areas.

About Professor Kaushal Kishore

Kaushal Kishore was one of the outstanding Polymer Scientists of our country. He was a professor at the department of Inorganic and Physical Chemistry at the Indian Institute of Science, Bangalore, till his untimely demise in 1999 at the age of 56. Kishore received his early education in chemistry from Lucknow University and his Ph.D. from the Gorakhpur University under the guidance of the distinguished physical chemist, Professor R. P. Rastogi. After a brief stint at Gorakhpur University as a lecturer, he moved to the Department of Inorganic and Physical Chemistry, at the Indian Institute of Science, as an Assistant Professor in 1974; he rose through the academic ladder to become a full professor in 1984 and served as the head of the department during the years 1994-1998.

Kishore's formal training was in thermodynamics and combustion chemistry. His early work in collaboration with scientists at ISRO and DRDO led to several novel discoveries that shed light on the role of different components in solid propellants; one of the very significant findings was that the polymeric binders generated polyperoxides during aging and combustion, which in turn accelerated the combustion process. With this insight, he soon discovered a unique phenomenon that he termed "autopyrolysis", which catapulted him into fame. He contributed immensely to the field of polyperoxides, both in terms of understanding its formation and exploiting their potential for a variety of applications. Thus, in his early work, he brought to bear upon the phenomenon of combustion his deep understanding of chemical thermodynamics to formulate, quantify and provide a detailed mechanistic insight into this incredibly complex process. His early work on combustion steered him to several other important problems, namely flame retardancy, which lead him to define a new dimensionless quantity he termed "Flammability Index", design of new additives that would retard/inhibit the flammability of polymeric materials, probing the molecular underpinnings of "plasticization", with a primary focus on the effect of molecular architecture on plasticizing efficacy. During his last years he studied a broad class of polymers he termed "weak-link" polymers; these were analogous to polyperoxides, such as polydisulfides and polyselenides; his main interest was to understand the degradation mechanism of these weak link polymers.

Kishore's work was always characterized by its ingenuity, depth and simplicity of analysis. He saw science in everything and had a strong conviction and motivation to understand all phenomena he observed at the microscopic and, if possible, at a molecular level. His solid foundation in chemical thermodynamics brought to polymer chemistry a much-needed "thermodynamic bias" – a term he often used to characterize his work. Using numerous tools, starting from thermal analytical methods, rheological measurements, NMR and computational methods, he attacked problems with passion and a characteristic zeal – which often culminated in nailing the issue on the head. His students and coworkers remember him with great fondness – for he was not only their research guide but also their friend and a confidant.

Recognition for his achievements came in many forms. Professor Kishore was awarded the Bhatnagar prize in 1988, was elected to the Fellowship of the Indian Academy of Sciences in 1991 and later to that of the Indian National Science Academy in 1999. Kishore served on several important decision-making bodies in the country – various assessment committees, research councils of national laboratories and in many others.

About Kaushal Kishore Memorial Award

The Kaushal Kishore Memorial Award was instituted in 2014 to recognize young outstanding polymer scientists of our country who have made outstanding research contributions and have demonstrated the potential to become global leaders in their chosen fields of research. The corpse fund for this award was donated to the Society for Polymer Science (India) after the successful conduct of the FAPS-MACRO 2013 conference in Bangalore. The award is open to researchers, under 45 years of age, who are working in India and will be awarded biannually during the MACRO conference held under the auspices of SPSI. The award will carry a cash prize of Rs 100,000, along with a citation.

Prof. K. Kishore Memorial Award Winners of The Society for Polymer Science, India

2014	1)	Dr. M. Jayakannan, IISER, Pune
	2)	Dr. Satish A. Patil, IISc, Bangalore
2017	1)	Prof. Suhrit Ghosh, IACS, Kolkata
	2)	Prof. Rabibrata Mukherjee, IIT, Kharagpur
2018	1)	Dr. E. Bhoje Gowd, CSIR NIIST, Trivandrum
	2)	Prof. Priyadarsi De, IISER, Kolkata
2020	1)	Dr. Samir H. Chikkali, CSIR-NCL, Pune
	2)	Prof. Suryasarathi Bose, IISC, Bangalore