

Professor M. Santappa Award Lecture

Coulomb Interactions- Driven UCST Polymers

by

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Indian Institute of Science Education Research, Pune

Organized by:



Abstract

Thermoresponsive polymers have been extensively researched in the academic community and the major focus has also been on their wide range of applications in sensing and devices as well as in biomedical field. The water-soluble polymers with lower critical solution temperature (LCST) are most widely studied in terms of their use in biomedical sciences. But, polymers with upper critical solution temperature (UCST) behaviors are less studied, though conceptually they are equally useful. The UCST-type phase transition is driven by either hydrogen bonding (HB) or Coulomb interactions among the polymer chains. Consequently, there has been major development in synthesizing new UCST polymers with HB interactive functional groups. But, the explorations of UCST polymers that rely on Coulomb interactions are very less. Thus, our research is focused on the development of various new polymers with UCST due to the Coulomb interactions. I will discuss several recent achievements of various ionic UCST-type polymers including their phase behaviors and responsiveness towards other stimuli in our laboratory. Specifically, the discussion focuses on the synthesis of amino acid-based poly(zwitterionic), amino acid-based zwitterionic polysulfobetaine, poly(zwitterionic ionic liquid)s and discussion of their UCST-type behaviors due to intra- and inter-molecular electrostatic interactions between the pendent zwitterionic groups of the neighboring polymer chains. The synthesis of other type of ionic polymers such as phosphonium and imidazolium poly(ionic liquid)s, their copolymers and cationic polypeptides as well as their UCST-type behaviors due to the electrostatic ionic bridging interactions in the presence of added anion will also be discussed

About award winner

Tarun K. Mandal received his B.Sc. and M.Sc. in Chemistry from University of Calcutta, Kolkata. He completed his Ph.D. from Indian Association for the Cultivation of Science/Jadavpur University, Kolkata, India in 1997. After two successive postdoctoral stays at National Cheng Kung University, Taiwan, and Tufts University of USA, he joined Polymer Science Unit, Indian Association for the Cultivation of Science, Kolkata, India in 2001 and subsequently served as Associate Professor and Professor in the same department. From 2014, he has been a Senior Professor at the Polymer Science Unit and served as the Head of this Unit of IACS (2009-2012). He is a recipient of the MRSI Medal (2012) and the CRSI Bronze Medal (2013). He is a fellow of West Bengal Academy of Science and Technology.

Professor Mandal has made significant contributions in designing and developing of various block copolymers,



peptide-polymer hybrids, polymer nanostructures, stimuli-responsive poly(oxazoline)-based copolymers/poly(ionic liquid)s/polyzwitterions, amino acid-based polymers, polymer-inorganic hybrid nanostructures using different controlled polymerizations as tools for exploiting them in diversified area from advanced materials to catalysts.

He has supervised 14 students for obtaining their Ph.D. degree and few students are at various stages of their PhD. He has completed/is pursuing extramural projects funded by CSIR, DBT, BRNS, Nano Mission-DST, SERB, etc. as a Principal Investigator. He has published more than 100 articles in highly reputed international journals, which have more than 4200 citations. His peers have recognized his contributions by citing his publications; his present *h*-index is 31.

About Professor M.Santappa

Mushi Santappa born on October 2, 1923, obtained his BA (Chemistry) in 1943 from the University of Madras. He did his MSc (Chemistry) in 1946 from Banaras Hindu University. He obtained PhD (Organic Chemistry) in 1949 from University of London under the guidance of R.W. West followed by a second PhD (1951) in 'physical chemistry of high polymers' from Manchester University. Upon his return to India he joined the University of Madras (1952) as a Reader in Physical Chemistry and became a Professor in 1958. He served as Director, Central Leather Research Institute (CSIR-CLRI) from 1972-78. Subsequently he served as Vice-Chancellor of SV University, Tirupathi (1979-81) as well as the University of Madras (1981-84). He was conferred honorary DSc from Andhra, Madras, Sri Krishna Devaraya and Madurai Kamaraj Universities and honorary DLitt from Gulbarga University.



Professor Santappa published over 350 papers in peer-reviewed journals and guided 59 PhD students. He was awarded the S.S. Bhatnagar Prize for Chemical Sciences (1967), the Sir JC Ghosh Memorial Medal of Indian Chemical Society (1982), and the FICCI Award for Science and Technology (1985). He was elected Fellow of the Indian Academy of Sciences, Bangalore, National Academy of Sciences (India), Allahabad and the Indian National Science Academy, New Delhi.

Professor Santappa was initiated into the study of kinetics of vinyl polymerization as a PhD student working with Professor Meredith G. Evans, FRS (1904-1952) at the University of Manchester in the years between 1948 and 1951. Professor Evans, an early pioneer in the study of chemical kinetics, turned to the study of electron transfer reactions involving ferrous ions and hydrogen peroxide (Fenton reagent) and their ability to polymerize methyl methacrylate in aqueous emulsions Professor Evans elucidated the kinetics and mechanism of this reaction and further proposed that UV and visible light can promote internal electron transfer and,

thus, vinyl monomers can be polymerized under the influence of light (photo polymerization). Professor Santappa's PhD work concerned photo-initiated free radical polymerization of vinyl monomers. Upon his return to India Professor Santappa built an active school of research on the study of kinetics of vinyl polymerization. Beginning in 1955 he published a series of over 150 papers on kinetics and mechanism of vinyl polymerization and determination of initiation rates and chain transfer constants for a host of initiators and vinyl monomers. Along with Professor Santi R. Palit at the Indian Association for the Cultivation of Science, Professor Santappa, established the first rigorous school for polymer science research in India and trained a whole generation of polymer chemists who went on to practice the discipline with great distinction. Professor Santappa brought great visibility to Indian polymer research for about three decades. In 1983, he organized India's first ever IUPAC sponsored International Symposium on Polymers at Madras (Chennai). In 1996 he authored a book which comprehensively reviewed the status of polymer science in India

About Professor M. Santappa Award

The Award was instituted by the Society for Polymer Science, India, in 1988 to honour Professor Mushi Santappa, a distinguished physical chemist and a pioneer in polymer science research in India. Professor Santappa was the founder of the Department of Physical Chemistry, University of Madras. Under his dynamic leadership and erudite scholarship, the Department became a hub of polymer science research in the period 1952-1970.

The award is given biennially by the Society to distinguished scientists for outstanding research contributions made in India during the ten years preceding the year of the award in the field of Polymer Science.

Prof. Santappa Award Winners of The Society for Polymer Science, India

- 1988 Dr. V. M. Nadkarni, National Chemical Laboratory, Pune
- 1988 Dr. S. Sivaram, National Chemical Laboratory, Pune
- 1991 Prof. Ashok Misra, Indian Institute of Technology, New Delhi
- 1998 Prof. B. M. Mandal, Indian Association for Cultivation of Science, Kolkata
- 2004 Prof. A.K.Nandi, Indian Association for Cultivation of Science, Kolkata
- 2006 Dr. C. P. Raghunadan Nair, Vikram Sarabhai Space Centre, Thiruvananthapuram
- 2006 Dr. P. P. Wadgaonkar, National Chemical Laboratory, Pune
- 2010 Dr. Pralay Maiti, Banaras Hindu University, Varanasi
- 2014 Dr. Nikhil K. Singha, Indian Institute of Technology, Kharagpur
- 2017 Prof. Giridhar, Madras Indian Institute of Science, Bangalore