Professor Palit's Memorial Lecture

Developments in Polyether and Recent polycarbonate Synthesis Using Boron-Based Catalysts

by

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Abstract

With the exception of poly(propylene oxide) (PPO) and poly(propylene carbonate) (PPC) that can be obtained using the same double metal cyanide catalyst (DMC), other polyethers and polycarbonates generally require specific catalysts, either alkali bases for polyethers and complex organometallic systems for polycarbonates.

Several organocatalysts have been specifically designed over the last twenty years for the polymerization of epoxides in an attempt to ditch metallic systems but they could never be successfully applied to the synthesis of polycarbonates.

In a recent addition we have shown that upon associating alkyl boron to various onium salts not only polyethers but also a whole range of polycarbonates resulting from the copolymerization of epoxides with carbon dioxide (CO_2) can be synthesized with excellent catalytic activity. The role of boron centers is two fold: as a Lewis acid alkyl boron interacts with the anionic growing species, curbs their reactivity, forming an ate complex of moderate reactivity; boron also independently activates epoxides, enhancing their reactivity. As a result PPO could be generated free of any side reactions using such boron-based systems and PPC as well.

The presentation will actually discuss the potential, the activity, the respective advantages and limitations of two families of boron-based systems: the bicomponent family of boron-based systems associates alkyl boron with various onium salts; in the bifunctional family boron centers and anions responsible for the (co)polymerization initiation are included in a same molecule.

Besides epoxides and CO_2, these systems were also found efficient at (co)polymerizing a whole range of oxygenated monomers, such as anhydrides, cyclic esters, isocyanates and aldehydes.

References

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About the speaker

Yves Gnanou earned his Ph.D. in 1985 under the supervision of Prof. Paul Rempp from the University of Strasbourg, France. Subsequently, he joined the Centre National de la Recherche Scientifique (CNRS) as a researcher and then moved to the US where he did a stint at MIT (Massachusetts). He then returned to France and in the late 1990s he became the Director of the Laboratoire de Chimie des Polymères Organiques (LCPO) in Bordeaux.

In 2006, he was appointed Head of the Chemistry Institute of CNRS in Paris before moving to Ecole Polytechnique as Vice-President for Academic Affairs.

Since 2012, Yves Gnanou has been a member of the leadership of King Abdullah University of Scicne and Technology (Saudi Arabia), first as Dean of the Physical Science & Engineering Division and then as Vice-President for Academic Affairs. He now serves as advisor to the Provost.

His main scientific interests focus nowadays on sustainable polymer chemistry with a particular attention to CO_2 copolymerization for applications ranging from surfactants to degradable elastomers, to degradable polyurethane precursors. He has received several awards and his work has led to 350 odd publications in international peer reviewed journals. He is also an inventor on 26 patents, has written two textbooks and has edited several books.

About Prof. S.R. Palit

Prof. Santi Ranjan Palit was born in Calcutta on 24th March, 1912. In 1931, he came out first in First Class in the B.Sc. examination and the same performance was repeated in the MSc. examination in Pure Chemistry of the Calcutta University. The next two years after passing the MSc. examination was a period of agony of joblessness to him, since his mother (a follower of Mahatma Gandhi) opposed to allowing his son joining any Government service under the then British Government. At long last, it was through the intermediary of Dr. Shyama Prasad Mukherjee that he got a research fellowship at the Department of Pure Chemistry of Calcutta University under Prof. J. N. Mukherjee, (a renowned colloidal chemist) and published his first paper in 1933 on cataphoretic speed of colloid particles. But he left it after one year to join the Vidyasagar College as lecturer where he spent two years and then wrote a book on Elementary Physical Chemistry. In 1938, he joined the Lac Research Institute, Ranchi as a Research Assistant under Dr. H. K. Sen where he got exposed to the fascinating world of paints, varnishes, lacquers etc. The first paper on Cosolveney came out from there in 1940 and subsequently he received P. R. S and D. Sc degree of Calcutta University. Prof. Mc-Bain of the University of Stanford, California invited him to search solvents for soaps and in early 1945, he joined in McBain's laboratory working as a Bristol-Meyer Research Associate. Prof. McBain had a great admiration to him quoting "Palit has a special ability to look at a familiar thing from an unfamiliar angle". After that he started to work with Prof. Herman Mark at the Polymer Institute at Brooklyn as a part-time researcher after a full time service at the research laboratory of E. F. Drew & Company, a leading manufacturer of oil derivatives. He then started the work on cosolvency of high polymers and made vast experience on the rapidly developing branch of Polymer Science. On the basis of work done there he was given the P.R.J.C award. Mention may be made of two very successful co-workers of him at that time, who was Bruno Zimm, famous for Zimm plot and Turner Alfrey.

In 1947, amidst the climax of dawning independence, he came back to India. At that time Prof. Meghnad Saha, the then President of the Indian Association for the Cultivation of Science (IACS) was organizing the association in a new and promising manner befitting a leading research centre with emphasis on high polymers. Immediately, he appointed S. R Palit first as a planning officer and then as a Professor of Chemistry. Thus started the Physical Chemistry Department of the I.A.C.S. housed in a single room and a verandah of the then dilapidated premises at 210 Bowbazar Street, Calcutta. At 1950, IACS shifted to Jadavpur where he made a good school of polymer and physical chemistry. Regarding the Professor's activities on polymers, it will not be irrelevant to quote Prof. Herman Mark:" ..... during his (Palit's) activities at his institute in Calcutta he (Palit) developed into the leading polymer scientist in India and in fact, the most prominent representative of this discipline in the far East. His numerous publications and his successful and convincing delivery of many lectures at International Conferences continued to increase his reputation and made him to become a recognized member of the small group of leading polymer scientists in the entire world". He worked as a Guest Professor in Berlin 1965-66 and in 1966, he was a Visiting Professor at the University of Florida, USA. He became a fellow of the Indian National Science Academy (F. N. A) and a fellow of the Indian Academy of Sciences (F. A. Sc.). Number of successful doctoral students guided by Prof. Palit till 1975 was 80, but he stayed at IACS as Emeritus Professor till 1981 and guided about another 20 students His last three students were awarded the degree in 1980-1981. He published more than 300 papers, monographs etc and his most important contributions are particularly polymerization kinetics including chain transfer and dye partition techniques for detection of polymer end groups, (ii) Anomalous (non-Faradaic) electrolysis, nonaqueous titration etc. He died on 14 th August 1981 at calcutta after his coming back immediate from London delivering /demonstrating a talk on non-Farady electrolysis at Royal Society keeping a group of eminent polymer scientists working both in academic and industry in the country.

The fund for Prof. S.R. Palit award of SPSI has been raised by members of Kolkata Chapter from the organization of national (Polymer-2006) and International (Macro-2015) conferences at IACS, Kolkata.

Earlier Lectures

2017: Professor Sadhan C. Jana, University of Akron, Akron, Ohio, USA.
2018: Professor Chi Wu, The Chinese University of Hong Kong.