# **Department of Chemical Engineering Seminar Series**

## **Nanocomposites with Grafted Nanoparticles**



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Monday, November 2, 2015 Lecture: 4:00-5:00 p.m. <u>Physics Astronomy Building (PAA)</u> A110 Reception at 3:30 p.m. PAA A110

### Abstract

A central area of research in the soft matter community is in inorganic/organic hybrid materials with nanoscale inorganic particles. These materials have been focused on due to their promise of having synergistic thermal, mechanical and optical properties relative to the pure materials. It is now accepted that the spatial distribution of the inorganic nanoparticles critically affect the properties of the resulting materials, but a grand challenge is to control the spatial distribution of the inorganic, hydrophilic nanoparticles in the organic, hydrophobic polymer matrix. I focus on one particular approach to controlling nanoparticle spatial dispersion, the use of polymer-grafted nanoparticles. In the case where the NP and the grafted polymer chains energetically "dislike" each other, we have an architecture akin to a microphase separated block copolymer or a surfactant. Analogous to these "surfactants" these grafted nanoparticles also assemble into a range of morphologies, thus giving us the unprecedented ability to control the particle dispersion state.

In this talk I first focus on the factors controlling this assembly and use this knowledge to consider the utility of other approaches to self-assembly – we show that the use of crystallizable polymers allows us to control nanoparticle order, in particular by varying the rate at which these materials crystallize. This allows us to mimic the growth of organisms such as nacre and oysters, whose shells combine the dual advantages of high strength and toughness. In a different vein, these grafted nanoparticles show the ability to creating membranes that have the potential to revolutionalize the separation of hydrocarbons and in carbon sequestration.

#### Speaker Biography

Dr. Sanat Kumar received his BS in Chemical Engineering from the Indian Institute of Technology, Chennai, India; and his SM and ScD from Massachusetts Institute of Technology, MA. Currently, he is the Chair of Chemical Engineering at Columbia University (since 2010) and has been a professor there since 2006. Previously, he was a Professor of Chemical and Biological Engineering at Rensselaer Polytechnic Institute, and went from Assistant Professor to Professor of Materials Science & of Chemical Engineering at Penn State University. His activities include: (i) Department Chair (ii) Editorial Board, Macromolecules (iii) PI in NSF-NSEC joint across RPI and Illinois. (iv) PI was in two GOALI programs at RPI. (v) Editorial board & Editor, J. Poly. Sci. Polym. Physics. The total PhD students he has supervised is 28; the total post-docs supervised is 19.

