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Lecture Title:

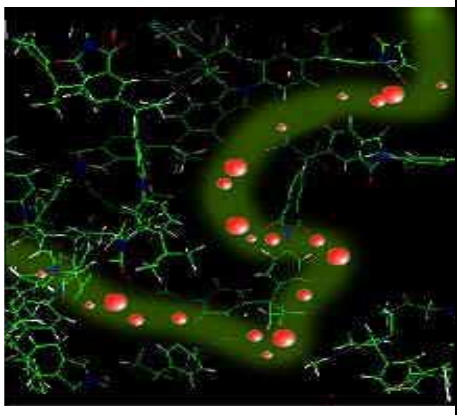
Metal Oxide-Polymer Nanocomposites

Abstract:

Polymer nanocomposites are attracting considerable scientific interest and R&D investment as their production is seen as a cost-effective way to substantially modify the properties of commodity polymers, such as polyolefins, nylon, PET and PMMA, and to achieve novel surface coatings. A wide range of different mechanical, thermal, electrical, permeability and optical improvements can be obtained, compared to more conventional polymer macro- or micro-composites.

In principle, oxide-polymer nanocomposites can be readily prepared by nanoparticle dispersion into thermoplastic or thermoset resins. However, there are several major issues confounding their more widespread application, including:

1. An understanding of nanoparticle-polymer matrix interactions at a molecular level, which is still in its infancy
2. Difficulty in identifying dispersion techniques, which do not adversely affect final materials' properties
3. A poor understanding nanoparticle design and manufacturing methods, which optimize final materials' properties

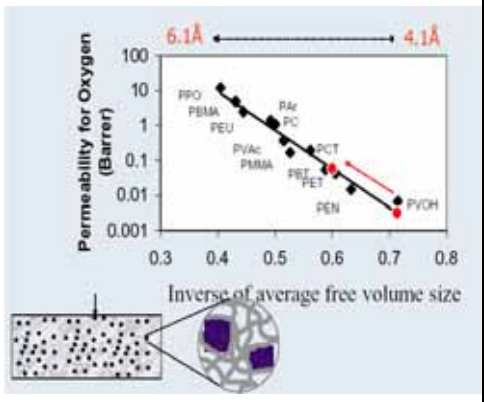


Nanoparticles are not simply "inert" additives into a polymer matrix; they interact with and perturb the polymer chains at a molecular level. The presence of multiple interaction forces (excluded volume, van der Waals attractions and electrostatic forces), configurational entropy, demixing, nanoparticle/polymer size asymmetry, and nanoparticle surface heterogeneity results in particularly complex behaviour both within the melt (in the case of thermoplastics during processing) and in the final properties.

Particular problems are found with dispersion of nanoparticles within polymers,

requiring the use of excessive quantities of coupling agents or dispersants. It is often initially hard to "wet" many nanoparticles and also to stabilize them against reagglomeration during processing. The very high surface area-to-volume ratio can require such substantial quantities of additive as to alter the composite properties and negate any cost savings.

Finally, most current nanoparticle production methods pose real challenges in control of size distribution, surface textures and size aspect ratios. With current interest in use of nanoparticles with dual- or multi-functionality into polymer composites, precise control of the particle physics and surface chemistry is still poorly understood.



This lecture will explore these issues with examples of metal-oxide polymer nanocomposites designed for control of gas permeability, for optical properties and for polyolefin nucleating ability. It will introduce positron spectroscopy And X-ray nanotomography as means of understanding the role that nanometer-sized transient voids have in controlling properties and characterizing nanocomposites. It will also look at what major challenges need to be overcome to realize the full potential of this new class of materials.