IN PURSUIT OF BLENDING POLYMERS WITH CARBON NANOTUBES

Marilyn L. Minus, Northeastern University
m.minus@northeastern.edu
Heng Li, Northeastern University

Key Words: Phase separation, blends, polyacrylonitrile, composite, carbon nanotube.

A liquid-solid phase separation method has been developed here to separate polymer/CNT blended phases with specific bundle size distribution from master heterogeneous polymer/CNT dispersions. This liquid-solid phase separation is triggered through addition of a non-solvent in the system. The fundamental issue of dispersing carbon nanotubes (CNTs) dispersion within a polymer matrix is also addressed in this work by studying a non-solvent induced liquid-solid phase separation process in polyacrylonitrile/CNT composite systems. To visualize the effect of phase separation, hybrid polymer/CNT buckypapers were formed through filtration. The hybrid film morphology is graded showing a distinct CNT-rich and polymer-rich layer. Examination of this layered structure reveals the separation of CNTs with specific bundle size. CNTs were uniformly dispersed within the polymer-rich layer due to a preferred polymer-CNT interaction during phase separation. Experimental, theoretical, and molecular dynamics studies were performed to show the fundamental mechanism behind layer formation in the composites and to understand the specificity of preferential polymer-CNT interactions. To this end, a geometric dependence described by a 'cylinder-in-sphere' model was established and shows a link between the critical CNT bundle size and polymer radius of gyration (R_g), which is dictates preferential polymer-CNT interactions. This model represents the geometric relationship required to form a blended polymer-CNT phase in the system under the phase separation conditions used. Understanding the use of phase separation as well as this geometrical dependence between filler and polymer is important to pinpoint nano-filler dispersion limits. Identifying these limits is critical toward the processing of superior polymer-based composites which fully utilizes the nano-filler reinforcement.

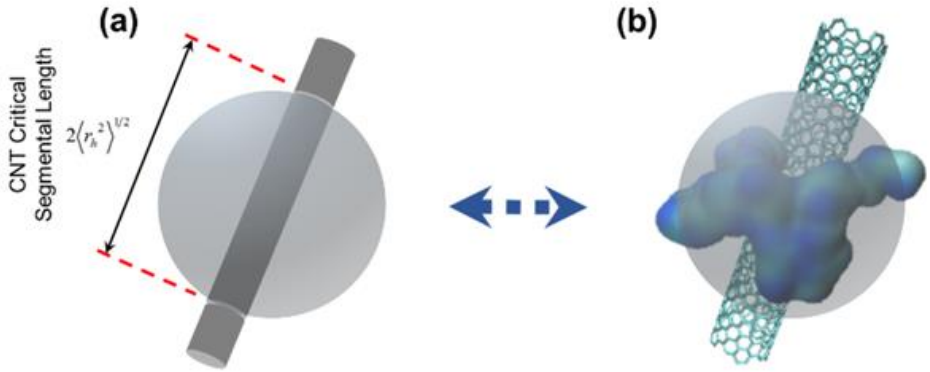

Figure 1 – Schematics showing (a) a 'cylinder-in-sphere' model and CNT critical segmental length and (b) part of CNT is trapped inside a polymer coil along CNT tube axis.