Example proposal introduction linked to PP presentation AgriLife

Project Description

1. Overview and Significance of Proposed Project

Despite all of the promise that composites containing nanoparticles such as carbon nanotubes hold, lack of microstructural control during their processing remains a significant hurdle to their widespread use.1-5 The ultimate **goal** of this project is to precisely tailor the microstructure of high aspect ratio nanoparticles in both liquid suspensions and solid polymer composites through the use of stimuli-responsive, water-soluble polymers to control the extent to which the nanoparticles are stabilized and dispersed. We **hypothesize** that polymer–particle interactions can be weakened or strengthened by increasing or reducing polymer viscosity through the adjustment of an external stimulus (e.g., pH, temperature, or light). The stimulus will modify the degree of ionization and/or the shape of a given polymer, which will, in turn, alter the degree of non-covalent interaction between the nanoparticles and the polymer, as shown in Figure 1. In general, stronger polymer–nanoparticle interactions should result in a better dispersed microstructure; weaker interactions will generate more bundled nanotubes or nanowires, resulting in a different set of properties. The heavily aggregated and fully exfoliated (dispersed) states shown in Figure 1 are the microstructural extremes. We expect that intermediate microstructures will also be possible with the appropriate choice of polymer and stimulus.

In addition to the novelty of using stimuli-responsive polymers to control nanoparticle organization, there are two important benefits to this approach. By focusing on an aqueous environment and water-soluble polymers, this work promotes the use of environmentally benign materials. Furthermore, polymer–particle interactions are non-covalent, allowing the intrinsic properties of the particles to be preserved.

Our overarching r**esearch objective** is to determine the range and sensitivity of microstructural control that can be achieved using stimuli-responsive polymers. The **questions** motivating this research are: To what degree can we tune polymer–nanoparticle interactions through non-covalent means? What are the effects of the interactions on the final composite microstructure and properties? How can we use our findings to engineer polymer structures by optimizing microstructural control of these nanoparticles? In order to balance breadth and depth of research, three model nanoparticles and three classes of stimuli-responsive polymers will be evaluated. To answer these questions, our **project objectives** are to:

- understand how polymer conformation influences nanoparticle dispersion and microstructure;
- relate nanoparticle microstructure to electrical, mechanical, and thermal behavior of
- nanocomposites;
- determine extent of conformational change needed to influence the range and sensitivity of nanoparticle tailoring; and
- understand effect of nanoparticle chemistry on the ability of SRPs to control microstructure.

The significance of our approach is that *materials could be engineered with precisely tailored performance by tuning the microstructure of the particles during manufacture*.

Figure 1. Schematic showing the change in nanoparticle microstructure resulting from a change in stimulus (pH, temperature or light) supplied to the water-soluble polymer matrix. We hypothesize that we can tailor the behavior of the composite by controlling the degree of aggregation or exfoliation of the nanoparticles