Project Title: Frontal polymerization of nanocomposites

Advisor: Leon Dean (PhD student in MatSE), Prof. Nancy Sottos (MatSE)

Project Description:

Frontal polymerization (FP) is a promising technique for rapid, energy-efficient production of materials. An initial stimulus (typically heat) causes the formation of an exothermic polymerization front that propagates spatially through the reaction vessel. Dicyclopentadiene (DCPD) is an example of a monomer suitable for FP because it is highly reactive and produces a mechanically robust polymer. We recently demonstrated that the FP of DCPD saves up to ten orders of magnitude in energy during the manufacturing of fiber-reinforced composites compared to conventional techniques (ref. 1). We are currently investigating FP as a manufacturing method for nanocomposites, which are composites in which the reinforcement phase has at least one dimension less than 100 nm. Figure 1 shows an example of carbon black-filled polymer nanocomposites manufactured using FP. We are interested in using nanoscale fillers to modify the rheology (flow behavior) of DCPD to enable 3D printing of multifunctional nanocomposites. As an undergraduate research assistant, you will be trained to prepare FP resins with various nanoscale fillers. You will characterize these resins using shear rheology, and you will utilize promising formulations to 3D print multifunctional nanostructures. You will also be expected to become familiar with scientific literature in the areas of frontal polymerization and 3D printing of nanocomposites.

Figure 1. Nanocomposites of poly(dicyclopentadiene) filled with carbon black (CB) manufactured via frontal polymerization with increasing CB loading from left to right.

Student background and expected research activities:

We are seeking a motivated, enthusiastic student with interests in *polymer science*, *3D printing*, and/or *nanocomposites*. Hands-on laboratory experience is desired, but not mandatory, as the student will receive the necessary training to perform the experiments in question. The student should be comfortable handling chemicals and operating testing equipment, be able to precisely follow safety protocols and experimental procedures, and possess strong communication skills.

Points of Contact:

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References:

(1) I. D. Robertson, M. Yourdkhani, P. J. Centellas, J. E. Aw, D. G. Ivanoff, E. Goli, E. M. Lloyd, L. M. Dean, N. R. Sottos, P. H. Geubelle, J. S. Moore, and S. R. White, “Rapid energy-efficient manufacturing of polymers and composites via frontal polymerization,” *Nature*, vol. 557, no. 7704, pp. 223–227, 2018.