Jessica Winter

High Throughput, Scalable Nanomanufacturing of Nanocomposites via Micellar Electrospray

In the last few decades, a number of synthesis routes to colloidal nanomaterials have emerged; however, the majority of these rely on low-yield, batch methods. Further, the integration of multiple nanomaterial components, which is desirable to achieve multi-functionality, has been challenging. Chemical synthetic approaches often produce materials with irregular shapes as a result of lattice constraints or with unintended interfacial doping. Here, we describe a novel approach to nanocomposite synthesis that combines a top-down process, electrospray, with a bottom-up process, micellar self-assembly. In this process, droplets containing hydrophobic nanoparticles and block co-polymer amphiphiles are ejected from a coaxial needle in a spray of micron-sized particles which then self-assemble into micelles encapsulating the hydrophobic particles via the interfacial instability method. Using this approach, nanocomposites can be synthesized in a nearly continuous process with a minimum 30 fold increase in production yields. Composites can range from 10-100 nm in size, which is tunable based on the polymer composition, with an average size distribution of ~ 15%. We have used this approach to create composite quantum dots, magnetic nanoparticles, magnetic quantum dots, and polymer composites for applications in biomedical imaging, separations, and drug delivery.