NANO HIGHLIGHT

Environmentally Benign Deagglomeration and Mixing of Nanoparticles

Pls: Rajesh N. Dave¹, Ram Gupta², Robert Pfeffer¹, Sankaran Sundaresan³,
Maria Tomassone⁴

¹New Jersey Institute of Technology, ²Auburn University, ³Princeton University,
⁴Rutgers University

Nanoparticles and nanocomposites offer unique properties that arise from their small size, large surface area, and the interactions of phases at their interfaces, and are attractive for their potential to improve performance of drugs, biomaterials, catalysts and other high-value-added materials. However, a major problem in utilizing nanoparticles is that they often lose their high surface area due to grain growth, or their high surface area is not available where it is needed. Creating nanostructured composites where two or more nanosized constituents are intimately mixed can prevent this loss in surface area, but in order to obtain homogeneous mixing, de-agglomeration of the individual nanoparticle constituents is necessary. In a unique approach [1, 2] a supercritical fluid (SCF), such as supercritical carbon dioxide, which has a liquid-like density and solubility, yet gas-like diffusivity and viscosity, and is environmentally friendly, is used as an ideal medium for intimately mixing nanoparticles. Figure 1 shows a TEM-EELS (transmission electron microscope-electron energy loss spectroscopy) image of a mixture of nano sized alumina and silica particles. This approach is also highly suitable for deagglomerating nanoparticles because the supercritical fluid can penetrate the pores within the nanoagglomerates, and upon rapid depressurization, can cause fragmentation and separation of the nanoagglomerates from within. This subsequently leads to intimate mixing. The proposed study will include a combination of experiments and multiscale simulations, at three different length scales, to obtain a fundamental scientific understanding of the deagglomeration and subsequent mixing processes.

The experimental and theoretical research will provide predictive capabilities that will help in optimization and scale-up, and subsequent technology transfer to industrial partners. Thus this work has the potential to evolve into major enabling technologies for producing nanocomposites in large quantities.

References
[1] For further information about this project email dave@njit.edu