NANO HIGHLIGHT
Environmentally Benign Deagglomeration and Mixing of Nanoparticles

NSF NIRT Grant DMI-0506722
PIs: **Rajesh N. Dave**[1], **Ram Gupta**[2], **Robert Pfeffer**[1], **Sankaran Sundaresan**[3], **Maria Tomassone**[4]
[1]New Jersey Institute of Technology, [2]Auburn University, [3]Princeton University, [4]Rutgers 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 nanostrauctured 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 the purpose of 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.

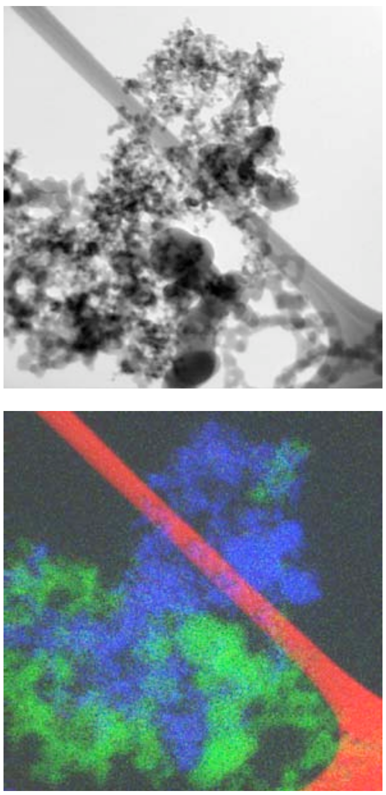

Figure 1. TEM (zero loss, top) image and EELS map (bottom, blue, Aluminum, green, Silicon) for an alumina / silica mixture undergoing a rapid expansion process shows excellent nano-scale mixing. The scale for the entire image is ~ 400 nm across.

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**
[2] Yang, J., Wang, Y., Dave, R.N., Pfeffer, R. Mixing of nanoparticles by rapid expansion of high-pressure suspensions, (2003) *Advanced Powder Technology*, 14 4, Pages 471-493.
[3] Wei, D., Dave, R., Pfeffer, R. Mixing and characterization of nanosized powders: An assessment of different techniques, (2002) Invited Review Contribution, *Journal of Nanoparticle Research*, 4 1-2, Pages 21-41.