

### **453c Monodisperse Core-Shell Silica Nanoparticle Dispersions in Liquid CO<sub>2</sub>**

*Stephanie S. Adkins, Jasper L. Dickson, and Keith P. Johnston*

Carbon dioxide has emerged as an environmentally benign alternative to traditional organic solvents in various industrial applications, such as dry cleaning, metal extraction, nanoparticles synthesis, photoresist drying, enzymatic catalysis, and microelectronics processing. Due to the weak solvent strength of CO<sub>2</sub>, as evidenced by its low cohesive energy density and low polarizability per unit volume, pressures on the order to 200-300 bar are typically needed to stabilize colloids, including microemulsions, miniemulsions, macroemulsions, polymer latexes, and inorganic silica and metal nanocrystals dispersions, in CO<sub>2</sub>. However, new CO<sub>2</sub>-based processes such as particle assembly by drop-casting and free meniscus coating require a vapor-liquid interface. At the vapor pressure (63 bar at 25C), the extremely low solvent strength of CO<sub>2</sub> is generally insufficient to solvate the steric stabilizers for colloids. Therefore, the steric repulsive forces are usually not strong enough to overcome the attractive van der Waals forces between particles and prevent flocculation. A novel approach to this problem is to modify the surface of the particles with a cross-linked polymeric shell which enables dispersibility by weakening the Hamaker interactions of approaching particles. The formation of the polymeric shell allows for the dispersibility of large particles at low pressures by removing the solvation obstacles associated with classical steric stabilizers.

The objective of this study is to examine the density-dependent interparticle interactions of a monodisperse core-shell silica nanoparticle dispersion in CO<sub>2</sub>. The size, stability, and interparticle interactions of the core-shell silica particles were measured as a function of CO<sub>2</sub> density using dynamic light scattering (DLS). Along with DLS, the core-shell silica nanoparticles were characterized with transmission electron microscopy (TEM), scanning electron microscopy (SEM), and elemental analysis. The modified core-shell silica particle dispersion showed a uni-modal size distribution in CO<sub>2</sub> and was stable for greater than thirty minutes in liquid CO<sub>2</sub> at pressures as low as the vapor pressure. The successful stabilization of monodisperse dispersions at the vapor pressure of CO<sub>2</sub> is potentially useful for a variety of applications such as the reaction, separation, coating, and microelectronics processes, in addition to the assembly of materials.