453a Stable Dispersions of Nanoparticles in Dense Co_2 Using Non-Fluorinated Ligands

Philip W. Bell, Madhu Anand, M. Chandler McLeod, Xin Fan, Robert M. Enick, and Christopher B. Roberts

Processing of nanoparticles for many applications often requires solvent based processing, deposition and maneuvering of particles onto surfaces. This is often performed by simply evaporating a liquid solution thereby generating considerable potential for solvent loss. However, solvent dewetting and capillary forces at the liquid/vapor interface of an evaporating droplet can lead to film defects and destruction of nanoscale features. As such, an alternative to using organic solvents is to use supercritical fluids, which are known to have negligible surface tension and favorable interfacial and wetting properties. Because of its natural abundance, low cost, and non-toxic nature, supercritical CO_2 has received much attention both as a medium for particle synthesis and dispersion. Unfortunately, CO_2 is a weak solvent that generally requires fluorinated surfactants for particle synthesis or fluorinated ligands to achieve particle dispersability. Since these fluorinated compounds are both expensive and environmentally persistent, the industrial viability of these processes has been severely hampered. Some of our recent work has focused on the synthesis and dispersion of nanoparticles in supercritical CO_2 formed using fluorinated ligands as capping agents. To remove the necessity for fluorinated ligands, nanoparticles were synthesized in organic solvents and then stably dispersed in dense CO_2. A highly branched, methylated carboxylic acid able to interact with CO2 showed high solubility in supercritical CO_2. By replacing the fluorinated ligands with these carboxylic acids, stable nanoparticle dispersions were obtained. This should greatly aid in CO_2 based nanoparticle technology as CO2 offers many processing advantages, while the fluorine-free ligands are both inexpensive and far more environmentally acceptable.

(1) McLeod, M. C.; Gale, W. F.; Roberts, C. B. Langmuir 2004, 20, 7078.