453f Electrostatic Stabilization of Inorganic Particles and Water Droplets in Supercritical Carbon Dioxide

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Herein we demonstrate colloids may also be stabilized in CO_2 by electrostatic forces, despite the ultra low dielectric constant of 1.5. Zeta potentials of micron-sized water droplets, measured in a microelectrophoresis cell, reached -70mV corresponding to a few elementary charges per square micrometer of droplet surface. This degree of charge was sufficient to stabilize water/CO_2 emulsions for an hour, even with water volume fractions of 5%. Hydrogen ions partition preferentially, relative to bicarbonate ions, from the emulsion droplets to the cores of surfactant micelles in the diffuse double layer surrounding the droplets. The micelles, formed with a low molecular weight branched hydrocarbon surfactant, prevent ion pairing of the hydrogen counterions to the negatively charged emulsion droplets. Dielectrophoresis of the water droplets at a frequency of 60 Hz leads to chains containing a dozen droplets with lengths of 50 µm. Electrostatic stabilization may also be used to stabilize metal and semiconductor colloids in CO_2 by the same mechanism. TiO_2 may be stabilized with ionic surfactants in CO_2 without the addition of any water. The charge per area is higher for the TiO_2 particles than the water droplets and zeta potentials are greater than 100 mV. The ability to form electrostatically stabilized colloids in carbon dioxide is particularly useful in practical applications, since steric stabilization in CO_2 is often limited by the poor solvation of the stabilizers.