Self-Division in Pickering Nano-Emulsions

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Pickering emulsions, *i.e.* particle-stabilized emulsions, have been studied intensively in recent years owing to their wide range of applications including biofuel processing and food preservation. They have also been developed as precursors to magnetic particles for imaging and drug delivery systems. In Pickering emulsions, particles and/or nano-particles with suitable surface chemistries adsorb at the droplet surfaces, with adsorption energy up to thousands of times the thermal energy. Many studies have reported the importance of nano-emulsions. For instance, these colloidal systems with a mean droplet size in the range of 10-100 nm have been considered as vehicles enhancing the transportation of drugs through the skin over conventional topicals. The characteristics of Pickering nano-emulsions pose a number of intriguing fundamental physical questions including a thorough understanding of the perennial lack of detail about how particles arrange at the liquid/liquid interface. There are a number of mechanisms available for the production of nano-emulsions. As traditional methods employed in the food industry since the mid 1990's have used valve homogenization and a microfluidizer, the use of low frequency ultrasound has gained prevalence, at least on a laboratory scale. The issue of the self-division mechanism in droplets stabilized by solid particles is tackled at a mesoscopic level using Dissipative Particle Dynamics (*DPD*) simulations within the *Metadynamics* and *Umbrella Sampling* frameworks. We consider a spherical water droplet in a decane solvent coated with nanoparticle monolayers of two different types: Janus and homogeneous. The chosen particles yield comparable initial three-phase contact angles, chosen to maximize the adsorption energy at the interface. We study the interplay between the evolution of droplet shape and the distribution of the particles at the interface during the self-division of the nano-droplet.