Mass transport phenomena for preparing ultrasmall nanoparticles

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Small nanoparticles with diameters of less than 20 nm offer significant advantages in nanomedicine because they exhibit deeper penetration into tumors and better vascular permeability. In our work, mass transport phenomena were used to reduce the size of colloidal nanoparticles. Our first approach involves the generation of osmotic pressure by layering hexadecane over an oil-in-water miniemulsion containing monomers.[1] As monomer molecules diffused from the nanodroplets into the hexadecane layer, the size of the nanodroplets significantly decreased, resulting in smaller nanoparticles after polymerization. This method could be generalized for many types of nanomaterials, including organic nanoparticles and nanocapsules (polystyrene, poly(methyl methacrylate)), and inorganic nanocapsules (silica). In a second approach, ultrasmall silica nanocapsules were prepared by concurrent processes of Ostwald ripening and a sol-gel reaction of alkoxysilane.[2] The obtained nanocapsules exhibited a diameter of 6 nm with a core-shell morphology. Our approaches take advantage of mass transport phenomena to make ultrasmall nanomaterials in a simple way, where the obtained nanoparticles and nanocapsules were smaller than those prepared with miniemulsion method, yet still contained less surfactant than those prepared in microemulsions. These methods are suitable for preparing ultrasmall nanomaterials for drug delivery, bioimaging and gene therapy.

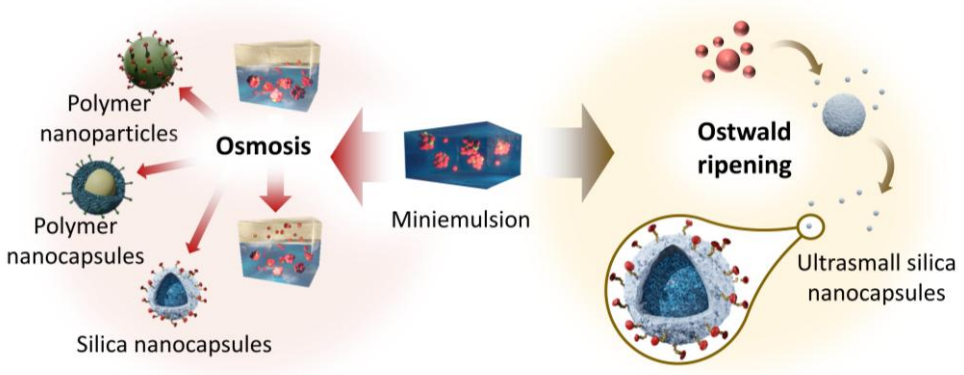

Figure 1: Reducing the size of nanoparticles and nanocapsules by osmosis and Ostwald ripening.

References:

[1] Doan-Nguyen, T. P.; Mantala, K.; Atithep, T.; Crespy, D. *ACS nano* **2022**, *17*(2), 940-954.
[2] Doan-Nguyen, T. P.; Jiang, S.; Koynov, K.; Landfester, K.; Crespy, D. *Angewandte Chemie International Edition* **2021**, *60*(33), 18094-18102.