Fabrication of Polymer Grafted Core-Shell Nanoparticles

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Principal Investigator(s): Christopher Ober
User(s): Yu Shao

Affiliation(s): Materials Science and Engineering, Cornell University

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Contact: cko3@cornell.edu, ys2295@cornell.edu

Primary CNF Tools Used: Zetasizer

Abstract:

Polymer-grafted nanoparticles (PGNs) possess the advantages of both polymers and inorganic cores, and demonstrate superior magnetic, optical, electronic, and mechanical properties. PGNs were synthesized by mini-emulsion polymerization and the brush canopy size, graft density and molar mass of the grafted polymer chains could be controlled by modifying the monomer feeding rate, the monomer concentration, and other parameters. Through combined technologies we are about to fabricate a series of inorganic-inorganic core-shell nanoparticles based on unique silicon-containing polymer precursor and unfold the structure-property relationship towards cutting edge magnetic and photoresponsive materials.

Summary of Research:

In this research, it is critically important to obtain stable colloidal emulsion systems that create a nano-encapsulation environment and then be able to graft uniform polymer brushes on the surface of NPs. To characterize the colloidal suspension, we use mainly dynamic light scattering (DLS) technique to monitor the emulsion condition before and after polymerization. As shown in Figure 1, particle size and distribution can be varied due to different monomer feeding ratio. Morphology of core-shell NPs is uniform with PDI close to 0.1 according to DLS and also confirmed by STEM (Figure 2). However, when it comes to preceramic polymer coating, it's tricky to make a uniform emulsion system.

As shown in Figure 3, even though the data file says good quality, the curve shows an asymmetric peak profile which means that the size distribution is not uniform. In addition, concentration and temperature will influence the colloidal system a lot. Progress needs more of modification.

Conclusions and Future Steps:

DLS is a facile tool to characterize the emulsion condition of colloidal system. For emulsions with nanoparticles and multiple ingredients, it's a challenge to make ideally uniform nano-encapsulation environments. Concentration and temperature play critical roles and need to be modified systematically in the future.

References:

[1] Chenyun Yuan, Florian Kafer, and Christopher K. Ober. (2021). Polymer-Grafted Nanoparticles (PGNs) with Adjustable Graft-Density and Interparticle Hydrogen Bonding Interaction.

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[3] Roselynn Cordero, Ali Jawaid, Ming-Siao Hsiao, Zoe Lequeux, Richard A. Vaia, Christopher K. Ober, "Mini Monomer Encapsulated Emulsion Polymerization of PMMA in Aqueous ARGET ATRP", ACS Macro Letters, 7, 4, 459-463.

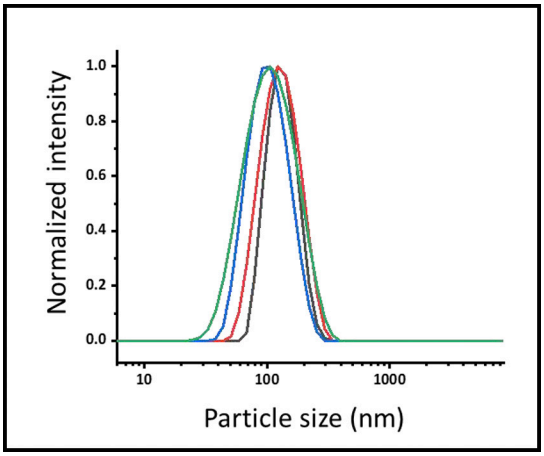

Figure 1: DLS overlay of CdS nanoparticles coated with silica shell.

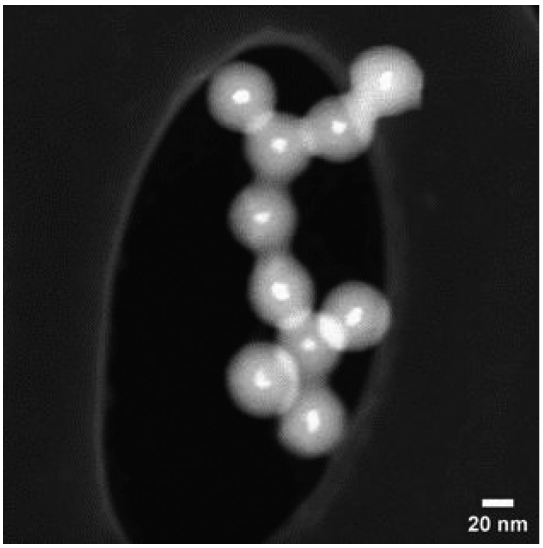

Figure 2: STEM image of CdS nanoparticles coated with silica shell.

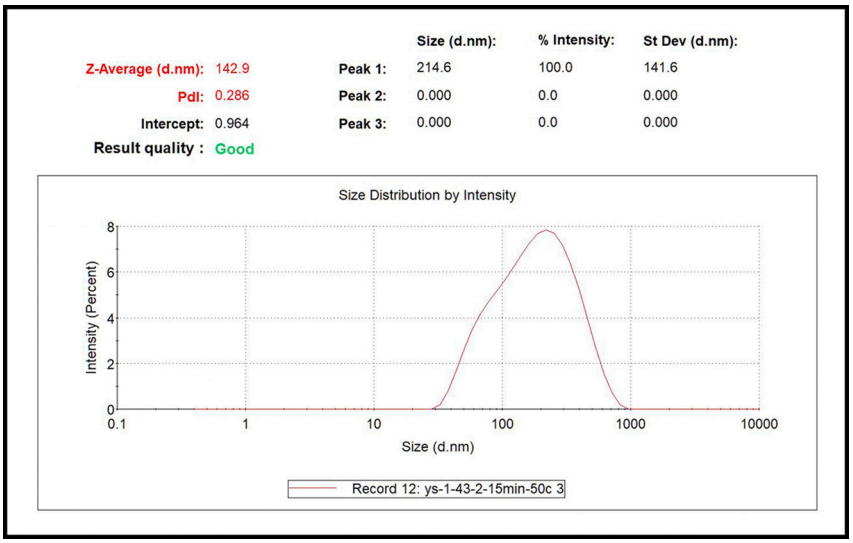

Figure 3: DLS of emulsion made by $CoFe_2O_4$ NPs and preceramic precursors at 50°C.