Engineering Hybrid Nanocapsules for Multifunctional Applications in Bioimaging

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For targeted bioimaging and theranostic applications, we have successfully developed a class of PEOlated polymeric micelle/silica as multifunctional nanocapsules for targeted bioimaging and controlled delivery. Bioimaging contrast agents, such as fluorescent conjugated polymers, CdSe/CdS/ZnS quantum dots (QDs), MnO_2 and Fe_3O_4 nanocrystals have been successfully encapsulated into poly(ethylene oxide) (PEO)-based polymeric micelle/silica dual layers via interfacial templating condensation. The encapsulation follows a green and straightforward microemulsion mechanism that directly proceeds in a near neutral pH aqueous environment. No detriment effects to the optical and magnetic properties of fluorescent conjugated polymers, QDs, MnO_2, and Fe_3O_4 nanocrystals are observed during encapsulation. The core-shell nanocapsules thus generated possess a polymeric micelle framework with a single QD/Fe_3O_4 nanocrystal encapsulated in the hydrophobic micellar core, an ultrathin (<5 nm in thickness) yet robust silica shell confined to the micellar core/corona interface and free PEO chains dangling on the surface. The free PEO chains effectively prevent nonspecific adsorption of biomolecules to the nanoparticles. Double shielding of polymeric micelle/silica shell remarkably improves the fluorescence resistance of conjugated polymers and QDs to strong acids and highly salted buffers. In vitro testing using MDA-MB-231 breast cancer cells demonstrates that these organic/inorganic dual layer-protected nanocapsules conjugated with folate show noncytotoxicity, bright fluorescence cellular imaging with high target specificity and improved performance in controlled delivery. In this talk, the latest development for the multifunctional nanocapsules is presented. The processing parameters involved in developing the multifunctional nanocapsules and their performance in bioimaging, both for T1 and T2, and theranostic applications are presented and discussed.