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Metal-Enhanced Fluorescence of Dye-Doped Silica Nano Particles

- Kalani B. Gunawardana,
- Nathaniel S. Green,
- Lloyd A. Bumm &
- Ronald L. Halterman

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Abstract

Recent advancements in metal-enhanced fluorescence (MEF) suggest that it can be a promising tool for detecting molecules at very low concentrations when a fluorophore is fixed near the surface of metal nanoparticles. We report a simple method for aggregating multiple gold nanoparticles (GNPs) on Rhodamine B (RhB)-doped silica nanoparticles (SiNPs) utilizing dithiocarbamate (DTC) chemistry to produce MEF in solution. Dye was covalently incorporated into the growing silica framework via co-condensation of a 3-aminopropyltriethoxysilane (APTES) coupled RhB precursor using the Stöber method. Electron microscopy imaging revealed that these mainly non-spherical particles were relatively large (80 nm on average) and not well defined. Spherical core-shell particles were prepared by physisorbing a layer of RhB around a small spherical silica particle (13 nm) before condensing an outer layer of silica onto the surface. The core-shell method produced nanospheres (~30 nm) that were well defined and monodispersed. Both dye-doped SiNPs were functionalized with pendant amines that readily reacted with carbon disulfide (CS_2) under basic conditions to produce DTC ligands that have exhibited a high affinity for gold surfaces. GNPs were produced via citrate reduction method and the resulting 13 nm gold nanospheres were then recoated with an ether-terminated alkanethiol to provide stability in ethanol. Fluorescent enhancement was observed when excess GNPs were added to DTC coated dye-doped SiNPs to form nanoparticle aggregates. Optimization

of this system gave a fluorescence brightness enhancement of over 200 fold. Samples that gave fluorescence enhancement were characterized through Transmission Emission Micrograph (TEM) to reveal a pattern of multiple aggregation of GNPs on the dye-doped SiNPs.