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Fluorescent Dye Copolymerized Silica Nanoparticles for Labeling and Sensing

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Fluorophores are often used in bioanalytical and medical applications as labels and sensors but their applications are not limited to these areas. There have been continuous research efforts to increase fluorescence intensity of these reporting labels and probes. One approach to achieve high fluorescence intensity is to incorporate several fluorophores into a single reporting or sensor entity which chemical and physical properties are controlled. Nanotechnology made possible these new designs. The most stable sensor and reporting label can be made if the fluorophores are copolymerized into the nanoparticle. Silica nanoparticles are one of the most economical ways to achieve these goals. Fluorescent dye copolymerized silica nanoparticles can be made of using almost any desired fluorophores, or more than one type of fluorophores, that can be modified to have suitable functional moiety for covalent binding to the silicate monomer used during the silica nanoparticle synthesis. Although fluorescent silica nanoparticles can be made by simply saturating commercially available porous silica nanoparticles with fluorescent dyes; solid or porous silica nanoparticles containing covalently copolymerized dyes have much superior properties as no leaching would occur. For example using appropriate functional moieties, absorption and fluorescence properties of the nanoparticle would change when complexes to metal ions, to detect pH changes, bind to biological molecules, etc. NIR dyes that are copolymerized in these structures have significant spectral advantages over visible dyes as the NIR spectral region (650-900 nm) offers reduced background interference and larger penetration depths. Fluorescent dyes confined to such small volume (20-100 nm diameter) often prone to self quenching. This can significantly be reduced by using dyes that have larger Stokes' shift. This presentation discusses facile synthesis of dye copolymerized silica nanoparticles. This can be achieved for example by using dye modified TEOS during the silica nanoparticle synthesis. The molar ratio of TEOS and modified TEOS will determine the fluorescent dye load in the silica nanoparticle. Dependent on the functional groups present in the reporting dye to be used to prepare the modified TEOS and its spectral properties, the resulting silica nanoparticle can be used for many applications. Several advantages emerge from using silica nanoparticle protected sensors; such as higher dye stability and brighter fluorescence. Several applications will be discussed including chemical, biological and medical uses of these fluorophore copolymerized silica nanoparticles.