Encapsulation of Semiconducting Nanoparticles in Amine-Functionalized Ormosils.

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Inorganic nanoparticles dispersed in organic matrices are of importance to a number of emerging technologies. However, obtaining useful properties from such organic-inorganic composites often requires high concentrations of well-dispersed nanoparticles. In order to achieve this goal the chemistry of the particle surface and the matrix must be closely matched. This is based on the premise of minimization of the interfacial free energy; an excess of free energy will cause phase separation and ultimately aggregation. Thus, the optimal system is one in which the nanoparticles are stabilized by the same molecules that make up the encapsulant. Yet, the organic matrix is typically chosen for its bulk properties, and therefore may not be amenable to chemical modification. Also, the organic-inorganic interface is often critical to establishing and maintaining the desired nanoparticle (and hence composite) properties, placing further constraints on proposed chemical modification. We have adopted the use of amine-functionalized trimethoxysilanes (ormosils) as both a stabilizing organic and encapsulating matrix. In this work, we demonstrate that ormosils can produce beneficial interfacial effects (see Figure 1) that can be maintained through the encapsulation process. CdS and CdSe nanoparticles were synthesized using a variety of stabilizing organics and encapsulated in epoxies, silicones, and ormosils. Ormosil stabilized nanoparticles could be incorporated into ormosil matrices at significantly higher concentrations that with other stabilizers or encapsulants. We discuss the role of chemical compatibility between the stabilizing organic and the encapsulant and relate changes in optical properties to interfacial phenomena. Materials are characterized via TEM, HPLC, XRF, and optical techniques.

Acknowledgments:
Sandia National Laboratories is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-AC04-94AL85000.

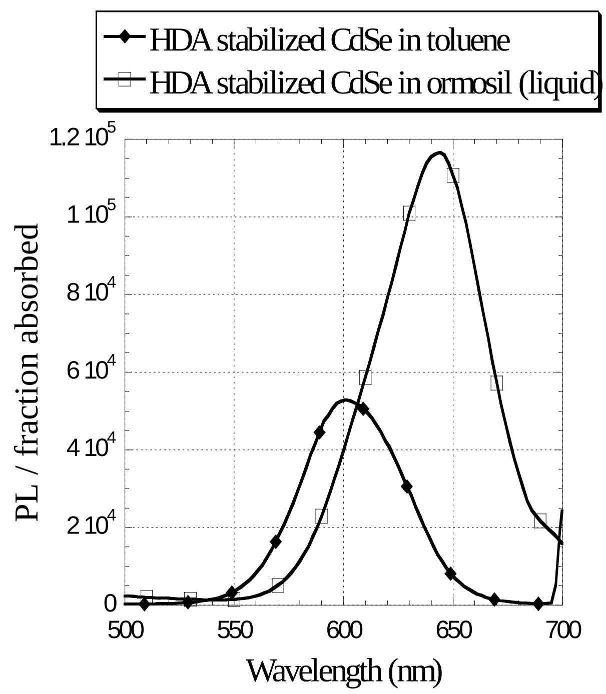

Figure 1. Enhancement of luminescence of HDA (hexadecylamine) stabilized CdSe nanoparticles via dispersion in ormosil.