Fluorescence microscopy in confined geometry: Single molecules, ions, and polymer quantum dots

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Over the past several years, our group at ORNL has developed techniques to isolate, manipulate, and probe single fluorescent molecules in liquid microdroplets or polymer micro/nanoparticles formed from solution. Confinement and manipulation of single molecules in "large" spherical host particles (d > 100 nm) have a number of interesting aspects and applications including development of single-molecule lasers, ordered arrays of single molecules, and molecular sorting. We are also exploring the luminescence and spectroscopy of single rare-earth ions (europium or terbium) caged in metal oxide nanocrystals. Luminescence imaging of single ions in doped nanocrystals shows interesting and perhaps somewhat surprising features including on-off blinking and multiple discrete luminescence intensity levels or 'bright states', suggesting possible important applications in display technologies, and optical data storage. We are also exploring the luminescence of quantum confined electrons on the surface of polymer nanoparticles. These species represent a new class of artificial atoms with a number of unique and interesting properties.

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Research sponsored by Division of Chemical Sciences, Biosciences, and Geosciences, Office of Basic Energy Sciences, U.S. Department of Energy, under Contract DE-AC05-00OR22725 with Oak Ridge National Laboratory, managed and operated by UT-Battelle, LLC.