PROBING SINGLE-ION LUMINESCENCE IN RARE-EARTH DOPED NANOCRYSTALS

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Recently there has been a great deal of attention focused on rare-earth doped nanocrystals (DNCs) as a new class of luminescent nanomaterials with novel and tunable optical properties. The luminescent wavelengths of the particles are defined primarily by the dopant ion and are not strongly sensitive to particle size or the choice of host material. However, some controversy exists as to the role of quantum confinement of the optical electron and particle size effects on the magnitude of the electric dipole transition moment. We describe recent results of experiments probing the luminescence properties of single europium and terbium ions in isolated yttrium oxide nanocrystals (2 -15 nm diam.). In our experiments, we used time-resolved fluorescence microscopy techniques similar to those used to probe single fluorescence molecules and semiconductor quantum dots, to image the luminescence from individual nanoparticles with a time resolution of a about 100 ms. In contrast with luminescence from larger crystals containing several ions, small particles believed to contain single ions show fascinating on-off behavior on a variable time scale. In addition, the single-ion luminescence shows at least 3 well-defined discrete intensity levels, or "bright states". We propose that the on-off blinking and multiple bright state luminescence from single europium ions derives from local symmetry fluctuations in the host crystal.

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