Università degli Studi di Milano Bicocca
Dipartimento di Scienza dei Materiali
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Seminar Room – Department of Materials Science U5

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Single-Photon Emission with Strained CdSe/CdS Colloidal Nanocrystals

0D colloidal quantum dots are becoming a viable, solution-processed alternative to epitaxial quantum dots. For instance, in contrast with epitaxial quantum dots, they can operate at room temperature, and their emission can be tuned to any desired wavelength by simply controlling the composition and size of the quantum dots. While both systems bear many resemblances, there are also essential differences. In this seminar, I will use this as starting point to discuss how we can exploit chemical synthesis to produce a variety of sizes and shapes of strained colloidal CdSe/CdS nanocrystals that show peculiar single-photon emission.
I will discuss how to synthesize highly fluorescent CdSe/CdS colloidal quantum dots that show (nearly) no intermittence. In addition, interfacial strain and piezoelectric fields in our CdSe/CdS pure-phase wurtzite quantum dots plays a particular role, as it increases the electron-hole separation and exciton-exciton repulsive interactions, especially for quantum dots with a large CdSe core. This leads to an extended exciton lifetime, but at the same time to a strong exciton-biexciton emission energy splitting. As these quantum dots have intrinsic fluorescence lifetimes that extend beyond 100 nanosecond, the emission rate can be increased by electrochemically charging them with up to 20 electrons, which increases the radiative recombination rate, while at the same time the nonradiative Auger rate remains suppressed due to the proper choice of quantum dots core and shell dimensions. Finally, the single-photon emission can be improved dramatically by spectrally filtering out the biexciton emission, which, again due to the unique features of our quantum dots, can be performed at room temperature due to the exceptionally large blue shift of the biexciton emission.