Protection of quantum dots – Embedding into ionic matrices

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Nowadays, semiconductor quantum dots (QDs) are in high interest as components in optoelectronic and photovoltaic devices due to their unique size-dependent optical properties.[1] They have a tunable and narrow photoluminescence (PL) and provide a high color purity. One of the most challenging tasks is the protection of these QDs to improve their chemical and photo stability from environmental influences e.g. moisture, heat and light. A protective layer has to be tight enough and defect-free to shield the QDs against external influences.[2]

The incorporation of colloidal quantum dots into ionic salt matrices (e.g. NaCl, KCl, KBr, etc.) enables the fabrication of robust and strongly emitting mixed crystals. The salt matrices appear to be an excellent protection against the environment and enhance the photo and chemical stability of the QDs.[2,3] The facile and reproducible method of salt crystallization allows to incorporate semiconductor QDs within a broad range of accessible emission wavelengths from green to red (Fig. 1).[4]

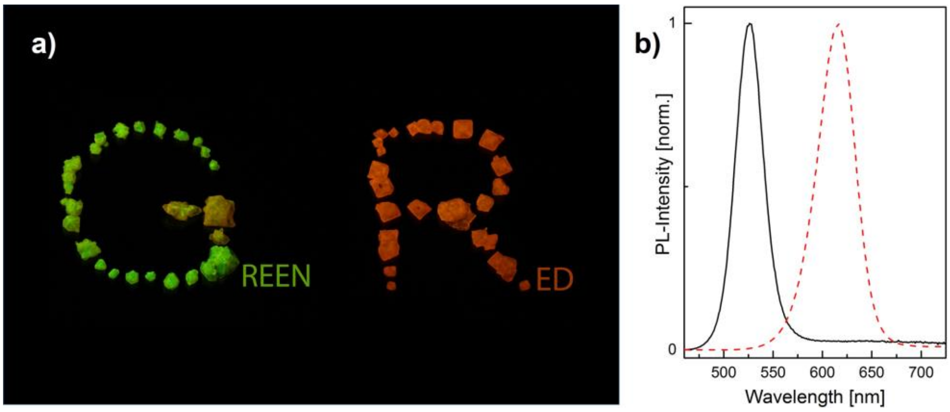

Fig. 1 (a) Photograph of typically green and red emitting NaCl-based mixed crystals containing colloidal CdTe QDs (taken with UV lamp, excitation at 365 nm). (b) PL spectra of the two mixed crystals from panel a.

A possible application is the use of mixed crystals as color conversion materials e.g. for producing white light-emitting diodes (WLEDs). The milled powder of the mixed crystals are resistant against the encapsulants (e.g. silicone or epoxide resins) and the final emission spectra can be tuned by controlling the amount of applied luminescent powder.[4]

These days, there are different crystallization methods for the incorporation of either aqueous- or oil-based QDs.[2,3] One of these is the "classical" crystallization in which mixed crystals with colloidal QDs are grown from a saturated salt solution within seven days under mild conditions.[2] As shown in Fig. 1 the incorporation of QDs into NaCl resulted in predominantly pyramidal shaped mixed crystals. Despite the growing interest to the encapsulation of QDs into inorganic matrices, the encapsulation process is presently not well understood. In this poster, we will focus on the mechanism and the kinetics of the encapsulation process. Moreover, the application of Kelvin Probe Force Microscopy (KPFM) in combination with optical spectroscopy methods allowed us to describe the peculiarities of the QD-matrix interactions and their influence on the shape, stability and optical properties of the final composite.

1) H. Weller *et al., Angew. Chem. Int. Ed.*, **1993**, *32*, 41-53.
2) T. Otto *et al., Nano Lett.*, **2012**, *12*, 5348-5354.
3) M. Adam *et al., Adv. Funct. Mater.*, **2015**, *25*, 2638-2645.
4) M. Adam *et al., J. Phys. Chem. Lett.*, **2016**, *7*, 4117-4123.