Highly Luminescent Nanocrystals: Protecting and Tuning of their Emission Properties

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The incorporation of colloidal nanocrystals (NCs) into composite materials under preservation of long-term stability and photoluminescence quantum yield (PL QY) is a challenging task for applications as color conversion materials, lighting or displays. Opposed to the commonly used polymers, the embedding of NCs into ionic salt matrices results in an even higher increase of the photo-, chemical and thermal stability while preserving their strong luminescence.[1]

Herein, we overcome the drawbacks of the current used methods,[1-4] e.g. loading, time and processability, by using a material property of the ionic matrix, namely cold flow. Under pressure (2.2 GPa) the NC-loaded salt (e.g. KCl, KBr, CsI, and NaCl) undergoes a sintering process which results in highly emitting and transparent NC-salt pellets (Fig. 1).[5] This versatile approach is applicable for various NC-systems (CdSe/CdS, CdSe/ZnS, InP/ZnS) and allows to adjust the NC-loading and to control the size, shape and thickness of the composite material. To demonstrate the applicability of the resulting NC-salt composites the pellets can act as color conversion material when stacked on top of a commercial blue-emitting LED.

Fig. 1 Scheme for the incorporation of various NCs into NC-salt composite materials using cold flow.

In addition, the immobilization of $CsPbBr_3$ perovskite NCs on potassium halide salts (KCl, KI) results in solid-state anion exchange reactions.[6] The post-synthetic tuning of the optical properties of the NCs can be accelerated under cold flow conditions. This is the first example of ion exchange involving NCs in the solid state. During this process the emission properties of the incorporated NCs, such as high PL QY (up to ~80%) and narrow full widths at half-maximum, are preserved. The embedded $CsPbBr_3$ NCs in KBr show unaltered stability for several weeks when combined with an additional silicone resin.

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