Tuning the Photoluminescence of InP Quantum Dots with Gallium

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Semiconductor nanocrystals (quantum dots, QDs) are well known for their superior photophysical properties and enabled advancements in several key technologies of the 21st century and numerous technological applications. However, the most studied II-VI semiconductor nanocrystals contain the toxic heavy metal element cadmium, which is limiting their utilization in commercial applications. This has drawn the interest to alternative materials with less toxicity but having similar photophysical features [1].

The newest generation of TV screens based on QDs have shown that there is a promising environmentally friendly alternative with similar optoelectronic properties, namely indium phosphide (InP) QDs. InP QDs possess a bulk band gap of 1.35 eV with an exciton Bohr radius of ca. 10 nm and thus allow to tune their photoluminescence (PL) from the visible to the near-infrared. Tuning the size and shape of InP QDs and thus tailor their optoelectronic properties can be achieved by different strategies, which range from different types and concentrations of precursors, synthesis temperature or post-synthetic manipulations like etching [2]. The incorporation of other elements like Gallium within the InP core synthesis is another possibility. Using a GaP intermediate layer before growing a ZnS shell has been shown to increase the PL quantum yield, which has been attributed to reduced lattice strain and the removal of phosphor vacancies [3,4]. Different Ga precursors were investigated but a thorough investigation in terms of their reactivity, localization in the QD and influence on the photophysical properties is lacking to date.

In this contribution we will present the detailed investigation of the presence of two different Ga precursors within the InP core synthesis. Photophysical characterizations (steady-state and PL life-time measurements), transmission electron microscopy, XRD and EDX gave insights into the reactivity of the Ga precursors, the Ga localization in the InP core and influences on the photophysical properties. The variation of the precursor and surfactant concentration and the utilization of different ligands for the Ga precursor allowed tuning the PL emission towards the blue or the red. Depending on the used precursor type we observed the formation of larger-sized InP/GaP core/shell nanocrystals or the formation of InGaP alloy structures enabling to assess the blue range of emission (475 nm) [5].

[1] P. Reiss *et al*., *Chem. Rev.* **116** (2016), 10731.
[2] S. Tamang *et al*., *Chem. Mater.* **28** (2016), 2491.
[3] S. Kim *et al.*, *J. Am. Chem. Soc.* **134** (2012), 3804.
[4] J. P. Park *et al*., *Scientific Reports* **6** (2016), 30094.
[5] K. D. Wegner *et al.*, *Chem. Comm.* **55** (2019), 1663.