RT Synthesis of Air-Stable and Size-Tuneable Luminescent ZnS coated Cd_3P_2 Nanocrystals with High Quantum Yields

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Abstract

The high temperatures usually required for the synthesis of quantum dots (QDs) are a major drawback, which, beyond obvious energetic concerns, represents a significant limit in the implementation of simple “routine” synthesis methods to ensure run-to-run reproducibility, automation possibilities, and standardization of the nanomaterials. Synthetic protocol to cadmium phosphide QDs, which is a conspicuous material by virtue of its ability to absorb and emit in the near infrared wavelength window (narrow bandgap -0.55 eV- and large excitonic radius -18 nm) also suffer from this major limitation (T> 250°C).[1,2] We will show how the design of a suitable precursor allows breaking this technological limitation and allows the room temperature synthesis of air-stable, size-tunable, and high optical quality (quantum yields > 50%) Cd_3P_2/ZnS QDs.[3] A large range of emissivity is easily covered (from ~600 nm to 1400 nm) thanks to the modulation of the concentration of reactants and of the temperature (30°C, 90°C). The strategy followed to achieve this two steps synthesis at low temperature is based on the choice and design of highly reactive and soluble precursors, $Cd(OAc)_2(OAm)_2$ (OAc = acetate, OAm = octylamine) and $(TMS)_3P$ (tris(trimethylsilyl)phosphine) for the formation of the Cd_3P_2 cores and $Zn(OAc)_2(OAm)_2$ and C_2H_4S (ethylene sulphide) for the coating process. ^1H, ^{13}C and ^{31}P solution and solid-state NMR studies will be presented and show the presence of a thin layer of oxide at the interface Cd_3P_2/ZnS and of tightly bond ligands (acetate and octylamine) at the surface of the QDs.

References

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[3] W.-S. Ojo, S. Xu, F. Delpech, C. Nayral, B. Chaudret Angew. Chem. Int. Ed. **51** (2012) 738.

Figures

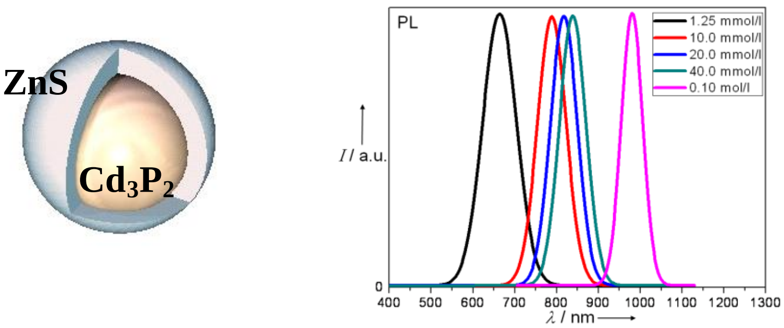

Fig.1 Concentration effect on the PL emissivity of core/shell Cd_3P_2/ZnS QDs