RT Synthesis of Air-Stable and Size-Tuneable Luminescent ZnS coated Cd$_3$P$_2$ 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$_3$P$_2$/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)$_3$P (tris(trimethylsilyl)phosphine) for the formation of the Cd$_3$P$_2$ cores and Zn(OAc)$_2$(OAm)$_2$ and C$_2$H$_4$S (ethylene sulphide) for the coating process. $^1$H, $^{13}$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$_3$P$_2$/ZnS and of tightly bond ligands (acetate and octylamine) at the surface of the QDs.

References


Figures

![Fig.1 Concentration effect on the PL emissivity of core/shell Cd$_3$P$_2$/ZnS QDs](image-url)