Oxide-Free Indium Phosphide Quantum Dots

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Indium phosphide quantum dots (InP QDs) have the potential to be an excellent, non-toxic alternative to traditional cadmiun selenide QDs. However, the syntheses of monodisperse, size-controlled samples remains a challenge, in part due to the complicated surface chemistry of these particles. In particular, InP QDs have been shown to be extremely air-sensitive and thus the treatment and prevention of surface oxides must be considered carefully when attempting to achieve controlled growth of these particles. [1] In particular, we have previously demonstrated that the use of classical high-temperature procedures with indium carboxylate precursors induces an indium oxide surface layer that readily forms as a result of decarboxylation processes leading to water-based, *in-situ* – formed impurities. [2]

We present here a comprehensive study that elucidates this oxidation mechanism utilizing a novel indium precursor, $In(amidinate)_3$, more reactive than traditional carboxylate or halide indium sources. [3] Indeed, while several reports utilizing different phosphorus sources can be found [4], the variation of the indium source has been much less described. Our research has granted insight into the mechanism of oxide formation, including the sources of oxidants arising from previously unconsidered side-reactions. This increased knowledge of ligand and surfactant chemistry is valuable to the further efforts of precise surface control. The possibility to avoid oxidation of the QD surface under the correct conditions will be exposed and we demonstrate the ability to successively grow multiple layers of oxide-free InP surfaces.

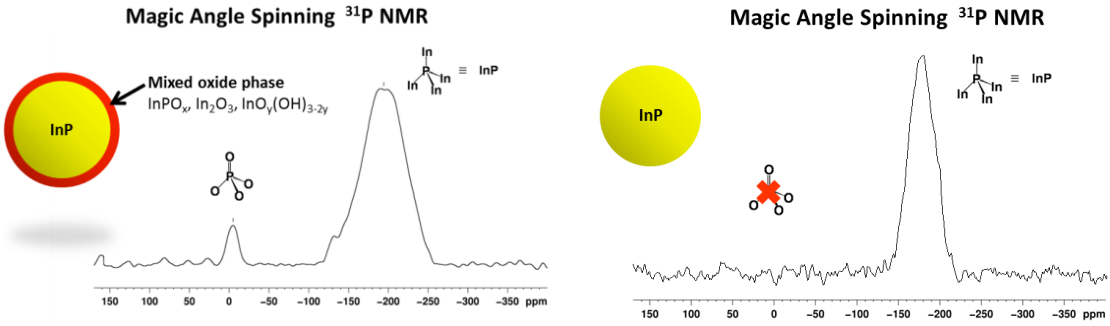

Fig. 1 MAS ^{31}P NMR Signals of InP Quantun Dots with (left) and without (right) an oxide layer

The QDs were fully characterized by TEM, and spectroscopic techniques such as UV-Vis, Photoluminescence Spectroscopy, and solution and solid state ^{1}H, ^{13}C, ^{31}P techniques, and notably the absence of oxides is shown using solid state (MAS) NMR spectroscopy (Fig. 1).

1) L. Xie *et al*., *Chem. Mater.*, **2015**, *27,* 5058-5063.
2) H. Virieux et al., *JACS*, **2012**, *27*, 4893-4898.
3) M.Tessier *et al.*, *Chem. Mater.*, **2015**, *27*, 4893-4898.
4) S. Tamang et. al., *Chem. Mater.*, **2016**, *28*, 2491.