A Novel Approach to the Solution-Phase Synthesis of Nitride Nanomaterials from Simple Organo-Amide Precursors

Yang Chen,[a] Nathan Landes,[a] Zhihui Liu,[a] Cameron Hurley,[a] Niladri Karan,[a] Rémi Beaulac[a]

[a]*Department of Chemistry, Michigan State University, East Lansing, MI, USA*

Due to the scarcity of reactive nitrogen precursors, III-V semiconductors such as gallium or indium nitride are challenging materials to prepare by colloidal chemistry methods, with most methods relying on the use of insoluble polar metal amides, yielding polydisperse and highly aggregated nanocrystalline samples. Indium nitride (InN) has many desirable properties for a wide range of applications, ranging from solid-state lighting (in combination with the notorious violet emitting GaN material, InN offers the yet untapped potential to cover the whole visible and near-infrared range from a single family of materials), to electronics and photo-electrochemical applications. Unfortunately, InN is not only challenging to prepare, but its intrinsic electronic properties are presently misunderstood - both bulk and nanocrystalline forms of the material exhibit high levels of n-type doping of unknown origin, which severely limits the use of InN in most areas where it would be of interest.

We recently uncovered an approach to synthesize colloidal indium nitride nanoparticles which is based on simple alkylamide precursors derived from the same fatty amine ligands that are often used in colloidal nanomaterial syntheses.[1] The alkylamide precursors serve a dual purpose, first generating in situ metallic indium nanoparticles, and then providing in a second step a nitrogen source for the growth of indium nitride nanorods catalyzed by the metallic indium through the well-established Solution-Liquid-Solid (SLS) growth mechanism. An intriguing aspect of this new scheme is the nature and origin of the reactive precursors that lead to the observed nitride chemistry, which has been unraveled by a careful quantitative analysis of the side-products generated through the reaction. A detailed analysis and comparison of the kinetics of the reaction, as well as of the electronic structure of SLS-grown InN nanorods with traditionally grown InN nanoparticles will be presented in relation with the underlying proposed mechanism responsible for the formation of InN nanocrystals.[2]

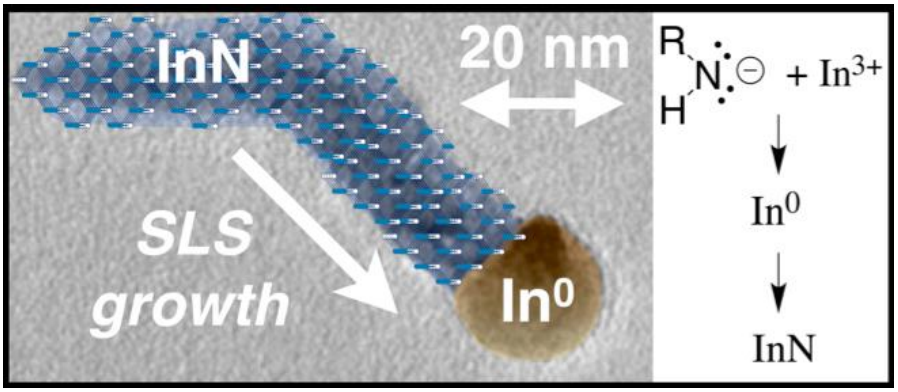

Fig. 1 SLS Growth of InN nanorods, catalyzed from In(0) droplets.

1) N. S. Karan, Y. Chen, Z. Liu, R. Beaulac, *Chem. Mater.*, **2016**, *28*, 5601.
2) Y. Chen, N. Landes, C. J. Hurley, R. Beaulac, *manuscript in preparation*