Towards Bright Indium-Zinc Nitride nanocrystals using greener synthesis methods

Simon M. Fairclough,[a] Rinku Saran,[b] Peter N. Taylor,[c] Pip C. J. Clark,[d] Edward A. Lewis,[e] Ben F. Spencer,[e] Sarah J. Haigh,[e] Wendy R. Flavell,[d] Richard J. Curry, Mark A. Green[a]

[a] *Department of Physics, King's College London, Strand, London, WC2R 2LS, UK*
[b] *ATI, Department of Electrical and Electronic Engineering, University of Surrey, Guildford, Surrey, GU2 7XH, UK*
[c] *Sharp Laboratories of Europe Ltd, Edmund Halley Road, Oxford Science Park, Oxford, UK*
[d] *The Photon Science Institute, The University of Manchester, Alan Turing Building, Oxford Road, Manchester, M13 9PL, UK*
[e] *The School of Materials, The University of Manchester, Oxford Road, Manchester, M13 9PL, UK*

III-V nitride semiconductors offer an exciting possibility to tune the intrinsic band gap energy from the infra-red through the visible into the ultraviolet spectrum by alloying and quantum confinement effects. Whilst nitride based systems have been mainly grown via CVD and MBE routes, they have been used to great effect in light emitting devices and photovoltaic devices [1,2]. At present, the routes to colloidal-based nitride nanoparticles are limited and have mainly utilised nitrification of oxide nanoparticles [3]. More recently, the direct synthesis of nitrides has focused on the thermal decomposition of metal precursors with ammonia, nitrates, azides or sodium amide, for which the resulting particles have demonstrated interesting catalytic and plasmonic features [1,4,5,6,7]. Whilst indium nitride (InN) nanoparticles have been synthesised via these methods, no photoluminescence has been reported thus far [5,6]. However, bright Zn_3N_2 has been synthesised via the thermal decomposition of highly pyrophoric diethyl zinc whilst bubbling highly volatile ammonia gas through the solution [7]. Alternatives to these highly volatile reagents for large scale manufacture are highly desirable. Here we will present the synthesis and characterisation of bright zinc, indium and alloyed nitride based nanocrystals (Fig. 1), using sodium amide as the nitrogen precursor.

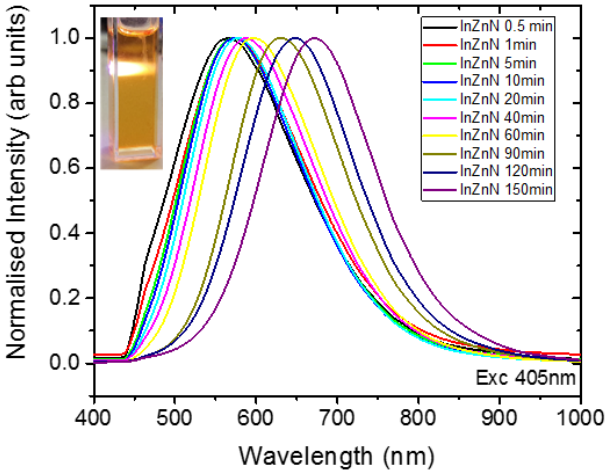

Fig. 1 Photoluminscence spectra of bright InZnN nanoparticles as a function of growth time made via sodium amide method. Inset: An image of a solution of InZnN in hexane under 405nm laser excitation.

1) B. Mazumder *et al.*, *J. Mater. Chem.*, **2009**, *19*, 4673.
2) S. Nakamura *et al.*, *Appl. Phys. Lett.*, **1994**, *64*, 1687.
3) R. Aghababazadeh *et al.*, *Surf. Sci.*, **2007**, 601, 2881.
4) J. Choi *et al.*, *J. Mater. Chem.*, **2006**, *16*, 3774.
5) N. Karen *et al.*, *Chem. Mat.*, **2016**, *28*, 5601.
6) P. Palomaki *et al.*, *J. Am. Chem. Soc.*, **2013**, *135*, 14142.
7) P. Taylor *et al.*, *J. Mater. Chem. C.*, **2014**, 2, 4379.