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Three-dimensional controlled growth of monodisperse sub-50 nm heterogeneous nanocrystals and their luminescent properties

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Abstract The ultimate frontier in nanomaterials engineering is to realize their composition control with atomic scale precision to enable fabrication of nanoparticles with desirable size, shape and surface properties. Such control becomes even more useful when growing hybrid nanocrystals designed to integrate multiple functionalities. Here we report achieving such degree of control in a family of lanthanide-doped upconversion nanomaterials. We experimentally verify the co-existence and different roles of oleate anions (OA^-) and molecules (OAH) in the crystal formation. We identify that the control over the ratio of OA^- to OAH can be used to directionally inhibit, promote or etch the crystallographic facets of the nanoparticles. This control enables selective grafting of shells with complex morphologies grown over nanocrystal cores, thus allowing the fabrication of a diverse library of monodisperse sub-50 nm nanoparticles. With such programmable additive and subtractive engineering a variety of three-dimensional shapes can be implemented using a bottom–up scalable approach.

The luminescent properties of the lanthanide-doped upconversion nanocrystals strongly depend on their composition and morphology. The relationships among these parameters have been interpreted in this report. The sensitizer doping concentration affects the luminescent emission more than the size of nanocrystals. Furthermore, the luminescence of upconversion nanocrystals is determined by both the surface deactivations and internal crystal defects. The engineering of upconversion nanocrystals is capable to manipulate the luminescent properties through the controlled crystal growth process.

Profile Dr Xiaoxue Xu has been working as Macquarie University Research Fellow in the Department of Chemistry and Biomolecular Science at Macquarie University since 2015. She joined in Prof Dayong Jin's group in 2014 and devoted to the inorganic luminescent nanocrystals for biomedical applications. Dr Xu received her PhD degree in 2012 from the University of Western Australia and also worked in the development of transparent ZnO and TiO_2 monolith materials for sunscreen cream and the fabrication of novel bone scaffolds using 3D printing technique at UWA for two years.

Staff and students at all levels are welcome to attend.

Venue and Time:
This talk will be held on Thursday 8 September at 2 pm at the Campbelltown Campus in Building 21, Lecture Theatre CA.21.G.03.

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