Solution synthesis, optical properties and applications of metal doped silicon nanocrystals

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Silicon Nanocrystals (Si NCs) are an interesting class of semiconductor nanocrystals due to their unique optical properties, high natural abundance, and low toxicity.\textsuperscript{1} The size and surface dependent optical properties of Si NCs combined with its low toxicity give it a strong future in applications ranging from bioimaging to LEDs and solar cells.\textsuperscript{1} Tuning the optical properties of Si NCs is a significant synthetic challenge. Key areas to improve include tuning the emission range, which if addressed will lead to dramatic improvements in Si NC applications such as optoelectronic devices (LEDs) and bioimaging.

Doping of semiconductor nanocrystals has been particularly successful at tuning the optoelectronic properties, unlocking a new range of emissions beyond simple size tunability (Cu\textsuperscript{2+} in InP), and enhancing quantum yields (Ag\textsuperscript{+} in CdSe).\textsuperscript{2,3} Doping of Si NCs to tune the optical properties is a promising and relatively unexplored method, with few examples in the literature.\textsuperscript{1,4}

This presentation will discuss the synthesis and characterization of Mn, Ni, and Cu doped Si NCs, highlighting their unique dopant dependent optical properties.\textsuperscript{4} Doped Si NCs were produced through use of strong hydride reducing agents to co-reduce metal dopant and silicon salt in the presence of quaternary amine surfactants.\textsuperscript{4} Doped Si NCs were shown to be highly monodisperse with comparable size to undoped Si NCs by transmission electron microscopy.\textsuperscript{4} The optical properties of doped Si NCs were studied by ultraviolet-visible spectroscopy, as well as time resolved and steady state photoluminescence spectroscopy.\textsuperscript{4} Doped Si NCs demonstrate distinctive optical properties such as enhanced absorption and emission redshifts of over 50 nm compared to pure Si NCs.

Fig. 1. Transmission electron microscopy and optical characterization of copper doped silicon nanocrystals at dopant concentrations of 2, 4, and 6 dopants per nanocrystal.