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# Luminescence from silicon nanostructures

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Synthesis of stable and luminescent core-shell structure of nanocrystalline silicon and silicon oxide has been a challenging problem. Our attempt to fabricate stable nanoparticles of $Si/SiO_2$ core/shell structures has revealed that fabrication route has significant impact on the structure of the nanocrystals (NCs) and hence on the properties of the synthesized systems. So far we have successfully synthesized stable and luminescent core-shell nanostructures of Si NCs and Si oxide having spherical and rod like structures (Fig. 1) via inexpensive techniques of mechanical milling and exfoliation of porous Si. The colloids of Si NCs exhibit intense room temperature PL, detectable with the unaided eye. The PL spectra of the colloidal Si NCs are characterized by appearance of double peaks and excitation dependent shift of emission peaks which is explained in terms of dominant transitions between quantum confinement induced widened band states and oxide related interface states. The emitting states of porous Si layers, however, are different and the peak is red shifted by ~1 eV compared to that of the colloids. This is explained in terms of discretization of phonon density of states during formation of individual nanorods. Dry and wet etching of the core-shell nanostructures in $CF_4$ plasma and aqueous HF respectively, resulted in partial removal of the oxide shell and formation of free standing spherical quantum dots of Si with dimensions ~2 nm (Fig. 2). Luminescent characteristics of the etched samples confirm the proposed mechanism of radiative transitions involving phonon bottleneck. Such core-shell nanostructures of Si and free-standing quantum dots represent important building blocks in nanoscale science and technology and have immense potential applications.

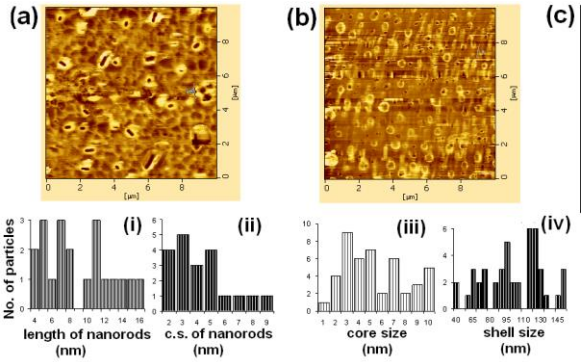


**Fig. 1:** (a) Rod like and (b) spherical core-shell structures of Si NCs surrounded by Si oxide

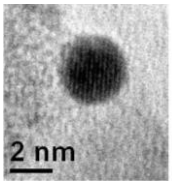


**Fig. 2:** Free standing luminescent quantum dot of Si