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Enhancing the Luminescence of Alkyl-Capped Silicon Quantum Dots by Using Metal Nanoparticles

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Abstract : Metal enhanced luminescence of alkyl-capped silicon quantum dots (C11-SiQDs) was obtained by mixing C11-SiQDs with silver nanoparticles (AgNPs). C11-SiQDs have been synthesized by galvanostatic method of p-Si (100) wafers followed by a thermal hydrosilation reaction of 1-undecene in refluxing toluene in order to extract alkyl-capped silicon quantum dots from porous Si. The chemical characterization of C11-SiQDs was carried out using X-ray photoemission spectroscopy (XPS). C11-SiQDs have a crystalline structure with a diameter of 5 nm. Silver nanoparticles (AgNPs) of two different sizes were synthesized also using photochemical reduction of silver nitrate with sodium dodecyl sulphate. The synthesized Ag nanoparticles have a polycrystalline structure with an average particle diameter of 100 nm and 30 nm, respectively. A significant enhancement up to 10 and 4 times in the luminescence intensities was observed for AgNPs100/C11-SiQDs and AgNPs30/C11-SiQDs mixtures, respectively using 488 nm as an excitation source. The enhancement in luminescence intensities occurs as a result of the coupling between the excitation laser light and the plasmon bands of Ag nanoparticles; thus this intense field at Ag nanoparticles surface couples strongly to C11-SiQDs. The results suggest that the larger Ag nanoparticles i.e.100 nm caused an optimum enhancement in the luminescence intensity of C11-SiQDs which reflect the strong interaction between the localized surface plasmon resonance of AgNPs and the electric field forming a strong polarization near C11-SiQDs.

Keywords : silicon quantum dots, silver nanoparticles (AgNPs), luminescence, plasmon
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