1B3b Silicon Quantum Dots Synthesized from HSQ Polymer: Blue-green and Red Photoluminescence Controlled by Chemical Etching

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1 Introduction

Silicon quantum dots (SiQDs) attract much attention as functional materials with the properties of natural abundance, tunable-wavelength photoluminescence (PL), and environmentally benign. As a result, SiQDs enable us to give sustainable society by developing LED [1], solar cell [2], and biological imaging [3]. In the present study, we synthesized dodecyl-functionalized SiQDs by conducting thermal pyrolysis of hydrogen silsesquioxane (HSQ) polymer and by successive chemical processes. PL color of SiQDs was changed by chemical etching from red to blue-green, and PL quantum yield (QY) was achieved up to 27 %.

2 Experiment

HSQ polymer was annealed at 1100 °C, and Si/SiO_2 matrices were obtained as a precursor. The matrices were etched by HF/HCl with different ratios and hydrogen passivated SiQDs (H-SiQDs) were obtained. After that, thermal hydrosilylation of H-SiQDs was conducted with 1-dodecene at 190 °C and colloidal dodecyl-functionalized SiQDs were obtained as the final product. Properties and structure of SiQDs were analyzed by PL spectra, PL-excitation spectra, PL QY, FTIR spectra, transmission electron microscope (TEM) image, and X-ray photoelectron spectroscopy (XPS).

3 Result and Discussion

PL spectra show red and blue-green of SiQDs, as shown in Fig. 1, which are obtained from lower and higher ratio of HF/HCl, respectively. The PL profile of the former SiQDs is independent of excitation wavelength (Fig.1 left), whereas that of latter one changes by an excitation wavelength (Fig.2 right). High QY up to 27 % was observed for the red light emitting SiQDs, whose value was 4 times higher than that of blue-green one.

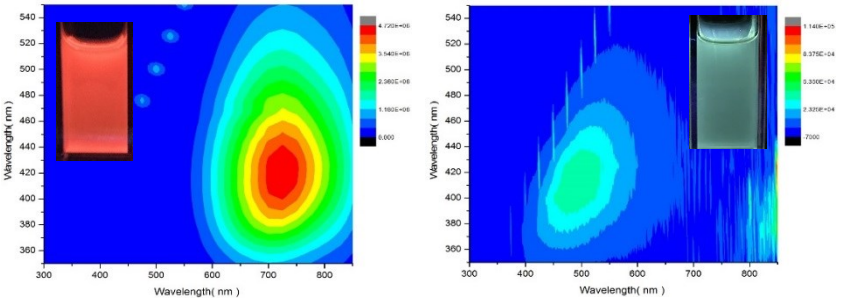

Fig. 1 PL and PL-excitation spectra of red (left) and blue-green (right) light emitting SiQDs. *Inset*: Photograph of SiQDs under UV light (365nm)

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