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Tenkých vrstev a nanostruktur

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TÉMA

Various ways of preparing and modifying silicon nanocrystals

Anna Fucikova

Department of Chemical Physics and Optics, Charles University in Prague, Czech Republic
Department of Thin Films and Nanostructures, Institute of Physics ASCR, v. v. i., Prague, Czech Republic

In this presentation we would like to summarize various methods of silicon nanocrystals preparation and present the pros and cons of each method. Especially, we concentrate on preparation of nanocrystals from hydrogen silsesquioxane (HSQ). The silicon nanocrystals are formed from HSQ molecules annealed at 1000°C in inert Ar atmosphere with 5% H₂. In this way we obtain silicon nanocrystals in silicon oxide matrix. The nanocrystals are released from the matrix by HF etching and need to be stabilized in order to prevent the nanocrystals from deterioration. In the stabilization process the surface Si-H group is usually replaced by an organic group. This process can be initiated by light, high temperature, microwaves, or radicals. The properties of passivated nanocrystals are varying greatly in photoluminescence (PL) quantum efficiency, PL peak position and width.

In cooperation with J. Linnros group we also developed a method for direct passivation of silicon nanocrystals during the annealing step. The individual silicon nanocrystals, when studied by single dot PL spectroscopy, exhibited significantly narrow emission peak at room temperature (average linewidth ~ 25 meV) compared to silicon nanocrystals embedded in a silicon oxide shell (150 meV). The PL from produced nanocrystals covers a broad spectral range from 530-720 nm (1.7-2.3 eV). Blinking and spectral hopping of individual nanocrystals were also detected. The silicon nanocrystals did not show any deterioration of luminescence for at least 16 months.

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