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The Investigation of Optical and Morphological Properties of CdSe Quantum Dots coated on the Forsterite Nanoparticles Substrate Synthesized by Combustion Sol-Gel Method

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Abstract

In the synthesis of quantum dots, quantum yield is always important. Furthermore, this definition depends directly on different factors, such as particle size, concentration, and temperature. However, one of the most important issues in quench of luminescence emission in these compounds is the presence of oxygen during synthesis. To prevent the formation of oxide compounds in the synthesis of quantum dots, controlled atmospheres are used.On the other hand, the application of quantum dots in labeling of bioscience is using widely in medicine and therapy of cancer cells. In the new method, CdSe quantum dots were coated on ceramic nanoparticles of forsterite, which is synthesized by the sol-gel combustion method and without presence of controlled of the atmosphere. The results obtained from the X-ray diffraction pattern represent the synthesis of the forsterite phase without impurities and segregation. After applying quantum dots on the substrate, the emission range of forsterite nanoparticles was shifted from blue to yellow. Moreover, Quantum yield of quantum dots was more than the samples, which did not be coated. Images of TEM reveal the quantum dots coated on Forrester nanoparticles in size of 5 to 7 nm. In addition, the images obtained from SEM showed agglomerated Forrester nanoparticles, in size of 200 nm. The mechanism of this synthesis is according to the creation of a high range order of quantum dots on substrate of forsterite nanoparticles.

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Introduction

Forsterite's crystal structure is orthorhombic with cell parameters a 4.75 A, b 10.20 A and c 5.98 A. Wadsleyite and Ringwoodite are two known polymorphs of Forsterite structure: The combination of SiO_2 and Forsterite forms $MgSiO_3$ [1-4]. SiO_4 4- molar ratio versus Mg^{2+} in Forsterite is 1:2. Si atom is located in the center of the SiO_4 4- anion and each oxygen atom is bonded to silicon by a single covalent bond [5, 6]. Oxygen atoms have negative charge, so they have to stay far from each other to reduce the repulsive force. Therefore, they form tetrahedral geometric shape. Forsterite cations are placed in M1 and M2 sites the M2 sites are bigger than M1 sites. [7, 8]. Forsterite powder has really helped to the restoration of bone. The compatibility of this composition with human body and biological cells is very unique that scientists have grown bony cells on the surface of this composition [9-11]. Mg_2SiO_4 is a good substance for coating of Plasmon QDs. Forsterite can be synthesized by various methods including solid phase sintering [12, 13], co-precipitation, hydrothermal [14-15], sol-gel [16-18], high energy ball milling [16] and combustion methods with different fuels [17]. Combustion method is an efficient way of photoluminescence Forsterite nanoparticles synthesis. In this method, a specific amount of nitrate resources and organic fuels are used [18]. The II-VI semiconductors such as CdS and CdSe as well as some of the III-V semiconductors such as GaAs which have relatively large values of Bohr diameter are found to be suitable systems for strong quantum confinement effect the size-dependent emission property, particularly for CdSe nanocrystals, renders it indispensable in the field of Nanocrystal-based emitters such as light-emitting diodes, photovoltaic devices, lasers, biomedical tags, etc. here we further put forward a simple method to directly deposit CdSe nanocrystals onto forsterite in alkaline solution. Despite that the heterogeneous nucleation is energetically favorable, the lattice compatibility between two domains strongly affects the nucleation and growth of second phase, since the interfacial strain ascribing to the lattice mismatch has to be released. With regards to the