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CATEGORY : Chemistry

PROJECT : "Bright, Luminescent Silicon Nanoparticles for Biological Applications"

AWARDS : Chemistry First Award

SCHOOL : Harvard University

FINALISTS : Alexandra Courtis

COUNTRY : United States

Bright, Luminescent Silicon Nanoparticles for Biological Applications

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Abstract

In the last two decades, there has been increased interest in the utility of quantum scale semiconductors. These fluorescent single crystals can be as small as 1 nm in diameter, and their size and shape has been shown to be controlled by the duration, temperature, and ligand molecules used in their synthesis. Quantum dots, provide clear benefits over the organic dyes currently used for tracking biological processes. Yet, as the production of quantum dots is often very costly, the search continues for finding an industry-ready synthesis for a quantum scale semiconductor which would have high yield, optimal durability, high luminescence, and a broad absorbance range. Silicon, in particular, has been of great interest as it is the second most abundant element on the Earth's crust and is generally a bioinert and electrochemically stable element.

We report the synthesis of water-soluble, luminescent silicon nanoparticles with potential applications to bioimaging. Through a solution state top-down approach, the synthesis of hydrogen capped silicon nanoparticles was achieved in various organic solvents. The surface of the nanoparticles was capped with the functional organic molecules rendering the Si-QDs both air and water stable. Cell studies performed with our silicon nanoparticles and human monocytes show the direct applications these particles could have for tracking biological processes and the progression of cancer in the human body. In attempt to shift the luminescence of these particles, alterations of experimental methodology was also explored in the areas of reaction solvent and heating time. Through these changes, shape control of silicon nanoparticles was achieved in the form of silicon nanorods. The synthesis of this new shape of silicon at the quantum scale was confirmed by ultraviolet spectroscopy, photoluminescence, and transmission electron microscopy. The results of this study indicate that the use of silicon nanocrystals for biomedical applications is feasible.

*Faculty mentor: Susan M. Kauzlarich

評語

主要的研究是發展新的合成方法製備奈米級的矽，並在表面上作改質以利於在生物造影的應用。研究內容具創新性，且研究具將來性，研究成果可再延伸作爲有效的標靶造影或是疾病檢測。