Nanotech

Micro Photoluminesce Characterization of Si Quantum Dots

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Context

Novel 3D nanomachining of Si developed at MESA+ offers the possibility of few nanometer, free standing Si quantum dots at the apex of a pyramid wire frame structure, Fig. 1 [1]. In principle, quantum confinement effects could be measured due to the small size of the dots. Furthermore, the confinement can result in a direct bandgap making (electro-) optical experiments an interesting possibility.

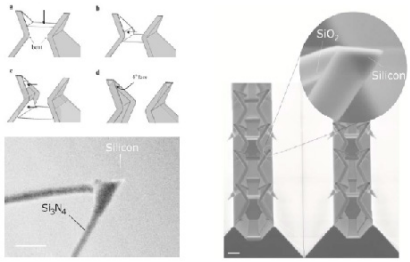

Fig. 1. 3D nanomachined Si quantum dots

Objectives&Methods

The ultimate goal of this project is to achieve electrically controlled single photon emission form Si. The first step is optical characterization of the Si quantum dots by micro photoluminescence. A laser is used to excite carriers, which leads to photon emission. Photoluminescence can provide information on electronic structure, bandgap energy and carrier lifetimes [2]. A low quantum efficiency is expected due to the indirect bandgap nature of Si and interference from the Si substrate could hinder measurement of the quantum dots.

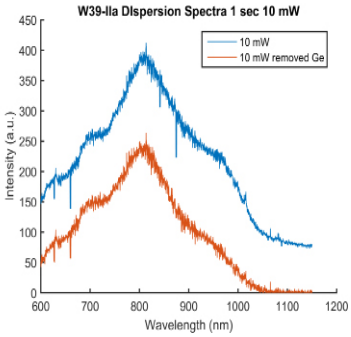

Fig. 2. Photoluminescence spectrum of Si quantum dots

Results

A possible indication of quantum dot emission might have been measured by removing the quantum dots from the Si substrate by ultrasonic dispersion and depositing them on a Ge substrate. Figure 2 shows the measured spectrum. The main peak at approximately 813 nm could coincide with the measured size of the quantum dots.

References

[1] Berenschot, J.W., et al., Nanotechnology, 20(47): p. 475302, 2009.
[2] M. Fox. Quantum Optics: An Introduction. Oxford University Press, New York, 2006.