Hybrid Nano-Scale Pattern Formation Through Nanocrystal Self-Assembly

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Abstract:

This project aims to create ordered arrays of semiconducting nanocrystals (NC) on silicon and silicon dioxide surfaces by taking advantage of template-assisted self-assembly. The ability to integrate optically-active materials with nano-scale precision onto silicon substrates in a cost-effective fashion is one of the key technologies necessary to build hybrid electronic-photonic integrated circuits.

In our approach, a nano-scale template is fabricated via electron-beam lithography. This template contains recessions on the surface that form arrays of dots and lines. By dispensing a solution containing semiconducting nanocrystals, we aim to show that the NC's self-assemble onto the template due to tuned capillary and electrostatic interactions. We have made the templates by electron-beam lithography with 100 nm features in poly(methyl methacrylate) PMMA.

We transferred the patterns made in PMMA to silicon or silicon dioxide surface via reactive ion etching. We have used two types of core/shell CdSe/ZnS nanocrystals for the self-assembly experiments. In order, they were 8 nm (dispersed in toluene) and 45 nm (dispersed in water) in diameter with peak photoluminescence emission at 680 nm.