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14. ABSTRACT

In this project we developed a new type of material system for use in opto-electronic applications. It consists of an array of nanorods. The nanorods are quantum semiconductor structures with high fluorescence quantum yields, and with their bandgap emission energy controlled by the diameter of the rod. These quantum rods are coated with a monolayer of organic surfactant which renders them highly soluble in organic liquids. We demonstrated a method by which these nanorods can be deposited from solution in the presence of an electric field, such that the nanorods are oriented perpendicularly to the substrate.

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Final Technical Report
Electro-Optic Materials Based Upon Inorganic Semiconductor Nanorod Liquid Crystals
AFOSR Grant No. FA9550-04-1-0065

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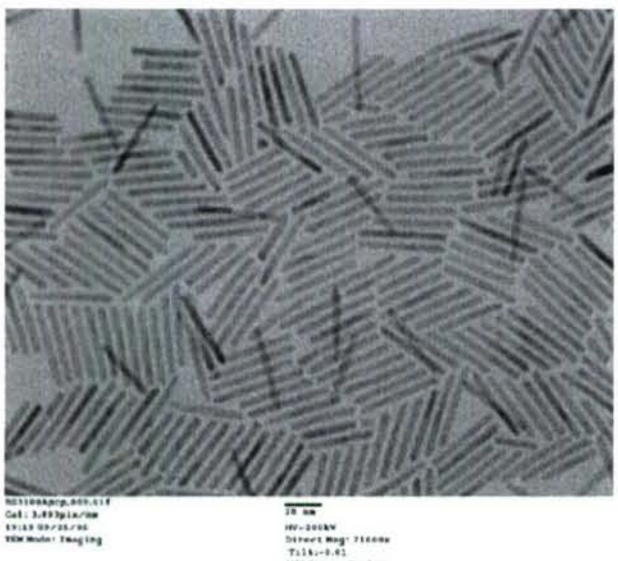
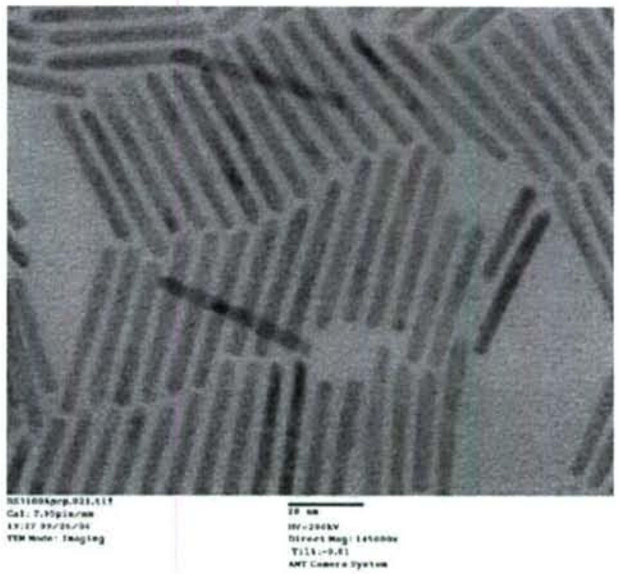
Final Technical Report

In the course of this proposal we have developed arrays of luminescent quantum rods, by deposition from solution. There are two aspects of the project which are of note. First is the solution process for growing rods, and the second is the approach employed for producing the arrays.

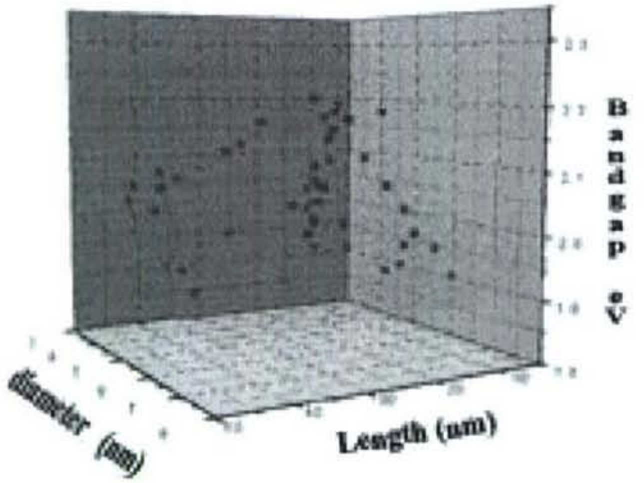
Quantum rods

We prepare quantum rods by growing nanocrystals of CdS/CdSe in a hot organic liquid (see Y. Yin and A. P. Alivisatos, "Colloidal nanocrystal synthesis and the organic-inorganic interface," Nature **437** (7059), 664 (2005).) A couple of examples of these quantum rods is shown below:

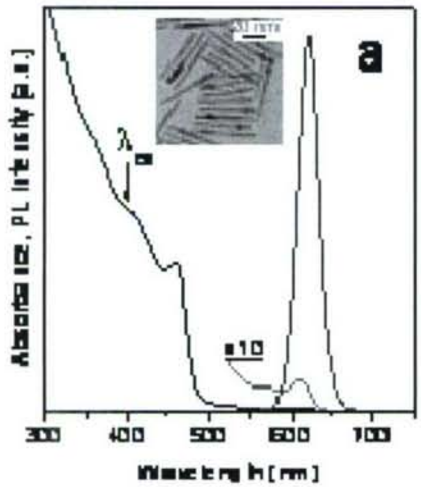




The bandgap of the rods can readily be tuned by variation of the diameter, while the length can be independently adjusted and has no affect on the bandgap, as shown below:

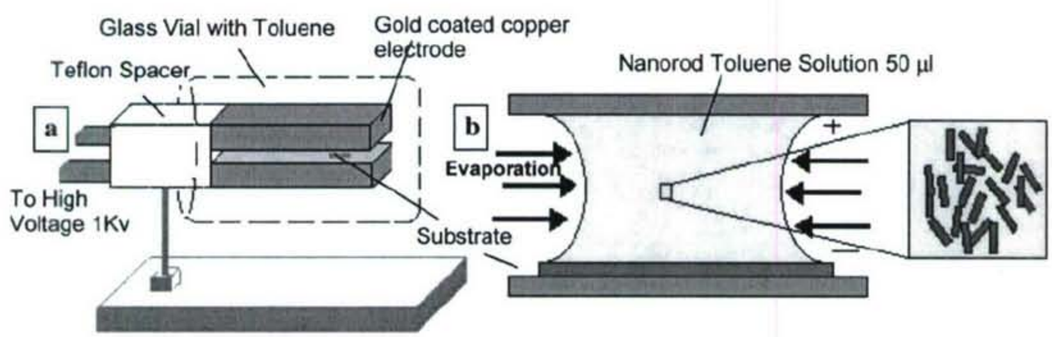


Of particular interest recently has been the success in obtaining such nanocrystals with high luminescence quantum yields, as high as 80%:

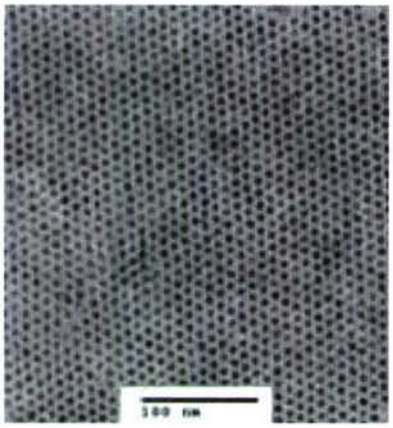


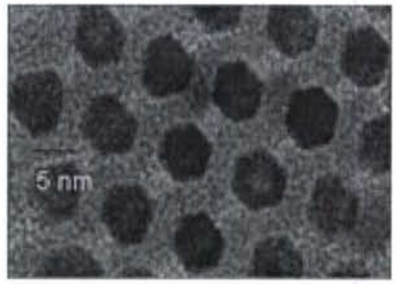
Alignment on substrates

As part of this project, we developed a robust approach for depositing ordered films of such nanocrystals, with the long axis oriented perpendicular to the substrate. This is done by evaporation of a solution containing the rods in the presence of an electric field.



Here are some examples of aligned rod systems:





These aligned nanorod systems with polarized light emission and high luminescence yields could be used in a variety of technologies of interest to AFOSR, especially in light emitting diodes and lasers.

Personnel Supported: List professional personnel (Faculty, Post-Docs, Graduate Students, etc.) supported by and/or associated with the research effort.

Principal Investigator: Paul Alivisatos
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Postdoc: Antonis Kanaras (50%); Kevin Ryan
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Publications: List peer-reviewed publications submitted and/or accepted :

M. F. Casula, Y.-W. Jun, D. J. Zaziski, E. M. Chan, A. Corrias and A. P. Alivisatos, "The Concept of Delayed Nucleation in Nanocrystal Growth Demonstrated for the Case of Iron Oxide Nanodisks," J. Am. Chem. Soc., 128, 1675-1682 (2006).

Y. Yin, C. K. Erdonmez, A. Cabot, S. Hughes, and A. P. Alivisatos, "Colloidal Synthesis of Hollow Cobalt Sulfide Nanocrystals, " Adv. Func. Mat., 16, 1389-1399 (July 2006).

NOT YET REPORTED TO AFOSR:

K. M. Ryan, A. Mastroianni, K. A. Stancil, H. Liu, and A. P. Alivisatos, "Electric-Field-Assisted Assembly of Perpendicularly Oriented Nanorod Superlattices," Nano Lett., 6(7), 1479-1482 (June 2006).