

PHYSICS DEPARTMENT COLLOQUIUM

“Synthesis, self assembly and applications of semiconductor nanomaterials”

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Self-assembly of nanoparticles of two different materials into a binary nanoparticle superlattice (BNSL) can provide a general and inexpensive path to a large variety of novel materials (metamaterials) with precisely controlled chemical composition and tight placement of the components. We generated families of BNSL structures using combinations of semiconducting, metallic, dielectric and magnetic nanoparticle building blocks.

Single-crystal PbSe nanowires and nanorings can self-assemble by oriented attachment of collections of nanocrystals that attach and fuse along identical crystal faces. Tailoring the reaction conditions allowed us to alter nanowire morphology from straight to zig-zag, helical, branched, or tapered. For electronic applications the nanowires can be aligned by applying an external electric field, or grown directly on a chip between source and drain electrodes.

We demonstrate the applicability of semiconductor nanocrystal arrays in solution-processed field-effect devices. The conductivity nanocrystal solids can be switched between n- and p-type transport by controlling the saturation of electronic states at the nanocrystal surfaces. The field-effect mobility in PbSe nanocrystal arrays is comparable to the mobility of the best organic transistors. In addition to electronics applications, highly conductive nanocrystal solids offer a promising fabrication approach for novel thermoelectric and photovoltaic devices.

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