Proceedings of the 2nd World Congress on Recent Advances in Nanotechnology (RAN'17)
Barcelona, Spain – April 4 – 6, 2017
Paper No. ICNNFC 135
ISSN: 2371-5308
DOI: 10.11159/icnnfc17.135

Inorganic Ligand-Capped Colloidal Nanocrystals for Electronic Device Application

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Extended Abstract

Colloidal nanocrystals can combine the advantages of crystalline inorganic semiconductors with the size-tunable electronic structure and inexpensive solution-based device fabrication.[1] They are of great interest due to these unique advantages for use in electronic and optoelectronic devices such as field-effect transistors (FETs), photovoltaic cells, and light-emitting diodes.[1-8] Efficient charge transport is crucial for high performance of nanocrystal-based electronic and optoelectronic devices.[2,3] Many practical implementations of nanocrystals are hindered by the poor electronic coupling in close-packed nanocrystal films, caused by the presence of bulky organic surface ligands.

In this study, to address this fundamental problem, various types of inorganic surface ligands are introduced.[2,4,5] By using optimized inorganic surface ligands, nanocrystal solids are prepared exhibiting band-like charge transport, high photoconductivity and tunable doping level.[6] For example, we explore the temperature-dependent Hall effect of inorganically capped InAs nanocrystals. In addition, a solution-based "soldering" process is introduced to fabricate ultra-high electron mobility (>300 cm^2/Vs) nanocrystal solids using colloidal nanocrystals with molecular "solders".[7,8] The high-mobility FETs were fabrcated by spin-coating a solution of $Cd_2Se_3^{2-}$-capped CdSe nanocrystals, followed by thermal annealing. Finally, we expand the application of the NC soldering process to core−shell NCs consisting of a III−V InAs core and a CdSe shell with composition-matched $Cd_2Se_3^{2-}$ molecular solders. Soldering CdSe shells forms nanoheterostructured material that combines high electron mobility and near-IR photoresponse.

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