Anisotropic cation exchange in one-dimensional CdSe nanocrystals into PbSe/CdSe heterojunction nanorods and PbSe nanorods

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In this presentation, we describe the direct pathway of Cd-to-Pb cation exchange in CdSe NRs and the role of ligands in cation exchange reaction. Mixing Pb-oleate and oleylamine triggers anisotropic cation exchange of nanorod that its partial conversion in mild temperature results in heterostructure with axial CdSe/PbSe heterojunctions, keeping the original morphology intact. Microscopic analysis revealed that the cation exchange proceeds asymmetrically along the <0001> direction at both tips of CdSe NRs; which the conversion rate appears to be higher in (000-1) planes. Notably, absence of oleylamine shows minimal extent of conversion suggesting that oleylamine would play a significant role in this solid-state reaction. DFT calculation revealed that the strong binding of oleylamine on the (000-1) facet of CdSe NRs is responsible for this asymmetric cation exchange. Our work on the new cation exchange pathway broadens design range of CdSe/PbSe heterojunction nanomaterials potentially with various morphologies, since template CdSe nanocrystals can be prepared in different shapes via facile colloidal synthesis.