Anisotropic cation exchange of CdSe nanorods into CdSe/PbSe Janus nanorods retaining original morphology

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Cation exchange is known for its versatility in the design of novel nanocrystals which cannot be synthesized by routine hot-injection or heating-up methods. Here, we report the direct methodology of Cd-to-Pb cation exchange in CdSe nanorods and the role of ligands in cation exchange reaction. While previously reported conversion method of using $PbCl_2$-oleylamine complex led to morphology change of nanorods into spherical nanoparticles, mixture of Pb-oleate and oleylamine triggered anisotropic cation exchange of nanorod with its morphology remains intact. When the mild reaction temperature is given, CdSe/PbSe Janus nanorods with axial heterojunctions were obtained. Microscopic analysis revealed that the cation exchange proceeds asymmetrically along the <0001> direction at both tips of CdSe NRs. Binding energy calculation based on density-functional theory revealed that the asymmetry of reaction rate would be caused by strong binding of oleylamine on the (000-1) facet of CdSe nanorods.