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Thermal doping by vacancy formation in copper sulfide nanocrystal arrays YEHONADAV BEKENSTEIN, KATHY VINOKUROV, SHAY KEREN-ZUR, ODED MILLO, URI BANIN, Hebrew University of Jerusalem —
Doping semiconductor nanocrystals (NCs) is a highly pursued challenge, providing another means, along with size and shape, for controlling their electronic properties. We present a new, impurity free, method for NC doping by thermal treatment at moderate temperatures of under 400K, thus creating vacancies leading to free charge carriers. This method is applied here for Cu_2S NCs, where Cu vacancies easily form due to the low chemical potential of Cu(0), resulting in p-type doping. This thermal doping procedure is used here to controllably increase the conductance of Cu_2S-NC arrays, achieving up to 6 orders of magnitude enhancement, for which we extract the activation energy for Cu vacancy formation, $\sim$1.6eV. The thermal doping effect manifests itself also in tunneling spectra by the emergence of in-gap states and a shift of the Fermi level towards the valance band, signifying p-type doping. In addition we demonstrated local thermal doping of the NC film via a focused laser beam, serving as the heating source, which enables fabrication of advanced NC devices.

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