TRANSPORT CHARACTERISTICS OF COLLOIDAL NANOCRYSTAL TETRAPODS IN PLANAR ELECTRODE DEVICES

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In recent years, there has been a remarkable advancement in the ability to grow anisotropic nanocrystals, such as rods, tetrapods,[1] and nanocrystals with even more complex branched shapes.[2] Experiments on such nanocrystals have demonstrated that they hold a great potential as active materials in single-electron transistors[3-5]. Tetrapods are an especially interesting class of nanocrystals due to their unique shape, where four arms branch out at tetrahedral angles from a central core (Fig. 1a). Drop casted onto a planar surface the tetrapods self align with one arm pointing upwards and three legs on the surface. By fabricating contacts to the individual arms, the tetrapods can function as multiterminal electronic devices.

In this work we position CdTe tetrapods [1] in between three planar electrodes on a Si/SiO_2 substrate and investigate the electronic properties of such devices. The electrodes, fabricated by electron-beam lithography and subsequent metal evaporation, point towards a central gap of 80 nm (see Fig. 1b). To position the tetrapods into the gap we cast a drop of the nanocrystal solution onto the substrate and use the technique of electrostatic trapping [6, 7] to attract the tetrapods in between the electrodes. The transport measurements on such multiterminal devices were performed at room and cryogenic temperatures. In the I-V characteristics of the tetrapods at low temperature (Fig. 2) we find a zero-current plateau of some hundred mV and a strong increase in conductivity near the bandgap energy (around 1.7 eV obtained from light-absorption measurements). These large energy scales, that lead to strongly non-linear I-V curves at room temperature, make such a device type suitable for applications under ambient conditions. We used the Si/SiO_2 substrate as a gate electrode and discuss the effect gating the tetrapod devices.

References:

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Figures:

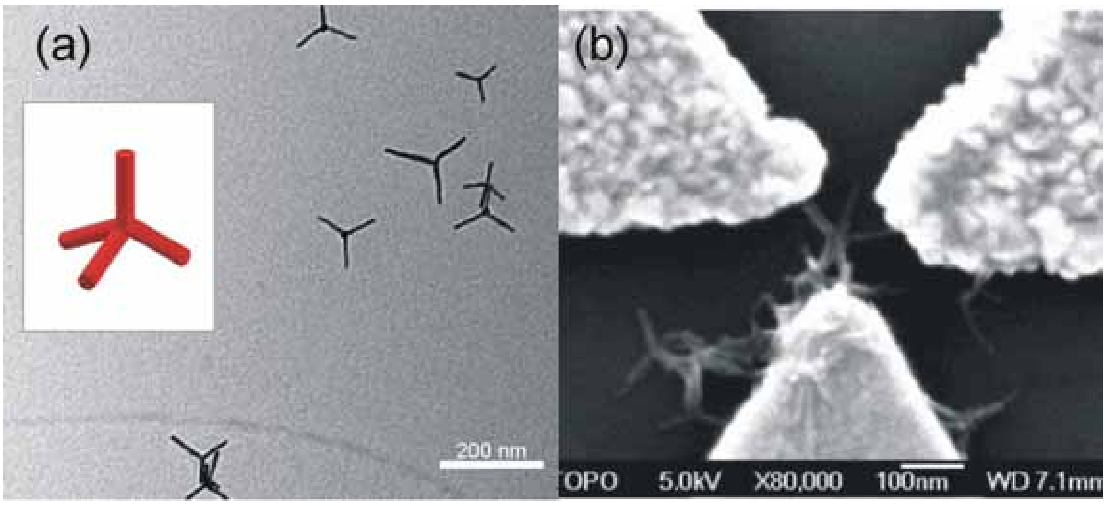

Figure 1: (a) Transmission-electron microscope image of tetrapod nanocrystals. The inset shows a schematic of the tetrapod shape. (b) Scanning-electron microscope image of trapped tetrapods in between electron-beam defined planar electrodes.

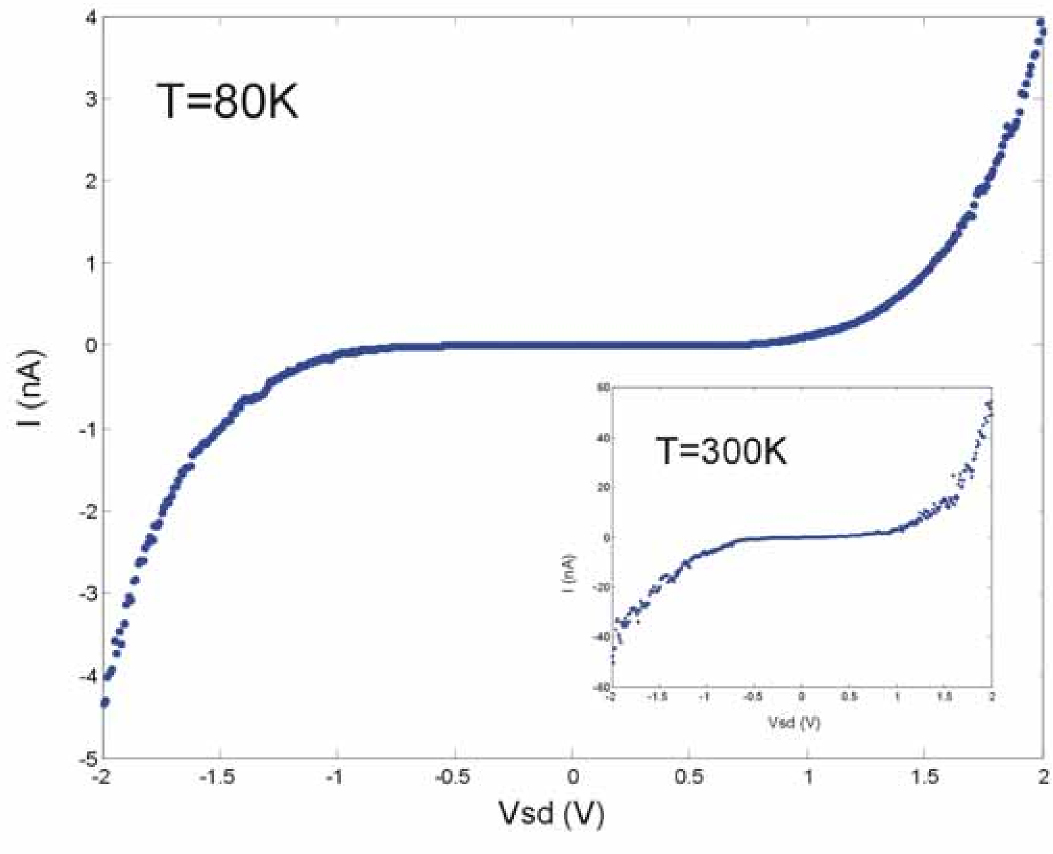

Figure 2: Current-voltage measurements of a tetrapod device at T=80K (the inset shows an I-V at room temperature of the same device).