Electrical Transport in Semiconductor Nanomaterials

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Electrical transport in various semiconductor nanomaterials is presented. In particular, the size- and temperature-dependence of electron transport in thin films of semiconductor nanocrystals (also known as quantum dots) is presented. Upon increasing temperature over the range 28–200 K, the electron transport underwent a transition in mechanism from Efros-Shklovskii-variable-range-hopping (ES-VRH) to nearest-neighbor-hopping (NNH). The transition occurred at higher temperatures for films with smaller particles. The electron localization length, estimated from the ES-VRH model, was comparable to the nanocrystal size and scaled systematically with nanocrystal diameter. The activation energy from the NNH regime was also size-dependent which is attributed both to size-dependent Coulomb effects and the size-distribution of nanocrystals. In addition, electrical transport in other nano scale semiconductor systems, including doped semiconductor nanocrystals and reduced graphene oxide, is briefly discussed. Finally, applications of these studies on fabrication of advanced electronic devices such as low voltage transistors and solar cells are demonstrated.