Electron co-tunneling transport in gold nanocrystals arrays

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Arrays of metallic, semiconducting, or magnetic nanoparticles with radii of $2-7$ nm can now be synthesized. Owing to their small self-capacitance, the charging energy for electron hopping between nanoparticles is large, of the order of 0.1 eV. Thus, these systems are ideally suited for the study of correlated electronic diffusion in presence of both disorder and strong Coulomb interactions. We describe low temperature current-voltage characteristics measurements of alkyl-ligated ~ 5 nm gold nanoparticles arrays in long screening length limit. Tailoring the length of the alkyl ligands surrounding the nanoparticles allows to tune the electronic tunnel coupling between the nanoparticles. For long ligands, i.e. weak tunnel coupling between the nanoparticles, the conductance follows an activated behavior with temperature $\propto exp(-T_0/T)$ and electrical field $\propto exp(-\mathcal{E}_0/\mathcal{E})$. For small ligands, i.e. large tunnel coupling, the dependence on temperature and electric field of the conductance crossover to Efros-Shklovskii type formulas $\propto exp(-T_0/T)^{1/2}$ and $\propto exp(-\mathcal{E}_0/\mathcal{E})^{1/2}$. This shows that, at low temperature and for large enough tunnel coupling, the electronic transport in metallic nanoparticles arrays occurs though electron cotunelling.