Abstract Submitted
for the MAR06 Meeting of
The American Physical Society

Transport Properties of Gold Nanoparticle Arrays at Low Temperatures

T. TRAN, University of Chicago, I. BELOBORODOV, X.M. LIN, V. VINOKUR, Argonne National Laboratory, P. JIANG, W. KANG, H. JAEGGER, University of Chicago — We investigated the effects of elastic and inelastic cotunneling on the electronic transport properties of Au monolayers and multilayers. Highly-ordered monolayers of dodecanethiol-ligated Au particles (6nm in diameter) were assembled onto Si$_3$N$_4$ substrates with prefabricated electrodes. Multilayers were created by adding layers to the original monolayers. Current-voltage (IV) measurements were performed with 50fA resolution down to 30mK. TEM images were taken posterior to all measurements. We found that transition from inelastic to elastic cotunneling occurred at $T \sim 5$K. In the inelastic cotunneling regime, the IV curves were found to be nonlinear for $k_B T < eV/N < E_C$ and linear when $k_B T > eV/N$ where $N$ is the number of grains across the electrode gap. In the elastic regime below 5K, the IV curves were found to be linear for $eV/N < (E_C \delta)^{1/2}$ where $\delta$ is the level spacing and $E_C$ is the charging energy. As a consequence of cotunneling, Efros-Shklovskii variable-range-hopping-like conduction (VRH) was observed near zero bias. Above $T \sim 80$-100K, transition from VRH to nearest-neighbor hopping took place. X.M. Lin, et al., J. Nanoparticle Res. 2 157 (2000). T.B. Tran, et al., Phys. Rev. Lett. 95 076806 (2005),