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Dynamics of Electron Relaxation in PbSe Quantum Dot Films

JESSE ENGEL, MATT SHELDON, WANLI MA, PAUL ALIVISATOS, UC Berkeley — Films of colloidally synthesized quantum dots exhibit an energy landscape disordered in both onsite energies and structural periodicity. Hopping models have proven very effective in describing the steady state conduction of these films, however much is still unknown about their dynamics. Electron localization leads to poor screening, permitting long range coulomb interaction, which can lead to "glassy behavior" such as long relaxation times and memory effects. Here, we present results on the time evolution of the resistance of thin films PbSe quantum dot transistors. We observe distinctive power law decays on the order of thousands of seconds, which vary with voltage and temperature. Transient peak heights and power law decay exponents are found to increase for higher applied fields, with peak heights reaching an order of magnitude higher than the steady state at electric field values of 100kV/cm. The decay transients for increasing fields are also found to turn into growth transients (exponent > 0) for decreasing fields, leading to pinched hysteresis loops in I-V characteristics for sweep rates greater than 0.01V/s. We correlate nonlinear features in the transient decay of film resistance and its equilibrium values to the dynamics of relaxation in the coulomb glass.

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