Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

One-dimensional Poole-Frenkel conduction in the single defect limit ELLIOT J. FULLER, DENG PAN, BRAD L. CORSO, O. TOLGA GUL, PHILIP G. COLLINS, Dept. of Physics and Astronomy, University of California Irvine — Theory predicts a range of phenomena in disordered one-dimensional (1D) conductors, but few physical systems exist for direct comparison with experimental observation. Recently, we demonstrated an electrochemical technique for adding a single, isolated point defect to a single-walled carbon nanotube (SWNT) in a field effect transistor device. A point defect, surrounded on either side by quasi-ballistic, semi-metallic SWNT is an ideal system for investigating disorder in 1D. Here, transport and Kelvin probe force microscopy independently demonstrate high-resistance depletion regions that can extend from 0.3 - 2.0 μm wide surrounding the defect site. The defect assists tunneling through this depletion region via a modified, 1D version of Poole-Frenkel conduction. The width of the depletion region is found to depend sensitively on SWNT diameter and carrier density, as expected for a molecular scale wire. Surprisingly, conduction is well described by the 1D Poole-Frenkel model over a wide range of temperature from 77 - 300 K and over a wide range of source-drain bias from 0.1 - 2.0 V.

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Date submitted: 14 Nov 2014 Electronic form version 1.4