

**Stony Brook University
The Graduate School**

Doctoral Defense Announcement

Abstract

Electron Transport through AlO_x Tunnel Barriers and OPE-Based Molecular Junctions

by

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This work presents results of a study of electron transport through aluminum-oxide based tunnel barriers and single-molecule transistors. Both systems have potential for a dramatic increase of the density and performance of integrated circuits with critical dimensions well below the scaling limits of the conventional semiconductor technology.

Transport properties of (Nb/)/Al/ AlO_x /Nb tunnel barriers have been studied for structures formed by (i) thermal oxidation and (ii) plasma oxidation, before and after their rapid thermal post-annealing at temperatures up to 650°C. The post-annealing results in a substantial increase of the barrier height of the thermally formed aluminum oxide, which (within a broad range of RTA temperatures) may be substantially higher than that of the plasma-grown AlO_x barriers. This fact, together with high endurance of annealed barriers under electric stress, may eventually lead to the fabrication of AlO_x and $\text{SiO}_2/\text{AlO}_x$ layered (“crested”) barriers for advanced floating-gate memories.

Electron transport through single molecular devices has been studied for structures of three types: (i) co-planar Au electrodes with ~5 nm gaps formed by e-beam lithography, (ii) co-planar Au electrodes with 1~2 nm gaps formed by electromigration, and (iii) nanowires crosspoints with vertical gaps of 3 to 5 nm formed by under-etched aluminum oxide layers. Two types of Oligo(Phenylene Ethynylene) based molecules (with or without a naphthalene diimide groups working as acceptors), capped with isocyanide terminal groups, have been investigated. For both molecules, nonlinear current-voltage curves with discrete current steps, due to tunneling through one or a few molecules, have been observed, and their dependence on the gate voltage and temperature have been studied in detail.

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