Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Ge/Si nanowire mesoscopic Josephson junctions JIE XIANG, Department of Chemistry, ANDY VIDAN, Division of Engineering and Applied Sciences, MICHAEL TINKHAM, ROBERT M. WESTERVELT, Department of Physics, CHARLES M. LIEBER, Department of Chemistry, Harvard University
— Superconductor-normal conductor-superconductor (S-N-S) Josephson junctions have displayed rich macroscopic quantum phenomena. A novel mesoscopic regime emerges when the width of the normal conductor shrinks to become comparable to carrier Fermi wavelength and its normal conductance becomes quantized in multiples of 2e2/h due to quantum confinement. We have previously demonstrated transport through individual 1D subbands in the hole gas formed in Ge/Si core/shell nanowire (NW) heterostructures. Here we present a study of the interplay between quasi-1D transport and proximity-induced superconductivity using Ge/Si NWs contacted by superconducting leads. Transport measurements on S-NW-S devices reveal high order resonant multiple Andreev reflections, indicating that the NW channel is smooth and that transport is highly coherent. By using a top gate to modulate carrier density in the NW, the critical supercurrent Ic can be tuned from zero to > 100 nA. Significantly, we found that Ic exhibits step-wise increases as a function of gate voltage, corresponding to transport through discrete 1D subbands due to radial carrier confinement. The implications of these results and possible applications of S-NW-S devices will be discussed.

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Date submitted: 17 Nov 2006 Electronic form version 1.4