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Two-dimensional epitaxial superconductor-semiconductor heterostructures: A platform for topological superconducting networks
J. SHABANI, Physics Department, CCNY, M. KJAERGAARD, H. J. SUOMINEN, F. NICHELE, Center for Quantum Devices, Copenhagen, Y. KIM, UCSB, K. PAKROUSKI, Theoretical Physics, ETH Zurich, S. KRAEMER, UCSB, T. STANKEVIC, P. KROGSTRUP, R. FEIDENHANSL, Center for Quantum Devices, Copenhagen, R. M. LUTCHYN, C. NAYAK, Microsoft Research, Station Q, M. TROYER, Theoretical Physics, ETH Zurich, C. M. MARCUS, Center for Quantum Devices, Copenhagen, C. J. PALMSTROM, UCSB — Theory suggests that the interface between a one-dimensional semiconductor (Sm) with strong spin-orbit coupling and a superconductor (S) hosts Majorana modes with nontrivial topological properties. A key challenge in fabrication of such hybrid devices is forming highly transparent contacts between Sm and S. Recently, it has been shown that a near perfect interface and a highly transparent contact can be achieved using epitaxial growth of aluminum on InAs nanowires [1, 2]. In this work, we present the first two-dimensional epitaxial superconductor-semiconductor material system that can serve as a platform for topological superconductivity, and the search for quasiparticles such as Majorana zero modes that are predicted to obey non-abelian statistics. We show that our material system, Al-InAs, satisfies all the requirements necessary to reach into the topological superconducting regime by individual characterization of the semiconductor two dimensional electron system, superconductivity of Al and performance of S-Sm-S junctions [3].

Javad Shabani
Physics Department, City College of New York

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