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Superconductivity and metal-insulator transition in Bi nanowires.[1] MINGLIANG TIAN, JIAN WANG, NITESH KUMAR, QI ZHANG, THOMAS MALLOUK, JIANENDRA JAIN, MOSES H.W. CHAN, Center for Nanoscale Science, Penn State University — Semi-metallic bismuth has long been a prototype system for quantum transport and finite-size effect studies, due to its long electron mean-free path, low carrier density and small carrier mass. We found Bi nanowires (NWs) of less than 100 nm diameter can be superconducting, metallic and insulating closely depending on the details of their microstructures, morphology and surface condition. For granular Bi NWs with grains showing (001) preferred orientation, the NWs are superconducting with Tc's of 7.2 and 8.3 K. Without (001) preferred orientation, the NWs show superresistive behavior. For single-crystalline Bi NWs, when the wires are embedded inside anodized aluminum oxide (AAO) membrane, insulating behavior is found below 1.0 K with low excitation current but metallic at a higher bias current. However, this metallic state can be tuned into insulating again by an applied magnetic field. We have also made measurements on an individual single-crystalline Bi NWs released from the AAO, an thin oxide layer is found on the wire surface. Interestingly, the wire was found to be superconducting below 1.5 K.

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