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Suppression of superconductivity in zinc nanowires by bulk superconductors

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When a superconducting nanowire of a few micrometers in length is connected to two macroscopic normal metal electrodes, a substantial fraction of the wire will become resistive due to the proximity effect. When such a wire is sandwiched between two macroscopic superconducting electrodes, the superconductivity of a nanowire is intuitively expected to become more robust through the coupling with its strong superconducting environment. This expectation is not fulfilled in our recent observation in a system consisting of zinc nanowires (ZNWs) between two bulk superconductors (Sn, In and Pb). We found evidence that the superconductivity of the ZNWs of 40 nm in diameter and 2 or 6 μm in length is suppressed completely or partially when bulk Sn or In electrodes are superconducting. When bulk Sn or In electrodes are driven into the normal state by applying a magnetic field, the ZNWs switch back to their superconducting state. This anti-proximity effect is significantly weakened when both Sn or In leads were replaced by Pb or one of the two superconducting electrodes is replaced by a normal metal. The phenomenon is not seen in wires with diameters equal to and thicker than 70 nm. *This work is in collaboration with N. Kumar, S. Y. Xu, J. G. Wang, J. Kurtz and M.H.W.Chan and supported by the Center for Nanoscale Science (Penn State MRSEC) funded by NSF under grant DMR-0213623.*