InAs Surface 2DEG and Interface Characterization of InAs/Al Structures Using Josephson Junctions

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Surface InAs quantum wells have become the focus of renewed theoretical and experimental attention partly because of their potential applications in topological [1] and superconducting quantum computation [2,3]. These applications require epitaxial contacts to superconductors with high transparency, tunable proximity effect, and coupling of the two-dimensional electron gas (2DEG) and superconductor. Thus it is really important to study the properties of 2DEGs at the surface and details of structural properties of interface between the Al and InAs.

In our work we study the quality of the InAs/Al interface using transport measurements. Quality of transparency is reflected in the supercurrent and induced gap through the Josephson junction. The product of the critical current (I_C) and the normal state resistance (R_n) is used to characterize Josephson junction properties. We compare the product of IcRn for variety of MBE grown InAs/Al wafers with different mobility, mean free path, interface barriers, and density. Currently we have reached $I_cR_n = 374$ μV approaching ideal case for ballistic short junctions. We discuss our data within known theoretical models and identify crucial material properties that influence the proximity effect and transparency between superconductors and semiconductors.

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[3] T. W. Larsen, K. D. Petersson, F. Kuemmeth, T. S. Jespersen, P. Krogstrup, J. Nygård, and C. M. Marcus. Phys. Rev. Lett. **115**, 127001 (2015)

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Supplementary Page

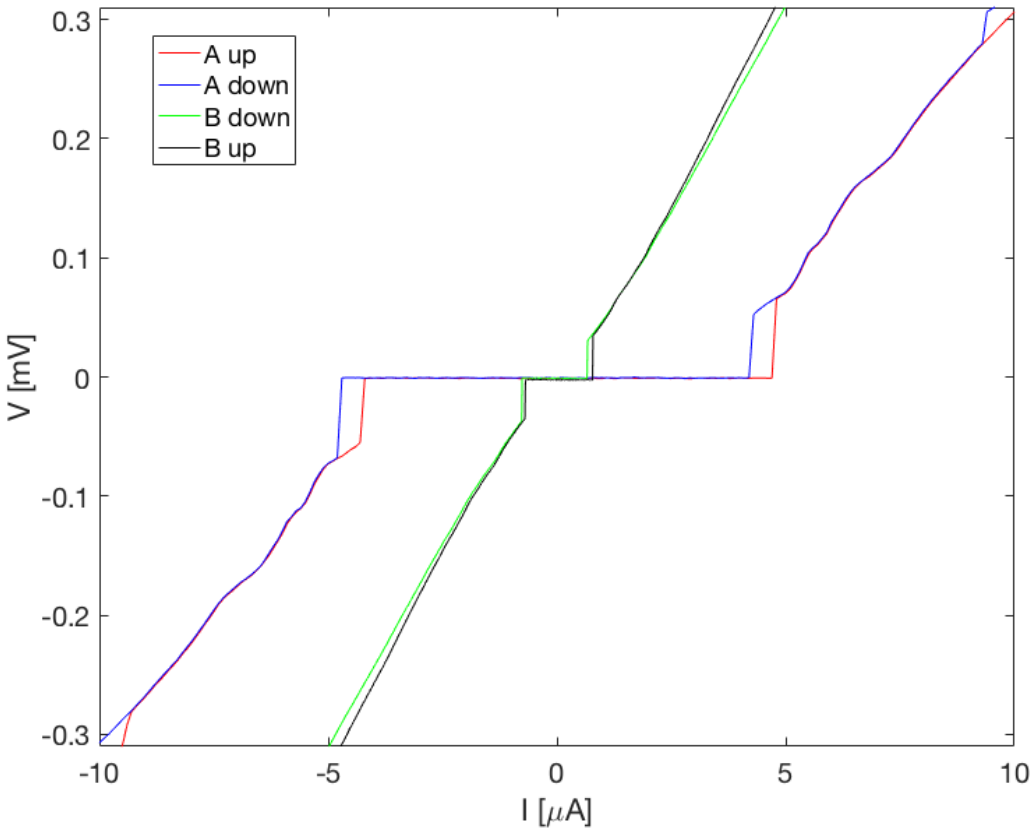

Figure 1. Selective removal of Al from InAs quantum well can allow fabrication of Josephson junctions. The I-V characteristic of such a junction on two different samples are shown at T = 15 mK. The schematic of the structure is the same for both samples but sample A has a higher mobility and quantum lifetime than sample B. For sample A, I_cR_n = 374 μV and for sample B, I_cR_n = 168 μV.