Coherent Andreev Reflection in Stress-Engineered Nb / Bi_2Se_3 Vertical Mesoscopic Junctions

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We probe Andreev reflection at an s-wave superconductor / three-dimensional Topological Insulator interface, a mesoscopic platform for proximity-induced unconventional pairing on spin-momentum-locked surface states [1,2]. Sputter-stress-engineered Nb survives multi-step lithography on MBE-grown Bi_2Se_3 while preserving bulk Nb superconductivity, yielding vertical four-probe Nb/Bi_2Se_3 junctions. The *R-T* shows the bulk Nb transition near 7.5 K and a lower-temperature crossover near 5.8 K below which the d*I*/d*V* spectra develop strongly enhanced Andreev-reflection features; we interpret this enhancement as the vertical transport path turning into a single effective coherent Andreev channel. A modified-BTK analysis of this regime yields an interface barrier $Z < 0.5$, indicating a clean, highly transparent Nb/Bi_2Se_3 interface enabled by stress-controlled, in-situ growth of the Nb layer.

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