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Specular Andreev reflection at the edge of an InAs/GaSb double quantum well with band inversion

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Recent interest to an InAs/GaSb double quantum well is mostly connected with the problem of two-dimensional (2D) topological insulator [1]. Similarly to the CdTe/HgCdTe quantum well, an inverted band structure can be realized in an InAs/GaSb double quantum well at some growth parameters. For the 10 nm GaSb well, a spectrum with an inversion gap δ is realized for the 12 nm InAs quantum well [2]. In comparison with the well-known CdTe/HgCdTe system, the InAs/GaSb double quantum well provides the stability of a III-V material and well-developed preparation technology.

Different correlated systems with band inversion are expected to demonstrate non-trivial physics in proximity with a superconductor. In the case of semimetals, the proximity is predicted to produce specular Andreev reflection [3]. Usually, the reflected Andreev hole remains in the conduction band of the normal metal (so called retro-, or intraband, Andreev reflection – RAR) [4]. However, for some specific situations, a hole can appear in the valence band, which is known as specular (or interband) Andreev reflection (SAR). The latter has been recently reported for graphene [5].

Here, we experimentally investigate transport through the side junction between a niobium superconductor and the mesa edge of a two-dimensional system, realized in an InAs/GaSb double (12.5 nm/10 nm) quantum well with band inversion. We demonstrate, that different transport regimes can be achieved by variation of the mesa step. We observe anomalous behavior of Andreev reflection within a finite low-bias interval, which is invariant for both transport regimes. We connect this behavior with the transition from retro- (at low biases) to specular (at high ones) Andreev reflection channels in an InAs/GaSb double quantum well with band inversion. In the case of the transparent NS interface, switching off the RAR

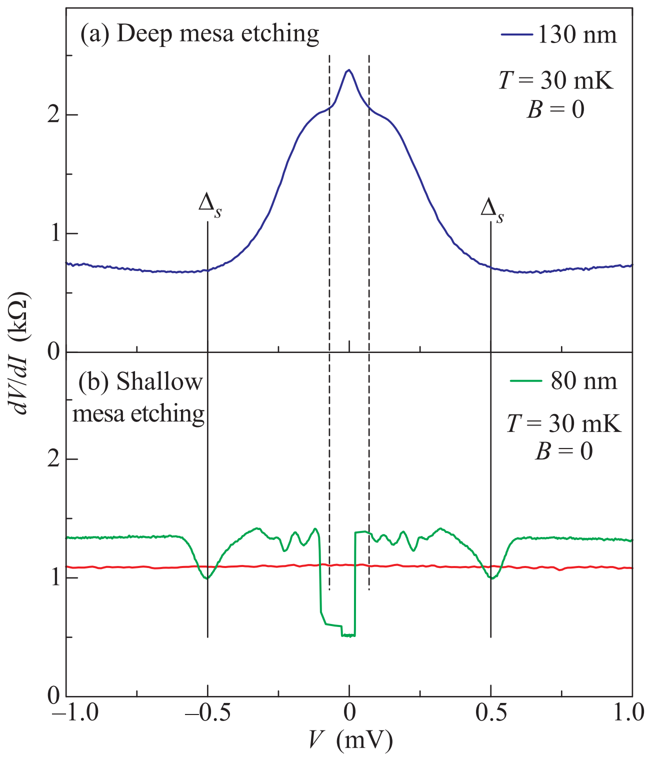

Fig. 1. (Color online) Examples of $dV/dI(V)$ characteristics of a single NS junction for deep (a) and shallow (b) mesa etching. In both cases, the superconducting gap $\Delta_s \simeq \pm 0.5$ mV (denoted by thin solid lines) can be clearly identified. (a) – In the case of deep etching, single-particle scattering is significant at the NS interface, since the subgap resistance strongly exceeds the normal (out-of-the-gap) value [4]. (b) – In the case of shallow etching, the NS interface is much more transparent. Specifics of the InAs/GaSb double quantum well seems to appear in the narrow $\pm$ 0.07 mV bias interval around zero, denoted by two thin dashed lines. The full width of this interval 0.14 mV$\ll \Delta_s$ is identical in (a) and (b) cases. All the curves are obtained at the temperature $T = 30$ mK$\ll T_c$ in zero magnetic field

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channel is accompanied by increase in the differential resistance.

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