Nb/(In,Fe)As/Nb 接合の超伝導特性と磁場応答

Superconducting properties of the Nb/(In, Fe)As/Nb junctions under magnetic fields

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Superconductor/ferromagnet/superconductor (SFS) junctions exhibit attractive phenomena like π-junction states [1] and triplet Cooper pairs [2], but the InAs-based diluted magnetic semiconductor systems containing Mn, e.g. (In,Mn)As, are inept in superconducting junctions because they all are *p*-type. Then we focus on a new ferromagnetic semiconductor (In,Fe)As. Unlike Mn, Fe supplies only spins and then (In,Fe)As:Be can be *n*-type[3], which is suitable in introducing superconductivity from the electrodes being free from Schottky barrier.

We fabricated SFS junctions by depositing Nb superconducting electrodes onto the surface of an MBE grown (In,Fe)As film with the Fe concentration of 6% and its Curie temperature about 120 K. The Nb electrodes are separated by a gap spacing of 0.6 to 1.2 μm, and the currents flow in the (In,Fe)As along the [-110] direction. Figure 1 displays the differential resistance of the junctions without external magnetic fields. All the junctions show a resistance dip at the zero-bias, and several junctions clearly exhibit the zero-resistance state manifesting a supercurrent in the ferromagnetic (In,Fe)As. As shown in Fig. 2, the critical current I_c oscillates against the magnetic fields H, indicating that the Josephson effect forms an interference loop at the junction without a direct contact of the Nb electrodes. The envelop of the I_c vs H curves shows a peculiar hysteresis attributable to the local magnetization in (In,Fe)As.

References

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[3] P. N. Hai, *et al*., Appl. Phys. Lett. **101**, 182403 (2012).

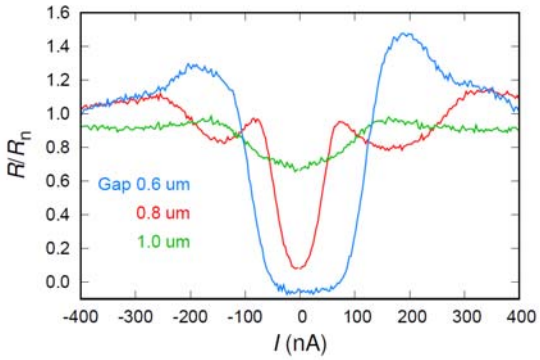

Fig.1: *R-I* characteristics of three junctions with the different gap spacing at 60 mK.

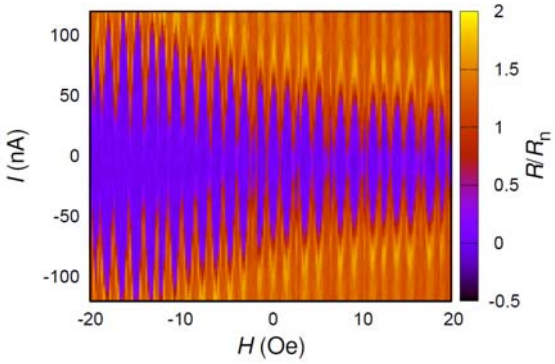

Fig.2: Field dependence of *R-I* characteristics for the junction with the gap spacing of 0.6 μm.