Enhanced Josephson coupling in PbIn-based graphene proximity junction

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A superconductor-graphene (SG) hybrid system provides a unique platform to study the relativistic electrodynamics of Dirac fermions in graphene, combined with the superconductivity. Successful realization of a superconductor-graphene-supercoductor (SGS) junction is the first step toward the observation of the relativistic quasiparticle behavior. However, the often-adopted superconducting electrode material, Al, provides low superconducting transition temperature and energy gap. To overcome the shortcomings, we fabricate proximity-coupled superconducting junctions consisting of a graphene sheet in contact with $\mathrm{Pb}_{1-x}\mathrm{In}_x$ (x=0.07) electrodes. A much higher superconducting transition temperature ($T_c \sim 7.0$ K) and a larger superconducting energy gap ($\Delta_{PbIn} \sim 1.1$ meV) of $\mathrm{Pb}_{1-x}\mathrm{In}_x$ alloy allow the observation of the Josephson supercurrent for temperatures as high as 4.8 K with a large value of the I_cR_N product of ~255 μV, an order of magnitude higher than that for Al-based SGS junctions. Magnetic-field and microwave responses of the junction yield direct evidences for genuine Josephson coupling through graphene. Multiple Andreev reflection is also observed in the subgap structure of the differential conductance (dI/dV).