Nanomagnet-induced Synthetic Spin-Orbit Coupling in a Superconductor-Semiconductor Nanowire

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Inhomogeneous magnetic fields generated by nanomagnet arrays are predicted to induce a synthetic spin-orbit coupling (s-SOC) in hybrid superconductor-semiconductor nanowires commonly used in the search for Majorana bound states [1]. By obviating the need for intrinsic SOC, nanomagnets could thus widen the range of materials available for realising topological superconductivity, for instance to include lower-disorder materials such as carbon nanotubes or silicon nanowires. Here we present conductance measurements of a proximitized Al/InAs nanowire (Figure 1) fabricated adjacent to an array of nanomagnets. In the Coulomb-blockade regime we observe tunnelling resonances at low source-drain bias consistent with the presence of sub-gap Andreev bound states [2]. Using a sequence of externally applied fields to switch the nanomagnets, we verify the expected shift in bound state energy between the anti-aligned and aligned nanomagnet configuration. Our results are consistent with quantum transport simulations and demonstrate the viability of using local magnetic textures to induce s-SOC in hybrid superconductor-semiconductor devices.

References

[1] Kjaergaard et al., Phys. Rev. B 85, 020503(R) (2012)

[2] Higginbotham et al., Nature Physics 11, 1017–1021 (2015)

Figures

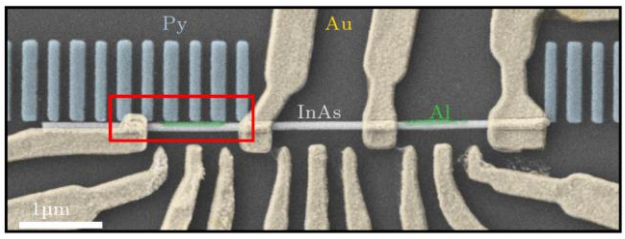

Figure 1: Scanning electron micrograph of the device, comprising an Al/InAs nanowire adjacent to an array of Py nanomagnets used to induce s-SOC.