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Spectroscopy of the superconducting proximity effect in nanowires using integrated quantum dots

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The superconducting proximity effect is the underlying mechanism of topologically non-trivial boundary states, like Majorana bound states, in semiconducting nanowires with a large spin orbit interaction. These protected states are potentially useful for quantum information technologies. However, spectroscopy of these states is challenging because of the poor energetic and spatial control of conventional tunnel barriers, defined by electrostatic gates. Here, we report electronic spectroscopy measurements of the proximity gap in a semiconducting indium arsenide nanowire segment coupled to a superconductor using a spatially separated quantum dot formed deterministically by crystal phase engineering. We extract the characteristic parameters of the proximity induced gap, which is suppressed for lower electron densities and fully evolved for larger ones. We understand this gate-tunable transition of the proximity effect as a transition from the long to the short junction regime of subgap bound states in the NW segment. Our device architecture opens up a way to systematic, unambiguous spectroscopy studies of subgap bound states, such as Majorana bound states.

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