ELECTRON TRANSPORT PHENOMENA THROUGH A SINGLE InAs QUANTUM DOT COUPLED TO Nb SUPERCONDUCTING LEADS

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Electrically tunable semiconductor quantum dots (QDs) are known as artificial atoms, where phenomena governed by quantum mechanics are relevant. In this project, we aim at understanding the quantum transport through a QD coupled with superconducting leads. In particular, the QD system combined to a Nb Josephson junction has not been fully demonstrated experimentally yet. The device was a single InAs self-assembled quantum dot (SAQD) placed in a 40 nm-wide nanogap between two superconducting Nb nanowires. The typical diameter of the InAs SAQD was about 80 nm. First we characterized the superconductivity of Nb thin films deposited using an electron-beam evaporator. The films exhibited low resistance at 4 K, indicating the existence of a superconducting state. We also applied the similar process to characterize a Nb nanowire for the use of superconducting leads. Then we prepared Nb nanogaps by electron-beam lithography on the InAs SAQD wafer, which already had a built-in back gate, using the conventional lift-off process. Using scanning electron microscope (SEM) to check the surface, we can select Nb nanogaps bridged well by an InAs dot. In the presentation, we will show results of electrical transport through such devices and discuss the proximity supercurrent flowing through the QD. The proximity supercurrent can be tested by current-biased 4-terminal measurements. Comparing to our previous work using the Al leads, the enhanced supercurrent can be expected because of the large superconducting gap of Nb.