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Development of Hafnium STJ for cosmic neutrino background search

The COBAND experiment searches for far infra red photons from decays of cosmic neutrino background. In order to achieve sensitivity for neutrino lifetime predicted by some theoretical model, 2% energy resolution is required for the detector. We are developing a superconducting tunnel junction detector (STJ) using Hafnium superconductor (Hf) that have very small bandgap. Bandgap of Hf is 0.021 meV that is 1/8 of aluminum generally used as a superconducting material. Therefore Hf-STJ gives eight times larger signal output and better sensitivity may be possible compared to other current STJ detectors. So far, quality of Hf-STJ is limited by leak current caused by ununiformity of insulator layer.
We fabricated 10 micron square and 200 micron square Hf-STJs with photolithographic techniques and measured its I-V characteristic by four-terminal sensing at temperature below 150 mK in a dilution refrigerator at University of Tsukuba. The leak current of 10 micron Hf-STJ is smaller than before, but it is still 100 - 1000 times larger compared to our goal. I-V curve looks similar to general STJ's characteristic feature and Josephson current was also seen. In this measurement, it was not possible to study I-V curve in detail or to check response to photons due to large leak current coming from thermal excitation at 150 mK close to critical temperature. We plan to measure this Hf-STJ at 50 mK by using an adiabatic demagnetization refrigerator in Korea in 2018 to reduce thermal noise.

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