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R&D of Hf-STJ for COBAND experiment

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Discovery of neutrino oscillations revealed that neutrinos have mass, but the absolute mass of the neutrinos still remains unknown. Since neutrinos are a massive particle, a heavier neutrino may decay into a lighter one with a photon emission. The photon energy is expected to be around 25 meV at maximum. The COsmic BAckground Neutrino Decay (COBAND) experiment aims at detecting the photons as decay products of cosmic neutrino background (C\nuB) and determining the neutrino mass. In addition, if we observe excess photons in the C\nuB decay from the prediction by the standard model (SM), it will indicate a physics beyond the SM. Therefore, the detector required in the COBAND experiment is to be capable to measure single photons with a resolution better than 2% at the energy of 25 meV to identify the photons from the two-body decay of neutrinos. Since semiconductor-based detectors cannot satisfy this requirement, we consider using superconducting tunnel junction devices based on hafnium (Hf-STJ), which is known to have the smallest superconducting gap at typical temperatures of low-temperature detector instrumentation. We have established dependable fabrication method to form a SIS structure of Hf-STJ. We also observed pulsed visible photons using the Hf-STJ devices. The leakage current, however, was still found to be much larger than 10 pA of the COBAND requirement. Here we report on the latest measurement and the recent progress of Hf-STJ development for small junction devices. We will discuss the junction-size dependence of the leakage current together with fabrication details on the sputtering conditions of Hf and oxidization method to form an insulation layer. Moreover, we will present the 6 keV x-ray responses measured in an adiabatic demagnetization refrigerator.

Less than 5 years of experience since completion of Ph.D

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