Development of superconductor tunnel junction detector with cryogenic amplifier for COBAND experiment.

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For COBAND collaboration

1. COBAND experiment

- **Cosmic Background Neutrino Decay search experiment**
  - The purpose of COBAND experiment is to detect neutrino mass by measuring the energy of neutrino decay photon.
  - Neutrino lifetime is very long (T>O(10^{12}) years).
  - We need to amplify the STJ signal near the STJ section.

- **Operation at cryogenic temperature (<3K)**
  - We are developing cryogenic amplifier for COBAND experiment.
  - We are developing cryogenic amplifier to detect neutrino decay photon for COBAND experiment.

- **Cryogenic SOI Amplifier**
  - We are developing cryogenic amplifier using FD300 MOSFET.
  - It consists of Nb/Al/AIOx/Al/Nb.
  - A constant bias voltage is applied.
  - Photons break Coper pairs into quasi-particles which tunnel through the insulator layer as a current.

2. Cryogenic SOI Amplifier

- **Issue**
  - The requirement for Nb/Al-STJ that leakage current is smaller than 100 pA is already achieved.
  - As a large amount of noise from refrigerator readout line prevents the detection of the far-infrared single photon, so we need to amplify the STJ signal near the STJ.

- **Requirement for cryogenic amplifier**
  - Operation at cryogenic temperature (<3K)
  - Capable of amplifying STJ’s fast signals (<10 μs)
  - Low power consumption and low noise

- **FD-SOI MOSFET**
  - FD-SOI(“Fully Depleted Skin on Insulator”) MOSFET
  - It has very thin body (<50 nm)
  - At 3 K, its threshold voltage shifts and Ids increase, but as far as we operate suitable voltage, it does not matter.
  - We develop cryogenic amplifier using FD-SOI MOSFET.

3. Test of Amplification

- **STJ-STJ6**
  - We succeeded in amplifying STJ’s signal illuminated by visible laser pulse with SOI-STJ6.
  - Because generated charge escape to stray capacitance on wires of four-terminal method circuit to measure STJ, output signal is smaller than its expectation value.
  - We need re-measurement without four-terminal method.

- **Charge injection test**

4. Summary

- We are developing cryogenic amplifier to detect neutron decay photon for COBAND experiment.
- We confirmed normal operation of SOI-STJ6 at 3 K.
- We succeeded in amplifying STJ signals for visible laser pulse with SOI-STJ6.
- Output signal is smaller than our expectation, so we need re-measurement.
- We will attempt to detect infrared single photon.