Development of TiN-MKIDs for CMB polarization observations

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***Abstract*—To understand the cosmic inflation observationally, one of the most important observations is that of B-mode polarization of cosmic microwave background (CMB) in the frequency range of 60~250GHz. For the observations, the detector array with noise equivalent power of less than 10^{-18}W/√Hz and more than 1,000 elements is required. We are developing the superconducting detectors called microwave kinetic inductance detectors (MKIDs[1]) for the observations. MKIDs utilize the change in the resonance features due to the inductance change of the superconducting circuit operated in the microwave frequency. When MMW radiation is absorbed by the superconductor and Cooper pairs are broken in it, then its kinetic inductance changes. We can easily achieve the multiple (more than 1,000) channels in parallel by differentiating the resonance frequency of each element.**

For the improvement of the sensitivity, the selection of material is crucial. We choose titanium nitride (TiN) as a good candidate because (1) its critical temperature (Tc) can be changed by the composition (0 <Tc< 5K), (2) the normal-state resistivity is large (facilitating photon absorption and providing a large kinetic inductance), and (3) the resonator of reactively sputtered TiN films show low loss (Q >10^7)[2]. We fabricated TiN films in various RF sputtering conditions and confirmed that T_C of TiN films varied with its composition by changing the flow rate of N_2 gas (Tc = 0.50K ~ 4.06K) . Then, we fabricated the TiN-MKIDs device, checked its response to the MW readout signals (Q ~ 3×10^5 @ 0.3K), and confirmed temperature dependence of the resonance peak. In this presentation, we will report the current status and the future prospect.

References: [1] P.K. Day et al., Nature 425, 817 (2003). [2] H.G. Leduc et al., arXiv:1003.5584v1 (2010).