The design and characterization of Dielectric Microcalorimeters for X-ray photon detection

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Dielectric Microcalorimeter (DMC) is a novel radiation detector utilizing GHz resonator (Sekiya et al. 2012). This detector is potentially a candidate to operate as an X-ray detector.The advantage of using DMC is that the detection mechanism is based on a phonon mediation with no Johnson noise or quasi-particle decay process. Therefore, in principle, DMC can achieve a better energy resolution detector than that of TES and MKID. Furthermore, a large format array of DMC can be easily multiplexed by the nature of a resonator circuit in the readout at GHz bandwidth.
\par This new detector concept has not yet measured the X-ray experimentally, and yet we successfully demonstrated our prototype DMC detects the IR radiation as a bolometer at the operation temperature of 2 K(See details in Kikuchi et al. in this conference).
\par In this presentation, we report the design of DMC for use as an X-ray photon counter. The design is optimized to detect the 5.9 keV X-ray. It is essential to select the dielectric material that has a desired sensitivity value ,α. We consider ^{18}O doped STO(STO18) and KTN as a candidate because the commonly used STO16 does not have a suitable α at 100 mK for our application. KTN is one of the perovskite-type materials. The dielectric permittivity and the specific heat of KTN is measured at cryogenic temperature. Both STO18 and KTN has a thermal sensitivity of $\sim10^{-3}$ at 100 mK, which is ideal for our application. If we assume a size of 300 um square DMC resonator operating at 100 mK, we need a Q-value of 2000 and $\alpha=10^{-3}$. As a first prototype DMC optimizing at 5.9 keV, we employ STO18 due to our familiarity of a processing technique using the conventional STO16. We will present the detailed detector design, and preparatory measurements to this detector.