INTRODUCTION

Our goal is to use microwave kinetic inductance detectors (MKIDs) to measure the temperature of the absorber of a microcalorimeter, to within 10 eV for a 5.9 keV X-ray absorption event. We design for similar sensitivity over the X-ray energy range 2 – 12 keV, and we would like to demonstrate 1,000 microcalorimeters in a tiled array.

Goal: 10 eV resolution at 6 keV
Goal: 2 – 12 keV operation range
Goal: 1,000+ microcalorimeter array.

MKID Physics

- MKIDs are resonant circuits patterned out of superconducting thin films.
- Each resonant circuits has a unique geometry which gives it a unique resonant frequency ($f_0$) and bandwidth, i.e. quality factor (Q).
- Numerous resonators are usually shunt-coupled to a common feedline, a superconducting transmission line.
- They are easy to bias and read out by multiplexing over the frequency domain, currently for a cost of ~$10 resonator or less.

Approach

- To increase energy resolution: (a) we increase readout power handling using a wide inductor, i.e. 10 μm. (b) we decrease two-level system noise by using a large capacitor, i.e. low E-field.
- This iteration, XR-9, uses cantilevered (tantalum) absorbers to enable close packed tiling of adjacent microcalorimeters.
- Resonators are made of a high $T_c$ material (Niobium) with a section of low $T_c$ material in close proximity to the absorber, where the $\delta$T from X-ray absorption is greatest and affects a large $\delta$L$_{kin}$
- Membrane release is done by a back side Bosch trench etch through the silicon wafer substrate followed by a HF dip to remove a SiO$_2$ etch stop layer and any excess surface states created by processing that lead to anomalously high heat capacity and noise.
- Thermal time constant tunable by membrane geometry and absorber volume/material choice.

REFERENCES


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