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Quantum efficiency study and reflectivity enhancement of AuBi absorbers

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We are developing high resolution transition edge sensor (TES) microcalorimeters for the Athena X-ray Integral Field Unit (X-IFU) instrument. The x-ray absorbers of the TES pixels must provide high quantum efficiency (QE) for the incident x-rays and high reflectivity to longer wavelength radiation. Our pixel designs use ~ 5 micron thick electroplated Au-Bi absorbers. The thickness of the Au and Bi layers are tuned to provide the desired pixel heat capacity and the vertical QE. The high heat capacity Au layer provides fast thermal diffusion of the x-ray energy to the TES and the Bi layer provides additional QE without adding significant heat capacity. In this paper we present the optimization of the absorbers for applications such as X-IFU. To calculate the QE precisely, we have included the effects of surface roughness, edge profile and filling factor of the absorbers and the effects of the different angles of incidence of the incoming x-rays from the X-IFU optic. The surface roughness of the top Bi layer, measured by using an optical surface profiler, was found to have negligible effect on the average QE. To improve the reflectivity of absorbers to low energy radiation we have introduced an Au capping layer on top of the Bi layer. This makes TES detectors less sensitive to shot noise from low energy photons, reduces stray power and eases the design of optical blocking filters. Reflectivity measurements in the wavelength range 300 nm - 20 microns show a significant increase in reflectivity compared to bare Bi layer. This is consistent with the expected reflectivity difference of bulk Au compared with bulk Bi. Characterization of TES pixels with and without the Au capping layer showed no evidence that the capping layer affects the absorber thermalization properties.

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

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