Effects of a rear-surface copper coated silicon nitride membrane on thermal crosstalk in an x-ray microcalorimeter array

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We are developing small pixel arrays of transition-edge sensor (TES) microcalorimeters with pixel pitch as fine as 50 μm for astrophysical, solar physics, and laboratory applications. These arrays are fabricated on solid silicon substrates rather than silicon nitride membranes in order to provide sufficiently fast time constants so that x-ray count-rate requirements can be met, and to ease fabrication of fine-pitch pixels in large arrays. To minimize thermal crosstalk in this geometry, previous small-pixel array designs implemented a thermally conducting copper plane within the silicon-based substrate, underneath the TES arrays but separated by a silicon oxide insulation layer.

This geometry has demonstrated very low levels of thermal crosstalk, even at fine pixel pitch. However, this fabrication approach often leads to stress between substrate layers that causes structural failures. Furthermore, this design cannot be integrated with other pixel designs requiring the suspension of pixels on silicon nitride membranes within a hybrid array format. Therefore, we have developed a new design in which a copper heat-sinking layer is deposited directly onto the back surface of a silicon nitride membrane supporting the small pixels. We present the results of recent crosstalk measurements on a 12x12 array of 50 μm pitch pixels with this new design. We show that we reduce the thermal and electrical crosstalk as a function of distance to the source pixel to the same level as with the previous geometry. Additionally, we investigate the possible effects of microstrip wiring between pixels on the magnitude of the thermal crosstalk.