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A study of TES X-ray microcalorimeter array with different absorber towards the observation from 50 eV to 15 keV for STEM-EDS

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We developed a transition edge sensor (TES) X-ray microcalorimeter array with two different-thickness absorbers in the same device, for the wide energy band from 50 eV to 15 keV.
Studies of astromaterials, such as sample-return missions (e.g., HAYABUSA2 and OSIRIS-REX), provide valuable insights into the formation and the evolution of the solar system. Astromaterials include several small and large quantity elements like Si, O, and C and have sub-micro scale structure. To analyze the astromaterials in sub- micrometer scale, one of the useful tools is Energy-dispersive X-ray spectroscopy (EDS) in conjunction with a scanning transmission electron microscope (STEM). We had developed a 64-pixel TES X-ray microcalorimeter array for STEM-EDS which had an energy resolution of about 7 eV (FWHM) at the energy band from O Kα to Fe Kα (Maehata+2015, Hayashi+2017, 2018). However, the TES array is low sensitivity to small quantity elements at low energy band below 300 eV, since the intensities of those peaks are low to that of continuum component by an absorption of an optical filter and a X-ray window in the fridge. In order to obtain high sensitivity at both the high and the low energy bands, we designed a TES chip with two types absorbers of different thickness. We fabricated it by controlling only the absorber thickness without changing the TES geometry. For the low-energy bands, we set the thickness of the absorber to 300 nm. The saturation energy of the TES with thinner absorber is about 3 keV and the energy resolution of that is 3 times better than that of the conventional TES. The TES pixels for the low-energy band are placed on position which occupied 20% of total counts of whole incident X-ray photons to the TES array. On the other hand, for the high-energy bands, we applied the conventional absorber thickness.
In this paper, we present details of the fabrication methods and of the performance of the system.

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

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