16th International Workshop on Low Temperature Detectors
20 24 | July 2015

Performance of Transition-edge sensor X-ray micro-calorimeters optimized for energies below 2 keV

Main author:

LEE S.-J.

Co-authors:

Adams J.S., NASA Goddard Space Flight Center
Audley H.E., NASA Goddard Space Flight Center
Bandler S.R., NASA Goddard Space Flight Center
Betancourt-Martinez G.L., NASA Goddard Space Flight Center
Chervenak J.A., NASA Goddard Space Flight Center
Eckart M.E., NASA Goddard Space Flight Center
Finkbeiner F.M., NASA Goddard Space Flight Center
Kelley R.L., NASA Goddard Space Flight Center
Kilbourne C.A., NASA Goddard Space Flight Center
Lee S.-J., NASA Goddard Space Flight Center
Porter F.S., NASA Goddard Space Flight Center
Sadleir J.E., NASA Goddard Space Flight Center
Smith S.J., NASA Goddard Space Flight Center
Wassell E.J., NASA Goddard Space Flight Center
Yoon W., NASA Goddard Space Flight Center

We have developed fine pitch closed-packed arrays of transition-edge sensor (TES) microcalorimeters for X-ray astrophysics. Such arrays will allow the study of diffuse X-ray sources such as the warm-hot intergalactic medium (WHIM) with high spectral resolution. They can also be used as soft X-ray spectrometers at synchrotron light sources for biology, chemistry, and material science. We measured the performance of a 50-um pitch 12x12 pixel microcalorimeter array. Each pixel has a 45x45x4.2 um^3 gold absorber cantilevered above a TES by a gold stem. Since the detector responsivity to soft X-rays in terms of current change in the TES was highly non-linear with X-ray energy at its optimal bias point (very low in the transition), an alternative data processing approach other than conventional optimal filtering of current signals was applied. Each X-ray signal in current was converted to its corresponding resistance change of the TES before optimal filtering, which resulted in improved energy resolution. The predicted

FWHM resolution at 1.5 keV was 0.47 eV based on signal-to-noise ratio measurements while the measured FWHM resolution for 1.5-keV Al Ka X-rays was 0.75~eV, which is the highest resolution to date using a non-dispersive detector. Possible explanations for the difference between predicted and measured resolutions will be discussed, and the feasibility of the detector in other applications, e.g. soft X-ray spectroscopy at synchrotron light sources, will also be discussed based on measured detector parameters such as the decay time constants.