Characterization system of 64 pixel array TES microcalorimeters

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X-ray energy dispersive spectroscopy (EDS) performed on electron microscopes allows elemental composition analysis within a nano-scale structure with a simple operation. For element identification with high accuracy X-ray detectors with excellent energy resolution are desired in the EDS system. Usually Si(Li) semiconductor detectors (SSDs) are used for the EDS on typical electron microscopes. The energy resolution of the SSD has been achieved theoretical limit of 120 eV full width at half maximum (FWHM) at 5.9 keV. Because recent advanced material research desires further improvement in the energy resolution of the X-ray detector in the EDS system on a scanning transmission electron microscope (STEM),

we have been conducted development of a transition edge sensor (TES) microcalorimeter EDS system mounted on the STEM (Maehata et al. in this workshop).

Although the single pixel TES microcalorimeter was demonstrated an excellent energy resolution <10 eV (FWHM) performed on the STEM in the energy region of 2 keV, a counting rate was limited to be 300 counts per second (cps) due to a sensitive area of 150 μm x 150 μm.

Therefore a 64 pixel array TES microcalorimeter is being developed for achieving the counting rate larger than 5 kcps in the EDS performed on the STEM. The number of

pixels was selected to be 64 with consideration of the arrangement of the X-ray optic and the geometrical dimensions of the snout. Each pixel is individually connected with the input coil of the superconducting quantum interference device (SQUID) array. In order to reduce the number of wire, bias lines are connected in series for 8 pixel TESs and corresponding SQUID arrays, respectively.

For characterizing the 64 pixel array TES microcalorimeter, it is necessary to obtain response of each pixel to X-rays in the 64 pixel operation with the series bias line connection.

In this work, characterization system of 64 pixel array TES microcalorimeters was constructed with using a 3He-4He dilution refrigerator with the cooling power of 60 μW at a temperature of 100 mK. A stick with 384 of Manganin wire was inserted into the refrigerator for operating the 64 pixel array TES microcalorimeter and corresponding SQUID arrays. The stick was thermally anchored at the top flange of an inner vacuum chamber and the end of the stick was attached to the 1 K pot with sufficient thermal contact. At the end of the stick Manganin wires were connected with Nb-Ti wires which were wired to connectors placed on the holder attached to the mixing chamber. The heat flow to the mixing chamber through the Nb-Ti wires was estimated to be 300 nW.

In this presentation, we report details of the characterization system of 64 pixel array TES microcalorimeters and present status of characterization of the 64 pixel array TES microcalorimeter.