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DEVELOPMENT OF STJ AS A NEW X-RAY DETECTOR

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1. Introduction

STJs are promising X-ray detectors as high energy resolution spectrometers due to the small excitation energy to break the Cooper pairs to product detectable electrons. The expected energy resolution is about 5 eV for a 6 keV incident X-rays (see review by Kraus et al. and Esposito et al.). We have developed a large area ($178 \times 178 \mu m^2$) Nb/Al/AlO_X/Al/Nb STJs (Kurakado et al. 1993) and series-connected STJs with a position resolution of $35 \mu m$ for α particles (Kurakado 1997) at Nippon Steel Corporation. As a focal plane detector in fu ure X-ray missions, we are developing STJs whose targert characteristics are ; an energy resolution of 20 eV at 6keV, an effective area of 1 cm^2, and position resolution of $100 \mu m$.

2. Experiment at TMU

A measurement system for STJs with an X-ray generator attached to a ^{3}He cryostat to be cooled to 0.35 K is fabricated at Tokyo Metropolitan University. Using this system, we succeed to detect X-ray signals from both single and series-connected STJs.

From a single STJ detector of $178 \times 178 \mu m^2$, an energy resolution of 112 eV at 5.9 keV including 95 eV electrical noise is obtained (see Fig.1). Utilizing the X-ray generator, we measure the X-ray energy vs. pulse height relation for 6 incident X-ray energy at the same condition. We found that

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the energy scale is well represented by a parabolic function(see Fig.2), because the recombination rate of quasi-particles in the superconductor is proportional to the power of the density of the pseudo particles, i.e. the square of the incident energy.

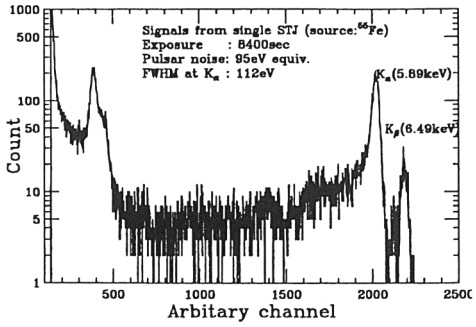

Figure 1. The energy spectrum obtained by a STJ

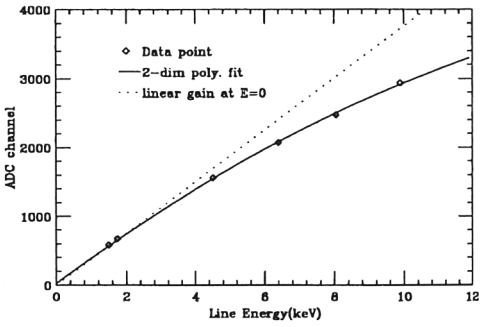

Figure 2. The X-ray line energy vs pulse height

3. Future developments

To obtain the good energy resolution, it is necessary to reduce the readout noise. Frank et al. obtained a good energy resolution (29 eV at 5.9keV) with a SQUID readout. Recombination loss of the pseudo particles in the superconducting layer drops the signal current. Multi-trap structure (for example, Nb/Ta/al/AlO_X/Al/Ta/Nb) to gain the efficient tunneling of the quasi-particles is proposed (Kurakado 1997). And we are starting the position sensing of X-rays with series-connected STJs analyzing the rise-time and pulse height of each events.

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