

THE NIST TES MICROCALORIMETER, NOW AND IN THE FUTURE

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The NIST microcalorimeter is a successful new type of x-ray detector that has undergone several generations of development. It has already served as a basis for ongoing efforts to commercialize x-ray microcalorimeters. These are detectors, operating at extremely low temperatures, in which the energy deposited by individual x-ray photons produces a temperature pulse whose amplitude is registered with high accuracy. This talk will concentrate on microcalorimeter detectors using a Transition Edge Sensor (TES) as a thermometer. They are distinguished by the use of superconducting Josephson Junction electronics which are unconventional by the standards of previous x-ray detection. We explain the tradeoffs that are made in order to optimize high energy resolution, large detection area, or high count rates. We shall describe sources of noise and drift and how they affect resolution and performance.

The versatility of the microcalorimeter x-ray detector will be illustrated with spectra produced on a scanning electron microprobe. They are characterized by an energy range of several keV, with an energy resolution of a few eV. Examples of measurements which cannot be produced by existing detectors include quantitative analysis with interfering fluorescence spectra, high-resolution x-ray spectroscopy of core lines from multiple elements, and valence band emission spectra at very low energies. Some estimates of accuracy and the effects of brehmsstrahlung backgrounds will be given.

The future of microcalorimeter detectors encompasses a number of different paths. High energy x-ray and gamma detectors, soft x-ray detectors, and multiple pixel imaging or area detectors are all under development. The widespread acceptance of these detectors will depend on parallel progress in dewar and refrigeration technology, as well as on electronics and software which provide consistency of performance and ease of use.