Heat capacity and thermal conductance measurements of a superconducting/normal mixed state by detection of single 3 eV photons in a Magnetic Penetration Thermometer

Main author: STEVENSON Thomas

Co-authors: Balvin Manuel, NASA Goddard Space Flight Center
Bandler Simon, NASA Goddard Space Flight Center
Denis Kevin, NASA Goddard Space Flight Center
Lee Sang-jun, NASA Goddard Space Flight Center, and Oak Ridge Associated Universities
Nagler Peter, Brown University
Smith Stephen, University of Maryland Baltimore County
Stevenson Thomas, NASA Goddard Space Flight Center

We report on measurements of the detected signal pulses in a molybdenum-gold Magnetic Penetration Thermometer (MPT) in response to absorption of one or more 3 eV photons. We designed and used this MPT sensor for x-ray microcalorimetry [1]. In this device, the diamagnetic response of a superconducting MoAu bilayer is used to sense temperature changes in response to absorbed photons, and responsivity is enhanced by a Meissner transition in which the magnetic flux penetrating the sensor changes rapidly to minimize free energy in a mixed superconducting/normal state [2]. We have previously reported on use of our MPT to study athermal phonon energy loss to the substrate when absorbing x-rays [3]. We now describe results of extracting heat capacity C and thermal conductance G values from pulse height and decay time of MPT pulses generated by 3 eV photons. The variation in C and G at temperatures near the Meissner transition temperature (set by an internal magnetic bias field) allow us to probe the behavior in superconducting/normal mixed state of the condensation energy and the electron cooling power resulting from quasiparticle recombination and phonon emission. The information gained on electron cooling power is also relevant to the operation of other superconducting detectors, such as Microwave Kinetic Inductance Detectors.
