Performance and Characterization of Magnetic Penetration Thermomter Devices for X-ray spectroscopy

We are developing magnetic penetration thermometers (MPTs) for applications in X-ray astronomy. These non-dissipative devices consist of an X-ray absorber in good thermal contact to a superconducting thin film with a transition temperature around T=100mK.
A microfabricated superconducting planar inductor underneath is used to store a persistent current and couple the superconductor's diamagnetic response to a readout SQUID.
The strong temperature dependence of the diamagnetic response make these devices suitable for highly sensitive macroscopic thermometers that are capable of achieving very high energy resolution.

We present results achieved with MPTs consisting of MoAu bilayer sensors attached to overhanging square 250 μm by 250 μm gold absorbers that have demonstrated an energy resolution of ΔE_FWHM=2.3eV at an X-ray energy of 5.9keV. A similar device has shown ΔE_FWHM=2.0eV at 1.5 keV.

Under certain conditions and for specific device geometries, the temperature responsivity of the MPTs can vary on long timescales degrading the spectral performance. We present the characterization of different inductor geometries to optimize the design for the highest possible temperature sensitivity and compare different device designs with respect to responsivity stability.

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