Microfabricated Thick Proximity Bi-layers as Sensors for Magnetic Penetration Thermometers (MPTs)

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Whereas metallic magnetic calorimeters for high resolution x-ray spectroscopy use dilute paramagnetic alloys as temperature sensors operated at temperatures below 30 mK, magnetic penetration depth thermometers (MPT) make use of the steep temperature dependence of the magnetic penetration depth of a superconducting sensor, potentially offering i) improved T-sensitivity ii) at higher, easier accessible temperature.

In the MPTs which we presently fabricate and investigate, a superconducting sensor is placed in the weak magnetic field produced by a persistent current in a superconducting coil. Operated below Tc of the sensor, the temperature change upon the absorption of an x-ray in the detector leads to a change of the magnetic flux density B(r) inside the sensor and in its vicinity which is detected by the pickup coil of a SQUID and serves as a measure of the absorbed energy.

So far we have studied a number of different elemental superconductors, Hf, Ir, Ti, Al, Nb, and recently thick proximity bilayers of aluminum and gold/silver, promising a large range of operational temperatures. We have also demonstrated that the penetration of flux lines and the hysteresis behavior can be engineered by patterning the superconducting sensor layer in form of discs or stripes.

We present data on MPT sensors with various geometries and materials. We discuss the achieved temperature sensitivities and the operating conditions for non-hysteretic response.