

Fully Automated AC Susceptometer for milli-Kelvin Temperatures in a DynaCool PPMS

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Abstract— We have developed a commercial apparatus to measure the AC-susceptibility of small samples (1 mg to 500 mg) from 50 mK to 4 K using a versatile top loading dilution refrigerator. This susceptometer is readily available to perform fully automated AC measurements in both, cryogen free and liquid cooled Physical Property Measuring Systems (PPMS). AC susceptibility measurements can be performed with AC excitation fields in the range of 0.01 Oe–4 Oe (peak) for frequencies from 10 Hz to 10 kHz and in the presence of a static DC field of up to 12 T. The design of the susceptometer employs a novel approach which virtually eliminates heating of the sample stage by thermally anchoring the coil set at 1.8 K, using superconducting wire for the excitation coil, and using a coil design which limits induced eddy currents on the dilution unit. The sample is mounted to a sapphire sample holder attached to the dilution stage and positioned in the center of one of the pickup coils. An additional trim coil on the coil set allows for dynamic removal of any background signals during the measurement, facilitating sample measurements for moments as small as 2×10^{-7} emu. We present measurements for various samples to demonstrate the capabilities and performance of this new instrument. In the current design, AC susceptibility measurements down to 50 mK can be performed in less than 8 hours after mounting the sample.

Keywords (Index Terms)— Dilution refrigerators, cryogenics, magnetic susceptibility, magnetometers, materials testing.

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