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The Measurement and Uncertainty Analysis of Thermal Resistance in Cryogenic Temperature Sensor Installation

The choice of the appropriate installation method plays an important role for accurate temperature measurement. In the cryogenic and high vacuum environment, due to poor contact between the cryogenic temperature sensor and the surroundings that the sensor is installed and intended to measure, the self-heating from sensor measuring current brings about temperature difference and creates a potential temperature measurement error. The self-heating temperature difference is directly proportional to the thermal resistance for a mounted sensor, which means that lower installation thermal resistance of sensors is advantageous to obtain better measurement results. In this paper, a measurement model for the installation thermal resistance of sensor is built in terms of two currents method which is always used to measure self-heating effect. A cryostat that can provide variable temperature in the accurate temperature measurement and control experiments is designed and manufactured. This cryostat can reach 3K in a few hours and the sample temperature can reach as high as 20 K. Based on the experimental results, the measurement uncertainty of the thermal resistance are also analyzed and calculated. To obtain the best measurement results in our cryostat, the thermal resistances of sensors with two installation methods are measured and compared.

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