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C2Or4B-02: Cernox® versus germanium cryogenic temperature sensor stability comparison over the 1 K to 27 K temperature range

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Germanium resistance thermometers (GRTs) have played a crucial role in the dissemination of both the 1976 Provisional 0.5 K to 30 K Temperature Scale and the International Temperature Scale of 1990 to cryogenic experimenters worldwide. GRTs combined a small physical package with a sensing element that possessed high temperature sensitivity and very high stability over thermal cycling and time. The fabrication method allowed for tweaking the GRT response curve to maximize sensitivity for a desired temperature range. For thermometry applications, the best GRTs were fabricated with arsenic doping. and these devices were commercially available from multiple companies for nearly 50 years. At present, however, commercially available GRTs are nearly nonexistent as germanium crystal growers are reluctant to work with arsenic dopants. For cryogenic temperature applications below30 K, the most promising alternative is Cernox® resistance thermometers (CxRTs). CxRTs have characteristics similar to GRTs including small physical size, high stability, and a temperature response curve that can ne tailored to maximize performance over a given temperature range. To date, no direct comparison of calibration stability between CxRTs and GRTs using an identical test protocol has been performed. In the present work, A group of 15 GRTs and 25 CX-1050-CU devices were calibrated against ten NIST/NPL calibrated thermometers over the 1.2 K to 30 K temperature range, and subsequently thermally cycled slowly from room temperature to 1.2 K approximately once per week for 50 weeks. Following the 50 thermal cycles, both groups were recalibrated against the ten NIST/NPL calibrated thermometers. Data was analyzed in terms of temperature shift between the pre- and post-thermal cycling for both groups of thermometers. For GRTs, the preliminary results show the post- versus pre-thermal cycling calibration data average stability ranging from 0.5 mK (standard deviation <1.0 mK) for temperatures less than 4.2 K, and less than 1.5 mK (standard deviation <1.7 mK) for temperatures up to 30 K. For CxRTs, the preliminary results show the post- versus pre-thermal cycling calibration data average stability to be similar to that of GRTs, with lightly higher standard deviations about the average ranging from 1.0 mK for temperatures less than 4.2 K, and less than 2.1 mK for temperatures up to 27 K.

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