Assessment of Hysteresis Uncertainty in the Calibration of Platinum Resistance Thermometers

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Thermal hysteresis of platinum resistance thermometers (PRTs) was investigated in the temperature range of −196 °C to 450 °C. The wider the measured temperature range of the PRT hysteresis, the higher the observed hysteresis effect of the PRT near the mid-point of the temperature range. The magnitude of the hysteresis, defined as the difference in the resistance converted to an equivalent temperature difference between heating and cooling processes, has been observed to reach up to 100 mK in PRTs used over the full temperature range. However, some PRTs did not conclusively exhibit hysteresis even in the widest temperature range, and the upper bound of hysteresis corresponded to only a few mK. Clear hysteresis of the PRTs in this work was repeatable at a quantitative level, and the hysteresis of the PRTs in a wider temperature range was larger than the value linearly scaled from the measured hysteresis in a narrower temperature range. Therefore, when assessing the uncertainty associated with the hysteresis of PRTs, hysteresis should be measured in the complete temperature range of the calibration process and the calibration process should be designed so as to give a reliable estimate of the hysteresis. During the investigation of the relaxation time scale, the PRTs were intentionally undercooled below the temperature of the designated measurement point in a controlled manner to assess the impact on hysteresis. It was observed that such deviation from the prescribed treatment of the PRT during hysteresis measurements could result in an underestimation of the hysteresis. Therefore, it is best to strictly abide by the supposed direction of temperature change to accurately obtain the upper bound of the hysteresis uncertainty in a given temperature range.

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