13. Platinum-Cobalt Resistance Thermometers

The platinum-cobalt thermometer having a cobalt content of 0.5tomic percent has been developed since 1978 (Shiratori and Mitsui (1978), Shiratori et al. (1982)]. This type of thermometer is available in a standard capsule and in an IPRT-like package (stainless-steel hermetic case). Results of testing and an assessment of stability are available at present only for the industrial type: Shiratori et al. (1982) reported changes of less than 10 mK after several hundreds of cycles between room temperature and 4 K, and Pavese and Cresto (1984) confirmed this behaviour. When the thermometers are cycled between 77 K and 500 K (total heating time ~ 200 h), changes of R(0 °C) are smaller than the equivalent of 100 mK and changes of R(77 K) smaller than the equivalent of 30 mK. Most of the change occurs after the first 50 h of heating. Specific testing for reproducibility between 2 and 20 K [Sakurai and Besley (1985)] has confirmed reproducibility within ± 10 mK when the thermometer is cycled to room temperature, and has shown that it may improve to a few millikelvins if the thermometer need never return above 100 K.

Shiratori and Mitsui (1978) studied the resistance/temperature characteristic of the standard type and proposed as a reference function the following equation that fits the experimental points between 3 K and 27 K to within 10 mK:

$$\frac{R(T')}{R(0\,^{\circ}C)} = A_0 + A_1 T' + A_2 T'^3 \left(1 + B_1 T' + B_2 T'^2\right) \qquad (13.1)$$

where T' = T - 11.732 K; A_0 = 7.7510 x 10^{-2}; A_1 = 8.6680 x 10^{-4}; A_2 = 2.8377 x 10^{-6}; B_1 = 2.3167 x 10^{-2}; B_2 = 1.4370 x 10^{-5}.

For the industrial type, the manufacturer supplies a reference table of resistance versus temperature which matches any particular thermometer within ± 0.5 K (4-30 K) or ± 0.4 K (above 30 K). With three calibration points at 0 °C, 77.3 K and 4.2 K, the accuracy is claimed to improve to ± 0.1 K above 16 K and to ± 0.2 K between 4.2 K and 16 K (Shiratori et al. (1982)]. Between 2 K and 29 K a simple sixth-degree polynomial was found to fit the experimental data with a maximum deviation of ± 1 mΩ (equivalent to ± 10 mK) at the sensitivity minimum near 13 K. The estimated accuracy of the experimental data was ± 5 mK (Pavese and Cresto (1984)].

The commercially-available, standard-type platinum-cobalt thermometer is probably less reproducible than the corresponding rhodium-iron thermometer; its stability on thermal cycling is likely to be in the range of a few millikelvins.