

PART 1: TECHNIQUES AND THERMOMETERS FOR APPROXIMATING THE INTERNATIONAL TEMPERATURE SCALE OF 1990

The most common and best-characterized thermometers for very low temperature use are those that relate temperature to electrical resistance. In Part 1 there is a discussion of germanium, rhodium-iron, and platinum resistance thermometers together with their associated calibrations and interpolation formulae for approximating the ITS-90. The use of germanium is normally restricted to below 30 K. The same has been true for rhodium-iron although the chief reason for not using it to near 300 K has been competition from platinum. With platinum, calibration at a few fixed points coupled with simple interpolation will reproduce the ITS-90 moderately accurately. Germanium and rhodium-iron thermometers, on the other hand, must be individually calibrated because no two thermometers of the same type have exactly similar resistance/temperature characteristics, and there must be calibration at many points because interpolation of the resistance/temperature relationship is difficult. They are used as transfer standards for maintaining the ITS-90 below about 25 K, defined in terms of thermodynamic thermometry.

Germanium resistance thermometers are small, relatively inexpensive, and very sensitive at the lower end of their range. Standard-type rhodium-iron resistance thermometers are much larger, much more expensive and less sensitive than germanium, but are more stable and have a wider range of use. Platinum costs the same as, or more than, rhodium-iron, and is the clear choice above about 25 K. Both platinum and rhodium-iron are extremely stable; with proper handling, which means treating the thermometers as fragile and not subjecting them to mechanical shocks or vibrations, variations as large as a millikelvin are unusual. Germanium thermometers are about an order of magnitude less stable.

Vapour pressure thermometry and magnetic thermometry are also discussed in Part 1 because of their fundamental use. No comparable treatment of the former appears to exist. Platinum thermocouples and infrared radiation thermometers are also included in Part 1 because they are widely used to approximate the ITS-90.

The discussion of these various thermometers is preceded by a description of the methods, and hence of cryostats, baths, and furnaces, for attainment of uniform temperature environments (Chapter 2) and by some discussion of fixed points (Chapter 3), the latter intended to complement, rather than duplicate, that in "Supplementary Information for the ITS-90" [CCT (1990)].