National Institute of Standards & Technology

Certificate

Standard Reference Material 1967

High-Purity Platinum Thermoelement

Pt-67

This Standard Reference Material (SRM) is a high-purity (99.999+wt.%) platinum wire, 0.51 mm diameter and 1 meter long, that has been prepared for use as the standard reference thermoelement for calibration of base-metal and noble-metal thermocouple materials in the temperature range -197 to 1768 °C. Standardized thermoelectric values for these applications, based on the International Temperature Scale of 1990 (ITS-90)[1], are given in NIST Monograph 175[2]. This material, Pt-67, replaces the former thermoelectric standard, Pt-27, which was used from 1922 to 1973. Selected portions of Pt-67 are used by the National Institute of Standards and Technology (NIST) and other national laboratories for calibration of thermocouple materials.

Extensive homogeneity testing was performed by NIST, as well as by five cooperating laboratories: Engelhard Industries, Inc.; J. Bishop & Co.; Johnson, Matthey & Co., Ltd.; RCA Laboratories; and Sigmund Cohn Corp. A combination of the following methods was used: chemical analysis techniques included optical emission and spark source mass spectrography, polarography, spectrophotometry, activation analysis, and vacuum fusion; and electrical measurements included thermoelectric, temperature coefficient of resistivity, and residual resistance ratio. The material is homogeneous within the limits of precision of most of these methods.

The original coordination and evaluation of data leading to certification of SRM 1967 was performed at NIST by R. L. Powell, (ret.) J. G. Hust, (ret.) L. L. Sparks of the Chemical Engineering Science Division (Boulder) and G. W. Burns of the Chemical Process Metrology Division (Gaithersburg).

The technical and support aspects involved in the revision, update and issuance of this Standard Reference Material were coordinated through the Standard Reference Materials Program by J. C. Colbert. The original coordination of certification efforts was performed by R. E. Michaelis.

Gaithersburg, MD 20899
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William P. Reed, Acting Chief
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(over)

Supplementary Information

The effect of impurities at temperatures above 1200 °C are discussed in a Special Publication [3] that describes this material, its preparation, characterization, and properties. This publication also provides a history of the development of this thermoelectric standard (Pt-67). Pt-67 (SRM 1967) is a selected, highly homogeneous portion of SRM 680 that was prepared by Sigmund Cohn Corp. by induction melting of high-purity platinum sponge in a zirconium silicate crucible, and by casting into a platinum-lined, water-cooled copper mold. The ingot was trimmed, swaged, and drawn into 0.51 mm diameter wire using the utmost precautions to minimize contamination.

For a reference junction at 0 °C, the difference between the thermoelectric voltages of Pt-67 and Pt-27 can be approximated by

$$\Delta E_{67\text{-}27} = -7.5 \cdot 10^{-3} t_{90}$$

where ΔE is expressed in microvolts and t_{90} in degrees Celsius (ITS-90). This relation was found to be valid from -197 to 1200 °C. The temperature coefficicent of electrical resistance between 0 and 100 °C,

$$\alpha = \frac{R\,(100\,°C) - R\,(0\,°C)}{100\,R\,(0\,°C)}$$

was found to be 3.926_9 (± 0.0012) x 10^{-3}/ °C. The residual resistance ratio, determined from the specimen's electrical resistance at the ice point and at the boiling point of helium,

$$RRR = R(273K)/R(4K),$$

was found to vary smoothly along the length of the wire from a value of 3407 to 3678. The average value is 3480.

Proper usage of this SRM requires careful annealing and handling techniques. The recommended procedures are:

1) Clean with ethanol and air dry.
2) Suspend the wire in a clean, dust-free enclosure and connect to a current source.
3) Continuously increase the current until the wire is at about 1200 °C.
4) Maintain this temperature for 10 minutes.
5) Slowly decrease the current until the temperature of the wire is just below incandescence, hold for 60 minutes and slowly cool to room temperature.
6) Care should be taken at all times to avoid unnecessary mechanical stresses of the wire. If the platinum is to be used at high temperatures, use special gloves or paper padding while handling.
7) High-purity sintered alumina tubing is recommended for insulating and protecting the platinum wire during use at high temperatures. After assembling the wire in an insulating tube, reanneal the assembly in a furnace for 60 minutes at 1100 °C, followed by cooling to 450 °C. The assembly should be maintained at 450 °C for 12 hours and then cooled to room temperature.

References

[1] Preston-Thomas, H., International Temperature Scale of 1990, Metrologia 27, 3 (1990).

[2] Burns, G.W.; Scroger, M.G.; Croarkin, M.C.; Gutherie, W.F.; Schiller, S.B., Temperature-Electromotive Force Functions and Tables for Letter-Designated Thermocouples Based on the ITS-90, National Institute of Standards and Technology (U.S.) Monogr. 175 (1990).

[3] Powell, R.L.; Sparks, L.L.; and Hust, J.G.; Standard Reference Materials: Standard Thermocouple Material, Pt-67: SRM-1967, National Bureau of Standards (U.S.) Spec. Publ. 260-56; February 1978.