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Coefficients of Thermal Expansion

NEW DATA ON PLATINUM AND PLATINUM-RHODIUM ALLOYS

The importance of an accurate knowledge of the properties of key reference materials such as platinum and its alloys has been emphasised here previously (1). For example, accurate values of thermal expansion are required in high temperature "constant volume" gas thermometry, where failure to take account of the unavoidable changes in the volume of the gas-containment bulb with temperature can lead to errors of several per cent in the measurement of the pressure ratios.

In support of its programme on gas thermometry, the National Bureau of Standards, Gaithersburg, U.S.A., has recently reported on the construction of apparatus for the measurement of thermal expansion, which allows changes in length to be measured to an accuracy of 1 part per million and temperature determinations to be made to within 0.01°C (2). In this paper, R. E. Edsinger, M. L. Reilly and J. F. Schooley also describe the use of the apparatus for measuring the thermal expansions of 99.95 per cent pure platinum and of two platinum-rhodium alloys, nominally containing 12 and 20 weight per cent rhodium, in the temperature range −27 to +570°C. The samples used were taken either from surplus materials used in the construction of bulbs for the Gas Thermometer or from pieces cut from used gas bulbs, all generally about 1mm thick.

Optical interferometry was selected as the means of measuring the dimensional changes, using the Merritt-Saunders technique, and the samples were heated in a multi-chambered, sealed furnace, based on a design by H. F. Stimson. A quartz window, to allow interferometric measurement, and a platinum resistance thermometer are incorporated into the furnace, which is capable of evacuation, so allowing variations in both the gas pressure and the type of gas employed. The platinum resistance thermometer was calibrated according to the IPTS-68 standard procedures.

The data obtained for the pure platinum and platinum-rhodium samples were analysed and fitted to 4th degree polynomial equations. From these equations, the values of the per cent linear expansion and hence the coefficient of linear expansion were calculated. These results show that substitution of rhodium into the platinum lattice reduces its thermal expansion in the range 0 to 350°C, then causes it to increase at higher temperatures.

A comparison of the results obtained in this study with previous work for pure platinum shows reasonable agreement, to within ±20ppm; the current work generally showing larger values for the linear expansion. Similar comparisons for platinum-20 per cent rhodium show very close agreement with some earlier results; but there were differences of about 50 ppm with the data of Barter and Darling (3).

In summary, this work has provided improved, more accurate data on the thermal expansions of platinum and platinum-rhodium alloys.

C.W.C.

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