

# Platinum and Its Alloys in Temperature Measurement

**Temperature Measurement 1975: Papers from the European Conference on Temperature Measurement** EDITED BY B. F. BILLING AND T. J. QUINN, Institute of Physics, London, 454 pp. £20 (\$50)

It is nearly five years since the last major conference on temperature measurement was held in Washington, and during this period there has been considerable activity over the whole field of standardisation and the formulation of temperature scales. The present volume contains the seven invited and 44 contributed papers given before an international conference held at the National Physical Laboratory, Teddington, England, in April last year, sponsored by The Institute of Physics, The Institute of Measurement and Control, The Institution of Electrical Engineers and the European Physical Society.

An introductory chapter by T. J. Quinn of the N.P.L. reviews the whole range of temperature standards; this is followed by six chapters covering specific methods, each containing a review paper and individual papers on techniques.

In the opening review paper on resistance thermometry J. S. Johnston of Rosemount Engineering deals with the construction, accuracy, reliability and application of the platinum resistance thermometer—a device now produced and used in industry in numbers of the order of several million a year—and refers to the newer technique of employing a screen-printed film of platinum instead of a fine wire. Detectors made by this process have a performance over the range  $-50$  to  $500^{\circ}\text{C}$  comparable with that of wire-wound glazed thermometers and may replace them in a number of industrial applications, although for many years the more conventional construction will continue to be used for their wider temperature range and good stability. One of the main problems in

resistance thermometers remains, however, the need for a detector capable of withstanding the vibrations and shock associated with some industrial uses. Here a construction in which platinum wire is fully encapsulated offers the greatest reliability.

Work at the National Research Council of Canada has recently shown that oxygen-activated thermal cycling effects can occur in platinum resistance thermometers, causing some instability, and a paper by R. J. Berry tentatively identifies this effect—first the oxidation of the platinum surface in the low temperature region and the subsequent dissociation of this oxide at around  $450^{\circ}\text{C}$ . The change is, however, measured only in parts per million and the usefulness of resistance thermometers in normal industrial practices is not likely to be affected.

A contribution by P. Marcarino and L. Crovini of the Istituto di Metrologia 'G. Colonnetti' of Turin proposes the use of the platinum resistance thermometer to define a provisional temperature scale up to the silver point,  $962^{\circ}\text{C}$ .

Low temperature resistance thermometry, using as the element the 0.5 atomic per cent iron-rhodium alloy introduced by Professor Brian Coles of Imperial College is dealt with in a paper by R. L. Rusby of the N.P.L. Its excellent long-term stability makes this device very suitable for precision work below  $20\text{K}$ .

The chapter on thermocouple thermometry opens with a review paper from G. W. Burns and W. S. Hurst of the National Bureau of Standards, Washington. This deals at some length with the seven types of couples that have become standardised internationally,

including of course the three principal platinum alloy combinations chosen for their resistance to oxidation, high melting points, reproducibility and long life up to as high as 1500°C. The newer combination—6 per cent rhodium-platinum against 30 per cent rhodium-platinum—has now been standardised for some years, primarily for use in the range 1250 to 1750°C, where it exhibits better mechanical strength and stability by comparison with the old established 10 and 13 per cent rhodium-platinum alloys against high purity platinum. These authors also draw attention to some modern applications of thermocouples to illustrate the severe requirements imposed by today's technology, including their use in nuclear environments, in glass manufacturing plants where temperatures of 1570°C are reached, and in high temperature tunnel furnaces used in the production of ceramics and ferrites. The

6:30 rhodium alloy couple has also been used for measuring gas-stream temperatures as high as 1750°C in the development of jet engines, while it is finding applications in the expendable thermocouple devices for instantaneous molten metal temperature measurements in the steel industry.

Many of the other papers in this volume have to do with the finer points of precision thermometry and the further development of the International Temperature Scale, an amended version of IPTS-68 being promised at the turn of the year. Precision thermometry has now become exceedingly complex and may seem somewhat remote from the practical needs of temperature measurement in industry, but much of the work described in these papers should none the less be of interest to both manufacturers and users of resistance thermometers and thermocouples.

L. B. H.

## The Electroless Plating of Plastics

Significant advances in the plating of plastics with metals such as copper and nickel have been made since the introduction of the "one step" process in which the sensitizer and the activator are applied to the substrate by immersion in a solution containing palladium chloride and stannous chloride in hydrochloric acid. This mixed system was first developed in 1961 by C. R. Shipley, who maintained that the solution contained colloidal particles which, when adsorbed on the surface of the work, provided catalytic sites for the metal to be deposited. Later workers have claimed, however, that their catalyst systems are true solutions and that their activity is due to the presence of soluble tin-palladium complexes.

Controversy on this point has continued, but a paper by E. Matijević and P. Zuman of the Institute of Colloid and Surface Science at Clarkson College of Technology and A. L. Poskanzer of the Shipley Company, Newton, Mass., now shows not only that these solutions do contain colloidal particles but that, on separating these out in an ultracentrifuge, they are active while the supernatant solution is not (*Plating*, 1975, **62**, (10), 958-965).

A total of 16 PdCl<sub>2</sub>/SnCl<sub>2</sub> systems were investigated, all samples being put through the ultracentrifuge at 25,000 r.p.m., and the two phases were separated for further examination. Ten of the solutions, as prepared before separation, were studied by electron microscopy, and all showed the presence of colloidal particles. Light scattering, which has been used by other workers as a test for the presence of colloidal particles in such catalysts, was found not to be a satisfactory means of discrimination.

Assessment of activity was carried out with all the samples, using epoxy laminated boards and copper plating after standard cleaning and sensitising procedures. Each formulation was aged for one week, separated in the ultracentrifuge, and the residue and supernatant fractions tested separately. In all cases the supernatant liquor showed no activity, while all the residues were highly active.

As the authors conclude, systematic chemical analysis of the colloidal particles present in these proprietary catalysts would seem to be highly desirable if the precise mechanism of their activity is to be established.