Thermophysical Data on Platinum

RESISTIVITY AND CONDUCTIVITY VALUES RECOMMENDED

Platinum is one of several key materials whose thermophysical properties such as electrical and thermal conductivities, heat capacity, coefficient of thermal expansion and diffusivity are used internationally as a basis for calibration and reference purposes. The choice of platinum among this key group of materials (which includes iron, copper, tungsten, silicon and sapphire) is based on its stability and inertness, its ready availability in high purity, its well-established electrical resistance-temperature relationship between 13.8 and 1200K, measured for the International Practical Temperature Scale (IPTS), and the consistency of measurements of thermal conductivity made at several national laboratories over the temperature range 100 to 1200K.

"Recommended" values of these properties for this group of materials are currently being prepared through the CODATA Task Group on Thermophysical Properties of Solids, which consists of an international co-operation between national laboratories. The recommended values of the electrical resistivity and thermal conductivity of platinum were reported by Guy K. White of the CSIRO Division of Applied Physics, Sydney, Australia, during the conference, "Thermal Conductivity 17", held at Gaithersburg, Maryland, U.S.A., in June 1983.

Electrical Resistivity

The task of selecting data for platinum has been made easier because of its role in the realisation of the temperature scale (IPTS) which is defined from 13.8 to 904K. Further efforts to extend the range of platinum resistance thermometers to the gold point (1337.6K) has contributed further data. The data have been corrected for factors such as thermal expansion and impurity scattering and fitted to polynomial equations. The recommended values are summarised in the Table as a function of temperature between 20 and 2000K. Resistivity at temperatures below 13.8K is not considered to be sufficiently accurate for recommended values to be assigned. Above this temperature accuracy is considered to be within 0.1 per cent, although only 0.3 per cent above 1300K.

Thermal Conductivity

The 1972 survey of the data by CINDAS has been taken as the basis for this study with more recent data at temperatures above 1000K being included. The influence of the purity of the platinum, defined by the average resistance

Recommended Thermophysical Values

Temperature K	Resistivity $10^{-8}\,\Omega m$	Conductivity W/m
20	0.03669	475
40	0.40381	141
60	1.1186	95
80	1.9531	83
100	2.8040	78
200	6.9169	72.6
273	9.82	71.7
300	10.871	71.6
350	12.805	71.6
400	14.712	71.8
450	16.592	72.0
500	18.445	72.2
600	22.070	73.0
700	25.588	74.0
800	28.996	75.2
900	32.292	76.6
1000	35.473	78.1
1100	38.540	79.9
1200	41.50	81.8
1300	44.35	83.9
1400	47.09	86.1
1500	49.74	88.4
1600	52.34	90.6 (90)
1700	54.93	92.7 (90)
1800	57.51	94.5 (90)
1900	60.11	96.0 (89)
2000	62.76	97.4 (88)

ratio, on the low temperature values has also been examined. This leads to the conclusion that the accuracy of the recommended values lies within 10 per cent below 100K, but improves to less than 3 per cent between 100 and 300K and less than 2 per cent in the range 300 to 1200K. Above 1200K accuracy decreases to 10 per cent uncertainty. The recommended values are again summarised in the Table; the values above 100K have been corrected for expansion. Those given for temperatures above 1600K are based on data that leads to values of the Lorenz ratio that are considered to be too high. More plausible values of the conductivity are given in the Table in brackets, but the author cautions that more measurements in this temperature range are needed.

The conference proceedings of "Thermal Conductivity 17" have been published by Plenum Press, New York, 1983 and readers of *Platinum Metals Review* are advised to refer to the original paper for a fuller description of the recommended values for both resistivity and conductivity, and for the basis on which they have been derived. C.W.C.

A Report of Fuel Cell Technology

The latest briefing of members of The Fuel Cell Users Group of the Electrical Utility Industry of the United States of America, which took place in Portland, Oregon in July, was designed to provide attendees with a thorough understanding of the status of technology development of the fuel cell. At the meeting it was apparent that, for a number of reasons, the move toward commercial exploitation of fuel cell technology was proceeding at a faster rate than in the past.

Although the 4.8MW phosphoric acid fuel cell power plant in New York is inactive the other demonstration plant built by United Technologies Corporation (U.T.C.), operated in Japan by the Tokyo Electric Power Company, successfully completed Phase 1 of the programme, that is the generation of 4.5MW of alternating current, in February. The unit ran for 100 hours during early June and the Phase 2 endurance test is continuing. While neither has been entirely satisfactory the experience gained has encouraged U.T.C. to proceed to the next stage of development. Twenty-three 11MW units of improved design are to be built and will be offered at competitive prices under guaranteed performance conditions. Additionally, in a programme sponsored by the Gas Research Institute, U.T.C. are manufacturing forty-nine 40kW fuel cells for on-site testing; four by the Department of Defense and the remainder by commercial participants. These phosphoric acid cells incorporate platinum-containing catalysts supplied by Johnson Matthey. To date the longest uninterrupted run has exceeded 75 days, and is continuing. It is important to note that these units are employed under actual working conditions at sites that include a laundry, offices and sports clubs where the combined heat and electric power output, and the environmental acceptability of fuel cells are of great benefit.

The modular construction of fuel cell power plants provided the flexability that will enable the power utilities to respond to changes in the predicted requirements for new and replacement generating capacity. The utilities are also seeking plant efficiency and reliability. With this in mind the Westinghouse Electric Corporation has now been given a contract by the Southern California Edison Company to design a 7.5MW fuel cell intended for the utility's transmission and distribution system.

The meeting was addressed by Mr. K. W. Maxwell, Managing Director of Rustenburg Platinum Mines who spoke of the large reserves that are available to meet the growing market for platinum, and the lead time that is necessary to establish new mining capacity. The known platinum reserves of the Merensky Reef are more than 300 million ounces, while beneath this is another platinum-bearing reef, known as UG2, which also contains in excess of 300 million ounces. It has been estimated that by the year 2000 the demand for platinum to be used in fuel cells for markets in the U.S.A. and Japan could amount to 580,000 ounces. A major investment of capital and a lead time of 18 to 30 months would be required to meet this demand. Rustenburg Platinum Mines is closely watching developments to ensure that sufficient platinum is available when it is required.

In view of the useful function performed by The Fuel Cell Users Group in North America, Johnson Matthey have suggested the formation of a similar group in Europe. G.J.K.A.