References

1 P. Monnartz, *Metallurgie*, 1911, **8**, (7), 161

2 T. P. Hoar, *Plat. Metals Rev.*, 1958, **2**, (4), 117

3 N. D. Tomashov, G. P. Chernova and L. N. Volkov, *Zashchita Metal.*, 1970, **6**, (4), 425

4 N. D. Tomaschow, G. P. Tschernowa, L. A. Tschigirinskaja and M. F. German, *Werkstoffe Korrosion*, 1976, **27**, (9), 636

5 G. J. Biefer, *Can. Metall. Quart.*, 1970, **9**, (4), 537

6 V. S. Agarwala and G. J. Biefer, *Corrosion*, 1972, **28**, (2), 64

7 N. D. Tomashov, V. I. Lakomskii, G. P. Chernova, G. F. Torkhov, L. A. Chigirinskaya and V. A. Slyshankova, *Zashchita Metal.*, 1977, **13**, (1), 10

8 N. D. Tomashov, G. P. Chernova, L. N. Volkov, A. P. Zakharov and Z. E. Sheshenina, *Zashchita Metal.*, 1973, **9**, (3), 314

9 M. A. Streicher, *Corrosion*, 1974, **30**, (3), 77

10 *U.S. Patent* 3,932,174; 1976
British Patent 1,314,653; 1973

11 M. A. Streicher, NACE Preprint, Toronto 1975 Paper No. 68, "Stress Corrosion of Ferritic Stainless Steels"

Temperature Measurement and Control

THE ADVANTAGES OF METAL-SHEATHED PLATINUM THERMOCOUPLES

The urgent need to conserve natural resources requires that the most careful appraisal be made of the many uses to which these resources are put; in particular by the industrialised countries of the world. The recent realisation that supplies of fossil fuels are not inexhaustible has prompted the investigation of many manufacturing processes where fuel savings might be achieved, and one outcome has been a better understanding of the contribution that accurate temperature measurement and control could make to both industrial efficiency and energy conservation.

At the Tempcon '77 conference held recently at Wembley, Middlesex, papers were presented covering many aspects of the control and measurement of both low and high temperatures, either directly or by remote control. In one of these papers, by P. I. Roberts of Johnson Matthey Metals, the characteristics, development and uses of platinum metal mineral insulated thermocouples were described.

Such thermocouples, insulated with refractory but sheathed in a metal—usually a platinum group metal—have a number of important advantages compared with conventional thermocouples which are both insulated and sheathed with refractory materials. These benefits include flexibility, smaller diameter, lower thermal mass so quicker response time, and superior resistance to mechanical and thermal shock.

Metal-clad thermocouples tend to be thermo-electrically less stable than refractory sheathed ones when used at temperatures above 1200°C, and this is caused by the transfer of rhodium to the negative limb, mainly from the metal sheath but also from the positive limb. Such effects can be greatly reduced in a number of ways which were described by the author.

First the quality of the insulation is a very important factor because, when sintered, it is capable of restricting the transfer of rhodium oxide in the vapour phase. Alternatively for use at higher temperatures the air in the metal sheath can be removed and replaced with an inert gas such as argon which is then sealed into the unit. For applications at particular temperatures it is possible to select platinum alloys for the thermocouple limbs so that rhodium loss has negligible effect on the electromotive force generated. By using such techniques the advantages of these thermocouples are gained and the problem of thermo-electric drift avoided.

One particularly interesting application of metal-sheathed platinum thermocouples featured in the paper was in the French nuclear industry. It was reported that no changes were detected in the thermo-electric output of platinum : 13 per cent rhodium-platinum thermocouples, enclosed in a composite sheath of 5 per cent rhodium-platinum and stainless steel, following irridation experiments lasting 150 days. This was most interesting as prior to the quoted work it had been considered that neutron bombardment would cause rhodium to transmute to palladium, resulting in calibration drift. Work on this subject is continuing and further papers are expected shortly.