Platinum Metal Contacts

PAPERS AT THE FOURTH INTERNATIONAL SYMPOSIUM ON ELECTRICAL CONTACT PHENOMENA

Platinum metals and their alloys featured in many of the fifty papers presented at the Fourth International Symposium, sponsored jointly by the Institute of Physics and the Physical Society and the Institution of Electrical Engineers, held in July at the University College of Swansea.

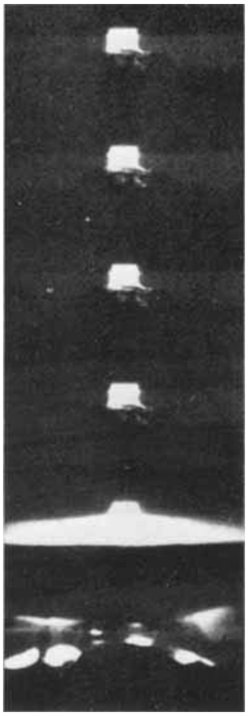
The characteristics of the surface films that may form on palladium, platinum and electro-deposited rhodium surfaces and their effects on adhesion and contact resistance under loads of less than 1 gram were examined by H. C. Angus of the International Nickel Company. Using a loop of fine wire which could be lowered into contact with a flat surface and subsequently withdrawn, it was found that, under very small loads of a few milligrams, electrical contact resistivity was high and there were few signs of adhesion between platinum and either platinum, palladium or rhodium. With loads above about 50 milligrams, however, strong cold adhesion was observed between the loop and the flat metal surface, and the contact resistance rapidly fell to very low values.

It is evident that under very low loads surface films interfere with the establishment of true metal-to-metal contact. Generally speaking, if the temperature of the contact surfaces is raised, the load required to cause adhesion becomes progressively lower, probably due to softening of the constriction areas of contact and to stretching of the surface films. The effect, however, may be complicated by the tendency of the films to thicken by oxide growth at temperatures up to about 600°C. At still higher temperatures, the oxide films decompose and welding becomes more easily effected. The method of test used in this investigation has been particularly valuable in showing a fundamental difference between the surface films on gold and on the platinum metals.

A paper by A. S. Darling and G. L. Selman of Johnson Matthey on the contact resistances and wear characteristics of some new palladium alloy slidewire materials presented interesting data, and is published in an enlarged and revised version in this issue.

Molten Bridges between Separating Contacts

The small molten bridges that may form and briefly bridge the surfaces of a separating contact have for many years been the subject



Disruption of molten bridge between separating platinum contacts in helium, breaking a direct current of 100 amperes at 6 volts. (Capacitance 4 F, inductance 0.06 H). 9000 frames per second, ×26. (Courtesy of Dr F. Llewellyn-Jones.)

of special study by the research workers in the Department of Physics at the University College of Swansea under the general direction of the Principal, Dr F. Llewellyn-Jones. The recent development in this laboratory of an ultra-high-speed camera capable of taking up to 20,000 pictures at 100,000 frames per second has revealed some hitherto unsuspected details of the process of rupture. A film shown by Dr Lewellyn-Jones in his introductory lecture to the symposium and described later by Dr B. R. Thomas, reveals that the molten bridge between platinum contacts may rupture and reform once or more times during the separation of the contacts before the electrical circuit is finally broken. With platinum contacts, this behaviour is all the more remarkable since no liquid or solid oxides can be present to introduce complications. A fascinating picture emerges of a minute maelstrom of forces which are let loose for a few micro-seconds in a cloud of platinum vapour and whirling electrons whenever a pair of platinum electrodes is opened to interrupt an electrical circuit.

Contact Operation

The action of opening and closing make-and-break contacts in breaking up and otherwise disturbing the films on the contact surfaces was considered in more than one of the contributions to the symposium. Dr H. W. Dinges and Dr H. Schmidt-Brucken, of Darmstadt, reported microscopical studies of the brown polymer film which forms on platinum metal contacts operating in organic vapours. The monomolecular layers first formed were seen to be brushed aside by local rubbing movements and often built up into small heaps around the actual contact areas. In these circumstances contact failure may only develop slowly and at irregular intervals, a conclusion supported by statistical studies of the contact resistance of relays operated for several million switching movements.

Dr A. Fairweather, Mr F. Lazenby and Mr D. Marr of the Post Office Research Station, London, have also studied the effects of the surface deformation caused by repeated closure on the electrical resistance of the surface films on contact surfaces operating in air. They have been particularly concerned with the pattern of the resistance changes which are observed and have attempted to correlate fluctuations with the mode of penetration or fracture of the protective films.

Deterioration of Metallic Contacts

Of more general interest, the deterioration of the electrical resistance between two metallic butting connectors was displayed most convincingly by Dr J. B. Williamson of the Burndy Research Laboratory, Norwalk, Connecticut, in an outstanding address. He demonstrated that since only a few point contacts normally provide the constrictive resistance and carry the whole of the electrical load, intersurface corrosion may proceed for months or years without noticeable effect on the current carrying capacity of the connector. The final stages of corrosion, however, may then cause complete electrical failure in a dramatically short period.

New Techniques

Among new techniques, scanning electron microscopy by reason of its great depth of focus would seem to have considerable promise as a means of studying surface changes produced by the operation of electrical contacts. A paper by T. A. Davies of the Allen Clark Research Centre of the Plessey Company Limited, Caswell, showed examples of the detail obtainable by this means.

Finally, mention should perhaps be made of a series of palladium alloys, proposed on theoretical grounds by Professor K. Mano of Tohoku University, Sendai, Japan, and T. Hare, of Fujitsu Limited, as being of high resistance to corrosion and organic polymer formation. They consist of palladium alloys with less than about 12 per cent of silver, copper, tin or antimony so that the 4*d* band of palladium is filled with valence electrons of one or more of these metals.

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