# Electroplating the Platinum Metals

## A RECENT SURVEY OF PROCESSES AND APPLICATIONS

As a result of fairly recent developments all of the metals of the platinum group are now available in the electrodeposited form – one of the most useful means of utilising their properties as surface coatings. A broad review of this subject, mainly of electrolytes and processes with which the author is familiar, and with special reference to their use in the electronics field, was given by F. H. Reid in a paper presented at the Annual Conference of the Institute of Metal Finishing held in May at Torquay.

While platinum can be electrodeposited from a number of electrolytes, and while it is the only member of the group which, like gold, resists oxidation up to the melting point, there is not a great deal of interest in its electrodeposition for electronic applications. In the majority of such cases it can in fact offer no advantage in electrical or mechanical properties over palladium, rhodium or gold.

### Rhodium Plating

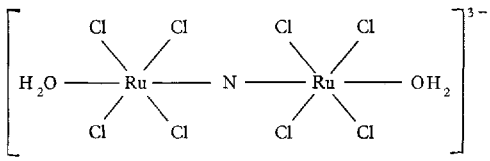
Rhodium remains well established in contact applications calling for good resistance to wear and to corrosion, although considerable interest has been taken during recent years in alternative coatings. Until the recent advent of ruthenium plating rhodium was in fact in a class by itself in terms of extreme hardness which, coupled with almost complete immunity from corrosion, accounts for its highly successful performance in contact applications over many years. The development of low-stress processes for rhodium plating has not, the author pointed out, had a marked effect, possibly because, as a result of systematic wear studies, thickness requirements have been reduced. While some specifications still call for thicknesses of 12.5 to 25$\mu$, most contact requirements are satisfactorily met by coatings of the order of 5 microns.

In connection with the difficulties sometimes encountered with rhodium deposits, the author emphasised that in his long experience application problems with rhodium could only rarely be unequivocably attributed to the presence of stress cracks, the effect of which can in any case be minimised by proper selection of undercoating deposit; more often internal stress was wrongly blamed for the exfoliation of coatings which was basically due to faulty pretreatment.

Attention has been focused on palladium plating over the past few years as an alternative to gold in printed circuit applications, particularly as, having regard to differences in density and in metal price, the cost of a palladium deposit is only about one-third of that of a gold deposit of equal thickness. Palladium is probably the easiest of the platinum group metals to deposit from a variety of aqueous electrolytes, and from the process viewpoint palladium may be regarded as in a fairly satisfactory position.

### Ruthenium Plating

Turning to ruthenium plating, the author described the nitrosyl-sulphamate electrolyte developed by Reid and Blake, referring particularly to the promise shown by deposits from this solution in early applicational assessments. Unfortunately there had been problems in manufacture of the solution, and it had now been generally superseded by electrolytes based on the unusual and interesting complex




salts of which could be readily prepared and isolated in well-defined crystalline form.

Physical characteristics of deposits from this type of solution are essentially similar to those from the nitrosyl-sulphamate electrolyte, and include a hardness comparable to that of rhodium, which imparts excellent wear-resistance to the coatings.

## Iridium and Osmium Plating

In dealing briefly with iridium plating, reference was made to the acid bromide electrolyte developed by Tyrrell, and to the electrolyte described by Conn, based on reaction between iridium chloride and sulphamic acid. In each case deposition rate is very limited and little information is available on coating properties. The extension of Tyrrell's work to the development of mixed bromide electrolytes for deposition of binary and some ternary alloys of the platinum group metals was likely to be of interest in relation to coatings for electrochemical or catalytic applications rather than in the electronics field, since in terms of physical properties, mainly hardness, so far studied, they appear to offer no special advantage over single metal deposits.

Osmium has been deposited recently from an alkaline electrolyte based on an anionic complex formed by reaction of osmium tetroxide with sulphamic acid. Little information is available on the properties of the coatings except in respect of wear-resistance, which appears to be superior to that of hard chromium.

## Applications in Electronics

In discussing applicational aspects, main interest centred on palladium and ruthenium. There were certain areas in the electronics field where advantages might be offered over gold in special circumstances, or where the use of a platinum metal in conjunction with gold might be desirable. The use of palladium plating as a protective finish on silver plated end-connector contacts in some high-frequency applications was mentioned, and it was questioned why this combination was not more widely adopted as an economic alternative to gold plating in other applications where silver migration was not a problem.

## High Temperature Applications

In elevated temperature applications deterioration of gold-plated surfaces could occur due to outward diffusion of substrate components, or in the case of alloy golds, by preferential oxidation of base metal components of the coating itself. In the former case the use of a thin platinum metal deposits as a barrier layer was well-established, and similar coatings applied over gold alloy deposits could well be effective in preventing oxidation during exposure to elevated temperatures during processing.

In soldering to thin gold plate on difficult to solder substrates, such as Kovar, rapid solution of gold in tin-lead may permit direct contact between solder and the substrate, leading to de-wetting. Palladium, though readily wettable by solder, has a much lower rate of solution in the latter than gold, and it was suggested that use of a thin palladium plate as a barrier layer might overcome the problem. Palladium was also of interest in connection with contact lubrication systems, where, by virtue of its marked affinity for organic materials, a thin coating of the metal might substantially improve the durability of lubricants on the highly-finished surfaces which are most desirable for optimum wear characteristics.

## Use in Contacts

Although currently available ruthenium plating processes suffer certain limitations in respect of the thickness of coating obtainable without cracking, deposits of 1 to 2 microns can be produced in reasonably sound condition, and ruthenium should be of immediate interest as a potential economic alternative to rhodium. Of special interest was the high electrical conductivity of the oxide, which suggested that the metal should have particular merit in contact applications at elevated temperatures.