

Precious Metal Finishing Revisited

ELECTRODEPOSITION OF THE PRECIOUS METALS: OSMIUM, IRIDIUM, RHODIUM, RHENIUM, RUTHENIUM

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This is a revised, slightly updated and enlarged edition of the 2003 book by Terry Jones (reviewed in this Journal by A. S. Pratt (1)), with three new chapters added to the end. The cover title remains slightly misleading, since the book covers both electrodeposition and electroless deposition of the rare precious metals. Fused salt plating is also dealt with, along with two new chapters devoted to electropolishing and stripping of all precious metals. The emerging area of electroless platinum deposition is addressed in the last new chapter, and the scant references to the electroless plating of the rare precious metals are sensibly incorporated into the chapters on electrodeposition. Despite the inclusion of electroless platinum deposition, the development of electroless palladium plating for circuit boards, which is a commercial success, is not dealt with. Plating of precious metal/base metal alloys for data storage (for example, platinum-cobalt) is also absent.

As early as page two, the author justifies his inclusion of rhenium by comparing its scarcity and physical properties to those of other precious metals. The increasing popularity of induced electroless rhenium plating with nickel-phosphorus and other metals to form electronic barrier layers, as well as magnetics, may have been worth addressing in an extra page or two.

Nevertheless, this book, written in a simple and readable way, is a welcome introduction to rare precious metal plating. A typical chapter comprises a survey of the desirable properties and applications of the metal, a list of popular modern plating baths, their optimum working conditions, an extensive account of deposition properties and even analytical control. Nearly all baths referenced are post 1970, with only a few from the 1960s, so readers are not presented with the full historical

development of many of the baths. Most references are from well known plating journals, for instance: *Journal of The Electrochemical Society*, *Metal Finishing*, *Plating and Surface Finishing*, *Transactions of the Institute of Metal Finishing* (the last one being the leading U.K. example) and other obtainable sources. Surprisingly, the author is a little short on applications for some metals, for instance rhenium and iridium, but this may reflect his greater knowledge of other metals dealt with in the book. Generally, the book places the metals in order of their industrial importance and plating success, beginning with popular rhodium. At fifty-seven pages, rhodium is allotted the longest chapter, half of it dealing with plating baths and half with deposition properties. The remaining metals have at least 20 pages devoted to each, except rarely used osmium stretched out at twelve pages.

Not surprisingly, the chapter on stripping metals is a little light, since precious metals are not noted for their ease of dissolution, from which the metal values must subsequently be recovered. However, recovery can be easily achieved using a precious metal scavenger, such as ion-exchange resin/fibre. This technology is not mentioned in the book. In general the book is well supported with equations, diagrams, graphs and tables.

Practical Plating Baths

Just how practical or useful some of the plating baths are depends on whether the reader has an academic or commercial interest – or has had the opportunity to evaluate them. From personal experience, the few plating baths I recognise in this book struggle to achieve the performance described. For example, it has always been difficult to find useful electroplating baths for pure iridium, and electroless iridium deposition remains in its

infancy. Electroless ruthenium plating baths are described; but stability, performance and deposition quality need further study and much improvement prior to commercial use. However, stable electroless platinum and platinum alloy plating baths can be constructed. They normally yield layers of 5–15 micron thickness, but greater than 30 micron thickness is achievable for demanding applications. After much research, Johnson Matthey marketed such baths ten years ago, under the TRIPLE-E® trade name, but with limited outside interest. Over the last decade, some in-house users have described working commercial electroless platinum plating baths, mainly for medical applications. This point is not highlighted in the book. Recently, an electroless platinum-rhodium alloy process has been patented by Honeywell Inc. (2). Electroless platinum is typical of areas of research where new applications have, for some years, stimulated industrial research but with restricted knowledge filtering into the open literature. As illustrated by these examples, the increasing speed with which new or improved precious metal deposition baths are reported will soon require the present book to be revised yet again.

This updated book may stimulate further research into new plating baths and into improving existing technology, and the author acknowledges his debt to two “bibles” of modern plating in his foreword (3, 4). The rise of electroless platinum and palladium plating should promote interest in the electroless plating of the other precious metals.

However, safer compositions, a wider range of operating conditions, better bath stability and turnover still need to be achieved for many of the electroless compositions noted in this book. Indeed, the quality and durability of deposits are of concern, particularly for high-temperature, electronic and medical applications. While many of the technologies described here have been advanced by industry, this book serves as a good background to investigate this interesting area.

References

- 1 A. S. Pratt, *Platinum Metals Rev.*, 2004, 48, (2), 59
- 2 A. S. Kozlov *et al.*, *U.S. Patent* 6,706,420; 2004
- 3 “Modern Electroplating”, 4th Edn., eds. M. Schlesinger and M. Paunovic, Wiley-Interscience, New York, 2000
- 4 W. H. Safranek, “The Properties of Electrodeposited Metals and Alloys – A Handbook”, 2nd Edn., American Electroplaters and Surface Finishers Society, Orlando, FL, 1986

The Reviewer



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