



formation of microstructure as well as nanocrystalline deposits using both DC and Pulse Plating are described. A systematic approach to the effect of additives, hitherto scarcely described in the literature, is also provided. The effect of Pulse Plating parameters on secondary current distribution (below the limiting current density) is critical. The use of simulation and modelling is also discussed, not least as used in an industrial setting. One important example of this is the modelling of copper electrodeposition for blind via filling. Of special importance in metal electrodeposition using Pulse Plating are phenomena at the electrode double layer in relation to mass transport and the effects of current pulsing on the double layer structure, which in turn, affects current efficiency. The effects of pulsed current on additives and microstructure as well as alloy deposition are also discussed. Finally, the various models used in simulation of metal and alloy electrodeposition are described.

In the second section, various aspects and requirements for industrial applications of pulse electrodeposition are set out. Thanks to electronic and electrotechnical developments in modern power supplies, these can deliver any conceivable pulse regime in terms of current and rapid voltage transients such as square wave pulses. Where suitable equipment is installed, this ensures that the deposition process can be optimised. The means by which an understanding of basic principles can be harnessed to the practical electrodeposition of metals is shown with special emphasis on identification of key pulse plating parameters. Especially helpful in this respect is a systematic approach to determining these parameters for rack and barrel plating. Finally, there is a consideration of the environmental aspects of pulse plating in terms of energy consumption and the related CO<sub>2</sub> emissions.

The third section of the book covers in great depth, the industrial applications of pulse plating. Of these, the most important is currently copper electrodeposition for printed circuit board manufacture with special emphasis on Pulse Reverse Plating for through-hole contacting and filling of blind vias. It is in these particular applications that the strengths of Pulse Plating become especially evident. Also covered is the deposition of nickel and its alloys as well as the deposition of nickel-phosphorus deposits, electroforming and formation of nanocrystalline nickel layers. Other processes include electrodeposition of tin and its alloys and the broad topic of chromium plating for decorative or functional applications. The deposition of precious metals and their alloys is discussed and the section concludes with an in-depth treatment of zinc and zinc alloy deposition, especially zinc-nickel.

The fourth and last section deals with special systems. This includes the use of pulsed current for anodising aluminium and its alloys, Electrochemical Machining (ECM) as well as electropolishing. Other applications include the deposition of nanostructured multilayers (CMM) and the potential applications of pulse plating for electrodeposition of composite coatings, especially those incorporating nano-sized second phase particles. The whole volume is systematically laid out with various aspects clearly classified. It leaves no doubt as to the huge potential of the method for future developments in electrochemical surface treatment and the associated equipment. This new work which will certainly become the accepted standard and is aimed not only at those researching new developments, but also at those working in an industrial setting and others seeking to acquire proficiency in the subject.

Prof. Dr. W. Paatsch, Berlin