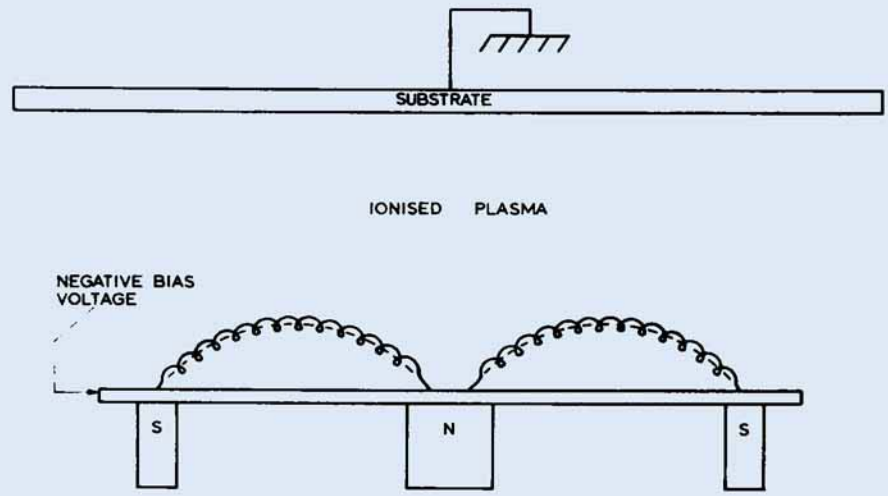
High-Rate Sputtering of the Platinum Metals

ECONOMIES IN PROCESSING TIME

The use of sputtering to produce coatings of the platinum group metals has a number of attractions. The coatings have good adhesion to the substrate, are dense, and have properties very close to those of the bulk metals. The disadvantage of conventional sputtering is the low rate of deposition which can be attained; a typical rate for platinum would be around 500 Å/min. For quantity production, higher rates are desirable, and for many metals recourse could be had to vacuum evaporation or electroplating, but the refractory nature of platinum group metals makes evaporation difficult, and except for rhodium, existing aqueous electroplating baths are not very satisfactory when electrical properties are important.

Attempts to increase sputtering rates simply by increasing power input result in serious heating of the substrate by secondary electron bombardment, but a recently developed technique, known as planar magnetron sputtering and now available commercially through Nordiko Ltd of Havant, Hampshire, avoids this heating problem and leads to an increase in sputtering rate amounting to an order of magnitude.

The system employs permanent magnets to set up a magnetic field which traps secondary electrons emitted from the target, preventing them from bombarding the substrate but using them to produce greatly enhanced ionisation in the sputtering gas. The arrangement used is shown in the diagram below.



The principle of operation of the planar magnetron high-rate sputtering electrode is shown in the diagram. Electrons emitted during sputtering are constrained by the magnets to follow helical paths round the lines of force

The three-electrode turret at the base of this Nordiko unit will accept normal or high-rate target electrodes, and can be used for any r.f. or d.c. sputtering techniques

Two magnets, one in the centre of the target with an upward facing north pole and one around the periphery of the target with a south pole facing upwards, set up a field with lines of force running as shown. Electrons emitted when sputtering takes place are constrained to follow helical paths round these lines of magnetic force. The length of this helical path is very large, the chance of an ionising collision with a gas molecule is correspondingly large and high plasma current densities result which give rise to high sputtering rates. Typically, a current density of 40 mA/cm^2 is obtained compared with about 1 mA/cm^2 in conventional systems.

By this technique, typical maximum sputtering rates are raised from 1000 Å/min to 18,700 Å/min for palladium, from 750 Å/min to 12,600 Å/min for platinum, and from 600 Å/min to 11,700 Å/min for rhodium. This large increase in sputtering rate can lead to considerable economies in processing times, and may open the way to new applications of platinum group metal coatings which previously would have required impractical processing times.

Circular high-rate sputtering electrodes are available up to 20 cm diameter for use in research and development equipment. These water-cooled electrodes contain the requisite magnets and can be used in place of, or in conjunction with, normal sputtering electrodes. For large scale production equipment, rectangular high rate electrodes are available for use with a linear travelling work table, drum mounted substrates or continuous roll coating.

The use of this modification enables the advantages of sputtering such as its controllability, reproducibility, uniformity and low pinhole density to be enjoyed while attaining high deposition rates together with low substrate heating and low radiation damage. C. H.