Hydrogen may also be produced in moderate quantities by the electrolysis of water, but to compete economically this process depends on the availability of a cheap source of electricity. Other methods of producing hydrogen, such as by steam reforming, the cryogenic process and as a by-product of chlorine production, are essentially applicable only to the large scale production of the gas, and are therefore not comparable with the absorption technique.

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Deposition of Platinum Films by Radio-Frequency Sputtering

The successful use of radio-frequency sputtering for producing mechanically stable, closely adherent, and essentially non-contaminated and highly conductive platinum films on gallium arsenide crystals has recently been described by S. P. Murarka of the Bell Telephones Laboratories, Murray Hill, New Jersey (*Thin Solid Films*, 1974, **23**, 323–326). In developing the technique, a primary object was to establish such conditions that the films should be of well-controlled thickness and also stress-free so as to ensure that they remained in perfect contact with the semiconductor. These requirements have been found of the greatest importance in developing the new generation of high power microwave devices known as Infinite Multiplication Avalanching Transit Time Oscillating Diodes—or IMPATTS.

The equipment made use of an unusually large target, 8 inches in diameter and (to support the parts to be coated) an equally large substrate table, both made of pure platinum. To remove unwanted residual gases, the system was pumped down to 5.10^{-9} torr, using a titanium sublimation pump in the later stages. During sputtering, tank nitrogen was leaked into the chamber to maintain pressure at 5.10^{-3} torr ± 4 per cent.

For sputtering, 100–500 watts of radio-frequency power was supplied at a frequency of 13.56 MHz. The rate of deposition was remarkably high—470 Å per minute with 450 watts at room temperature. The effects of varying such controllable factors as argon pressure and deposition temperatures were found to follow a predictable pattern. The rate of sputtering increased with increase in argon pressure from 1 to 4.10^{-3} torr, but the rate of increase fell off at higher pressures owing to the greater probability of collisions between the ions. Again, the rate of sputtering decreased as the temperature was raised (up to 260°C) at the higher temperatures the probability of the bombarding ions sticking to the surface became less.

The electrical resistivity of the platinum films is influenced by chemisorption and trapping of gaseous impurity, by damage to the surface from back scatter, by the grain size, and by chemical reaction with the substrate.

In the best conditions, films 2000 Å thick were obtained with a resistivity of 15 microhm cm, about 60 per cent higher only than the value for bulk platinum. Adhesion as tested by adhesive tape peel was excellent, and internal stress could be varied from 5.10^{9} dyn/cm^2 compressive to the same value tensile mainly by control of the substrate temperature.

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