Guest Editorial

Applications of Gold Metallurgy in Electronics

There are two main applications of gold in electronics, namely its use in low resistance electrical contacts with other conductors, and its incorporation into semiconductors as the element or its compounds as a means of modifying their electronic properties. Advances in gold metallurgy have contributed materially to the development of new production processes and new devices on an enormous scale.

In the low voltage solid state devices, which are so widely applied in computers, communication systems and instrumentation, high contact forces cannot be applied to break tarnish films and establish areas of high metallic contact across mating metallic surfaces. Gold and its alloys are used in various forms, and are superior to platinum and palladium films since they do not catalyse the formation of polymeric materials on the conducting surfaces, impairing conductivity.

For interconnecting the semiconductor chips in electronic circuitry, the three main techniques in use are wire, flip-chip, and tape-automated bonding. Studies of the effects of minute additions to the high purity gold, used in making bonding wire to the highest possible specifications, has contributed very materially to progress in wire bonding technology. Metallurgical problems arising from the formation of Kirkendall voids and embrittling intermetallics in the bonding of aluminium wire to gold and of gold wire to aluminium have also been much studied, but a complete solution has yet to emerge.

Much attention is also being given to the development of the multi-chip module in which a number of unpackaged integrated circuits are interconnected on a single high-density substrate. Very large markets for such products are expected to develop in the next few years, which can be expected to increase the use of gold in electronic circuitry.

Gold is, however, not used merely for the interconnection of components of electronic devices. In the absence of any treatment which predisposes in favour of ohmic behaviour, contacts between gold and n-type semiconductors exhibit an energy barrier which prevents the flow of electrons into the semiconductor from the gold, thus establishing a blocking or rectifying contact. Such behaviour, is, perhaps, less important than the fact that it can be exploited to impart ohmic

character to a Schottky energy barrier contact, by doping the semiconductor at the interface with either an n-type or p-type impurity and reducing the barrier height by alloying, using the contact metal as a carrier for the dopant. The contact metal is preferably gold because of its great alloying properties and resistance to environmental effects. It may be applied as an alloy of the dopant metal.

A voluminous literature has been built up which describes the evaluation of a wide range of techniques for the fabrication of stable ohmic contacts to compound semiconductors. The ramifications of the developments, including high speed switching devices, memory elements, surface barrier nuclear particle detectors and thyristors, are of the utmost importance. They all indicate that gold will long continue to be of the utmost importance in the electronics industry. Its use in this sphere must surely expand with time and increasing knowledge of methodology.

W S Rapson

Editorial Note

We regret to report that Dr Bill Rapson died suddenly on 25 June, aged 86, shortly after writing this contribution. An Appreciation of Dr Rapson will appear in *Gold Bulletin*, Volume 32, No 4, which will be a Commemorative Issue dedicated to Bill, as a mark of his substantial contribution to *Gold Bulletin* and the development of gold science and technology during his long lifetime.