Miniature Engineering

Scientists discovered that the microchip could be developed by using one of the earth's most abundant commodities

Silicon occurs naturally all over the surface of this planet in greater abundance than any other element except oxygen, with which it combines to form silica. Many of us spend most of our holidays lying on it and making our castles out of it. The whole of the microelectronics revolution is built on sand!

The importance of silicon to the microelectronics industry lies in its physical structure. In its pure form silicon is an extremely poor conductor of electricity. However, when controlled amounts of certain impurities are introduced, silicon becomes a semi-conductor.

The conduction of electricity through a substance is determined by the number of electrons in each of its atoms and the way they are bonded together. In metals, electrical current is carried by electrons without any firm bond. These electrons are free to wander about inside the atomic structure, transferring their allegiance with their electrical charge from one atom to another. In an insulator all the electrons are firmly bonded together; therefore a current cannot pass from one point to another.

The manufacture of pure silicon is a simple process. First, the raw oxide is refined chemically until it is 99.99 per cent pure. It is then placed into a crucible and heated to melting point, which is 1410°C (2570°F), in an atmosphere of purified inert gas, to keep out unwanted elements.

The process of introducing controlled amounts of impurities (known as 'doping') calls for the pure silicon to be combined with phosphorus, which produces 'n-type' silicon (so known because it carries the negative charge), or boron, which forms 'p-type' or positively chargeable silicon.

A large crystal is grown by introducing a perfect 'seed' crystal into the melt, and slowly withdrawing it, turning it at the same time.

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The Chip Furnace
The photograph shows a silicon chip furnace at work. Once the silicon has been refined, sliced, polished, masked and etched, it must be given a surface coating of silicon dioxide. This is done by heating the wafers to 1050°C (1920°F) then passing a stream of very pure oxygen or superheated steam over the wafers. While they are in the furnace, inside the 'boat', which is made of fused quartz, a layer of silicon dioxide forms over the surface of the wafer.

This layer is then selectively removed by the next etching process, and the cycle is repeated for each layer of the chip