

General Information

Discovery

J.J.Berzelius is credited with the discovery of silicon in 1824 in Stockholm, Sweden. However, Gay Lussac and Thenard probably prepared impure amorphous silicon in 1811. Deville prepared the second allotropic form of silicon, crystalline silicon, in 1854.

Appearance

Amorphous silicon is a brown powder, and crystalline silicon is a grey colour with a metallic lustre.

Source

Silicon makes up 25.7% of the earth's crust by mass and is the second most abundant element (oxygen is the first). It does not occur free in nature but occurs chiefly as the oxide and as silicates. The oxide includes sand, quartz, rock crystal, amethyst, agate, flint and opal. The silicate form includes asbestos, granite hornblende, feldspar, clay and mica.

Silicon is prepared commercially by electrolysis with carbon electrodes of a mixture of silica and carbon. Silicon is used extensively in solid-state devices and for this hyperpure silicon is required. This is prepared by thermal decomposition of ultra-pure trichlorosilane.

Uses

Silicon is one of the most useful elements to mankind. Sand and clay, which both contain silicon, are used to make concrete and cement. Sand is also the principal ingredient of glass, which has thousands of uses. Silicon is a component of steel, and silicon carbides are important abrasives and also used in lasers. Silicon is present in pottery and enamels, and in high-temperature materials.

However, increasing use for silicon is now being found in micro-electronic devices. The silicon is usually doped with boron, gallium, phosphorus or arsenic for use in transistors, solar cells, rectifiers and other instruments.

Biological Role

Silicon is essential to plant and animal life. It is non-toxic but some silicates, such as asbestos, are carcinogenic. Some workers such as miners and stonecutters who are exposed to siliceous dust often develop a serious lung disease called silicosis.

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Silicon is relatively inert. It is attacked by halogens and dilute alkali, but is not attacked by acids except hydrofluoric.

Silicones are important products of silicon, prepared by hydrolysing a silicon organic chloride. Hydrolysis and condensation of substituted chlorosilanes can be used to produce a great number of polymers known as silicones, ranging from liquids to hard, glasslike solids with many useful properties.

Physical Information

| | |
|--|-------------------------------------|
| Atomic Number | 14 |
| Relative Atomic Mass (¹² C=12.000) | 28.086 |
| Melting Point/K | 1683 |
| Boiling Point/K | 2628 |
| Density/kg m ⁻³ | 2329 (293K) |
| Ground State Electron Configuration | [Ne]3s ² 3p ² |
| Electron Affinity (M-M ⁻)/kJ mol ⁻¹ | 135 |

Key Isotopes

| | | | | |
|-------------------|------------------|------------------|------------------|------------------|
| Nuclide | ²⁸ Si | ²⁹ Si | ³⁰ Si | ³² Si |
| Atomic mass | 27.977 | 28.976 | 29.974 | 31.974 |
| Natural abundance | 92.23% | 4.67% | 3.10% | 0% |
| Half-life | stable | stable | stable | 650 yrs |

Ionisation Energies/kJ mol⁻¹

| | |
|------------------------------------|--------|
| M - M ⁺ | 786.5 |
| M ⁺ - M ²⁺ | 1577.1 |
| M ²⁺ - M ³⁺ | 3231.4 |
| M ³⁺ - M ⁴⁺ | 4355.5 |
| M ⁴⁺ - M ⁵⁺ | 16091 |
| M ⁵⁺ - M ⁶⁺ | 19784 |
| M ⁶⁺ - M ⁷⁺ | 23786 |
| M ⁷⁺ - M ⁸⁺ | 29252 |
| M ⁸⁺ - M ⁹⁺ | 33876 |
| M ⁹⁺ - M ¹⁰⁺ | 38732 |

Other Information

| | |
|---|-------|
| Enthalpy of Fusion/kJ mol ⁻¹ | 39.6 |
| Enthalpy of Vaporisation/kJ mol ⁻¹ | 383.3 |

Oxidation States

Si^{II}, Si^{IV}

Covalent Bonds/kJ mol⁻¹

| | |
|---------|-----|
| Si - H | 326 |
| Si - C | 301 |
| Si - O | 486 |
| Si - F | 582 |
| Si - Cl | 391 |
| Si - Si | 226 |