[Template:About](/wiki/Template:About" \o "Template:About) [Template:Distinguish2](/wiki/Template:Distinguish2) [Template:Redir](/wiki/Template:Redir) [Template:Infobox silicon](/wiki/Template:Infobox_silicon)

**Silicon** is a [chemical element](/wiki/Chemical_element) with symbol **Si** and [atomic number](/wiki/Atomic_number) 14. It is a [tetravalent](/wiki/Tetravalence) [metalloid](/wiki/Metalloid), more reactive than [germanium](/wiki/Germanium), the metalloid directly below it in the table. Controversy about silicon's character dates to its discovery. It was first prepared and characterized in pure form in 1823. In 1808, it was given the name silicium (from [Template:Lang-la](/wiki/Template:Lang-la), hard stone or [flint](/wiki/Flint)), with an **-ium** word-ending to suggest a [metal](/wiki/Metal), a name which the element retains in several languages. The present [English](/wiki/English_language) name was first suggested in 1817 to conform with the physically similar elements, [carbon](/wiki/Carbon) and [boron](/wiki/Boron).

Silicon is the eighth most [common element](/wiki/Abundance_of_the_chemical_elements) in the universe by mass, but very rarely occurs as the pure free element in the Earth's crust. It is most widely distributed in [dusts](/wiki/Dust), [sands](/wiki/Sand), [planetoids](/wiki/Planetoids), and [planets](/wiki/Planet) as various forms of [silicon dioxide](/wiki/Silicon_dioxide) (silica) or [silicates](/wiki/Silicate). Over 90% of the Earth's crust is composed of [silicate minerals](/wiki/Silicate_minerals), making silicon the [second most abundant element](/wiki/Abundance_of_elements_in_Earth's_crust) in the Earth's crust (about 28% by mass) after [oxygen](/wiki/Oxygen).[[1]](#cite_note-1) Most silicon is used commercially without being separated, and often with little processing of the natural minerals. Such use includes industrial construction with [clays](/wiki/Clays), [silica sand](/wiki/Silica_sand), and [stone](/wiki/Stone). Silicate is used in [Portland cement](/wiki/Portland_cement) for [mortar](/wiki/Mortar_(masonry)) and [stucco](/wiki/Stucco), and mixed with silica sand and [gravel](/wiki/Gravel) to make [concrete](/wiki/Concrete) for walkways, foundations, and roads. Silicates are used in whiteware [ceramics](/wiki/Ceramic) such as [porcelain](/wiki/Porcelain), and in traditional [quartz](/wiki/Quartz)-based [soda-lime glass](/wiki/Soda-lime_glass) and many other specialty [glasses](/wiki/Glass). Silicon compounds such as [silicon carbide](/wiki/Silicon_carbide) as used as abrasives and components high-strength ceramics.

Silicon is the basis of the widely used synthetic polymers called [silicones](/wiki/Silicone).

Elemental silicon also has a large impact on the modern world economy. Most free silicon is used in the [steel](/wiki/Steel) refining, [aluminium](/wiki/Aluminium)-casting, and fine chemical industries (often to make [fumed silica](/wiki/Fumed_silica)). Even more visibly, the relatively small portion of very highly purified silicon used in semiconductor electronics (< 10%) is essential to [integrated circuits](/wiki/Integrated_circuits) — most computers, cell phones, and modern technology depends on it.

Silicon is an essential element in biology, although only tiny traces are required by animals.[[2]](#cite_note-2) However, various [sea sponges](/wiki/Sea_sponges) and microorganisms, such as [diatoms](/wiki/Diatoms) and [radiolaria](/wiki/Radiolaria), secrete skeletal structures made of silica. Silica is deposited in many plant tissues, such as in the bark and wood of [*Chrysobalanaceae*](/wiki/Chrysobalanaceae) and the silica cells and silicified trichomes of [*Cannabis sativa*](/wiki/Cannabis_sativa), [horsetails](/wiki/Horsetail) and many [grasses](/wiki/Grasses).[[3]](#cite_note-3)

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## Characteristics[[edit](/index.php?title=(none)&action=edit&section=1)]

### Physical[[edit](/index.php?title=(none)&action=edit&section=2)]

[160px|thumb|left|Silicon crystallizes in a diamond cubic crystal structure](/wiki/File:Silicon-unit-cell-3D-balls.png)

[Template:Further](/wiki/Template:Further)

Silicon is a solid at [room temperature](/wiki/Room_temperature), with a melting point of [Template:Convert](/wiki/Template:Convert) and a boiling point of [Template:Convert](/wiki/Template:Convert). Like water, it has a greater [density](/wiki/Density) in a [liquid state](/wiki/Liquid_state) than in a [solid state](/wiki/Solid) and it expands when it freezes, unlike most other substances. With a relatively high [thermal conductivity](/wiki/Thermal_conductivity) of 149 W·m−1·K−1, silicon conducts heat well.

In its [crystalline](/wiki/Crystal) form, pure silicon has a gray color and a [metallic](/wiki/Metallic_color) luster. Like [germanium](/wiki/Germanium), silicon is rather strong,[Template:Vague](/wiki/Template:Vague) very brittle, and prone to chipping. Silicon, like carbon and germanium, crystallizes in a [diamond cubic](/wiki/Diamond_cubic) [crystal structure](/wiki/Crystal_structure) with a lattice spacing of 0.5430710 nm (5.430710 [Å](/wiki/Ångström)).[[4]](#cite_note-4) The outer [electron orbital](/wiki/Atomic_orbital) of silicon, like that of carbon, has four valence electrons. The 1*s*, 2*s*, 2*p* and 3*s* subshells are completely filled while the 3*p* subshell contains two electrons out of a possible six.

Silicon is a [semiconductor](/wiki/Semiconductor). It has a negative temperature coefficient of [resistance](/wiki/Electrical_resistance), since the number of free charge carriers increases with temperature. The electrical resistance of [single crystal](/wiki/Single_crystal) silicon significantly changes under the application of mechanical stress due to the [piezoresistive effect](/wiki/Piezoresistive_effect).[[5]](#cite_note-5)

### Chemical[[edit](/index.php?title=(none)&action=edit&section=3)]

[160px|thumb|left|Silicon powder](/wiki/File:Silizium_pulver.jpg)

Silicon is a [metalloid](/wiki/Metalloid), readily donating or sharing its four outer electrons, and it typically forms four bonds. Like carbon, its four bonding electrons enable it to combine with many other elements or compounds to form a wide range of compounds. Unlike carbon, it can accept additional electrons and form five or six bonds in a sometimes more [labile](/wiki/Labile) [silicate](/wiki/Silicate) form. Tetra-valent silicon is relatively [inert](/wiki/Inert); it reacts with [halogens](/wiki/Halogen) and dilute [alkalis](/wiki/Alkali), but most acids (except some hyper-reactive combinations of [nitric acid](/wiki/Nitric_acid) and [hydrofluoric acid](/wiki/Hydrofluoric_acid)) have no effect on it.

### Isotopes[[edit](/index.php?title=(none)&action=edit&section=4)]

[Template:Main](/wiki/Template:Main)

Naturally occurring silicon is composed of three stable [isotopes](/wiki/Isotope), silicon-28, silicon-29, and silicon-30, with silicon-28 being the most abundant (92% [natural abundance](/wiki/Natural_abundance)).[[6]](#cite_note-6) Out of these, only silicon-29 is of use in [NMR](/wiki/NMR) and [EPR spectroscopy](/wiki/EPR_spectroscopy).[[7]](#cite_note-7) Twenty [radioisotopes](/wiki/Radioisotopes) have been characterized, with the most stable being silicon-32 with a [half-life](/wiki/Half-life) of 170 years, and silicon-31 with a half-life of 157.3 minutes.[[6]](#cite_note-6) All of the remaining [radioactive](/wiki/Radioactive_decay) isotopes have half-lives that are less than seven seconds, and the majority of these have half-lives that are less than one tenth of a second.[[6]](#cite_note-6) Silicon does not have any known [nuclear isomers](/wiki/Nuclear_isomer).[[6]](#cite_note-6) The isotopes of silicon range in [mass number](/wiki/Mass_number) from 22 to 44.[[6]](#cite_note-6) The most common [decay mode](/wiki/Decay_mode) of six isotopes with mass numbers lower than the most abundant stable isotope, silicon-28, is [Template:SubatomicParticle](/wiki/Template:SubatomicParticle), primarily forming aluminium isotopes (13 protons) as [decay products](/wiki/Decay_product).[[6]](#cite_note-6) The most common decay mode for 16 isotopes with mass numbers higher than silicon-28 is [Template:SubatomicParticle](/wiki/Template:SubatomicParticle), primarily forming phosphorus isotopes (15 protons) as decay products.[[6]](#cite_note-6)

## History[[edit](/index.php?title=(none)&action=edit&section=5)]

Attention was first drawn to silica as the possible oxide of a fundamental [chemical element](/wiki/Chemical_element) by [Antoine Lavoisier](/wiki/Antoine_Lavoisier), in 1787.[[8]](#cite_note-8) After an attempt to isolate silicon in 1808, Sir Humphry Davy proposed the name "silicium" for silicon, from the Latin *silex*, *silicis* for flint, and adding the "-ium" ending because he believed it was a metal.[[9]](#cite_note-9) In 1811, [Gay-Lussac](/wiki/Gay-Lussac) and [Thénard](/wiki/Louis_Jacques_Thénard) are thought to have prepared impure [amorphous silicon](/wiki/Amorphous_silicon), through the heating of recently isolated [potassium](/wiki/Potassium) metal with [silicon tetrafluoride](/wiki/Silicon_tetrafluoride), but they did not purify and characterize the product, nor identify it as a new element.[[10]](#cite_note-10) Silicon was given its present name in 1817 by Scottish chemist [Thomas Thomson](/wiki/Thomas_Thomson_(chemist)). He retained part of Davy's name but added "-on" because he believed that silicon was a [nonmetal](/wiki/Nonmetal) similar to [boron](/wiki/Boron) and [carbon](/wiki/Carbon).[[11]](#cite_note-11) In 1823, [Berzelius](/wiki/Jöns_Jakob_Berzelius) prepared amorphous silicon using approximately the same method as Gay-Lussac (potassium metal and potassium fluorosilicate), but purifying the product to a brown powder by repeatedly washing it.[[12]](#cite_note-12) As a result, he is usually given credit for the element's discovery.[[13]](#cite_note-13)[[14]](#cite_note-14) Silicon in its more common crystalline form was not prepared until 31 years later, by [Deville](/wiki/Henri_Etienne_Sainte-Claire_Deville).[[15]](#cite_note-15)

### Mechanical watches[[edit](/index.php?title=(none)&action=edit&section=20)]

Since 2000, silicon has found a new use in mechanical watch movements. Several manufacturers of mechanical watch movements have incorporated silicon parts, mainly in the escapements and balance wheel regions. Silicon hair-springs are becoming more common as are silicon escapement wheels and forks. Silicon has several desirable properties when used in these contexts; It is thermally stable, shock resistant, and requires little to no lubrication. Ulysse Nardin pioneered these applications, with Omega, Breguet, Patek, Rolex, Cartier, and Damasko following.[[45]](#cite_note-45) Most of these parts for watch movements are manufactured by [deep reactive-ion etching](/wiki/Deep_reactive-ion_etching) (DRIE).[[46]](#cite_note-46)

## Biological role[[edit](/index.php?title=(none)&action=edit&section=21)]

[thumb|Silica skeletons of](/wiki/File:Radiolaria3434.JPG) [radiolaria](/wiki/Radiolaria) in false color.

Although silicon is readily available in the form of [silicates](/wiki/Silicate), very few organisms use it directly. [Diatoms](/wiki/Diatom), [radiolaria](/wiki/Radiolaria) and [siliceous sponges](/wiki/Siliceous_sponge) use [biogenic silica](/wiki/Biogenic_silica) as a structural material for skeletons. In more advanced plants, the silica [phytoliths](/wiki/Phytolith) (opal phytoliths) are rigid microscopic bodies occurring in the cell; some plants, for example [rice](/wiki/Rice), need silicon for their growth.[[47]](#cite_note-47)[[48]](#cite_note-48)[[49]](#cite_note-49) There is some evidence that silicon is important to nail, hair, bone and skin health,[[50]](#cite_note-50) for example in studies that show that premenopausal women with higher dietary silicon intake have higher [bone density](/wiki/Bone_density), and that silicon supplementation can increase bone volume and density in patients with [osteoporosis](/wiki/Osteoporosis).[[51]](#cite_note-51) Silicon is needed for synthesis of [elastin](/wiki/Elastin) and [collagen](/wiki/Collagen), of which the [aorta](/wiki/Aorta) contains the greatest quantity in the human body.[[52]](#cite_note-52) Silicon is currently under consideration for elevation to the status of a "plant beneficial substance by the Association of American Plant Food Control Officials (AAPFCO)."[[53]](#cite_note-53)<ref name=presentation>[Template:Cite web](/wiki/Template:Cite_web)</ref> Silicon has been shown in university and field studies to improve plant cell wall strength and structural integrity,<ref name=PHC>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> improve drought and frost resistance, decrease lodging potential, and boost the plant's natural pest and disease fighting systems.<ref name=Bangalore>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> Silicon has also been shown to improve plant vigor and physiology by improving root mass and density, and increasing above ground plant biomass and crop yields.[[54]](#cite_note-54)

## See also[[edit](/index.php?title=(none)&action=edit&section=22)]

[Template:Colbegin](/wiki/Template:Colbegin)

* [Amorphous silicon](/wiki/Amorphous_silicon)
* [Black silicon](/wiki/Black_silicon)
* [Covalent superconductors](/wiki/Covalent_superconductors)
* [List of countries by silicon production](/wiki/List_of_countries_by_silicon_production)
* [List of silicon producers](/wiki/List_of_silicon_producers)
* [Monocrystalline silicon](/wiki/Monocrystalline_silicon)
* [Polycrystalline silicon](/wiki/Polycrystalline_silicon)
* [Printed silicon electronics](/wiki/Printed_silicon_electronics)
* [Silicon tombac](/wiki/Silicon_tombac)
* [Silicon Valley](/wiki/Silicon_Valley)
* [Silicon Wadi](/wiki/Silicon_Wadi)
* [Transistor](/wiki/Transistor)

[Template:Colend](/wiki/Template:Colend) [Template:Subject bar](/wiki/Template:Subject_bar)

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* [Template:Cite book](/wiki/Template:Cite_book)

## External links[[edit](/index.php?title=(none)&action=edit&section=25)]

* [Silicon](http://www.periodicvideos.com/videos/014.htm) at [*The Periodic Table of Videos*](/wiki/The_Periodic_Table_of_Videos) (University of Nottingham)
* [WebElements.com – Silicon](http://www.webelements.com/webelements/elements/text/Si/key.html)
* [CDC – NIOSH Pocket Guide to Chemical Hazards](http://www.cdc.gov/niosh/npg/npgd0554.html)
* [New Semiconductor Materials - Ioffe Physicotechnical Institute St. Petersburg, Russia](http://www.ioffe.ru/SVA/NSM/Semicond/Si/)

[Template:Compact periodic table](/wiki/Template:Compact_periodic_table) [Template:Silicon compounds](/wiki/Template:Silicon_compounds)

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