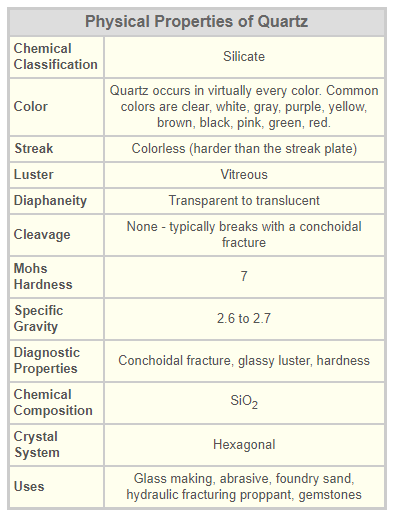
**QUARTZ**

Quartz is a chemical compound consisting of one part silicon and two parts oxygen. It is silicon dioxide (SiO2). It is the most abundant mineral found at Earth's surface, and its unique properties make it one of the most useful natural substances.

Quartz is the most abundant and widely distributed mineral found at Earth's surface. It is present and plentiful in all parts of the world. It forms at all temperatures. It is abundant in igneous, metamorphic, and sedimentary rocks. It is highly resistant to both mechanical and chemical weathering. This durability makes it the dominant mineral of mountaintops and the primary constituent of beach, river, and desert sand. Quartz is ubiquitous, plentiful and durable. Minable deposits are found throughout the world.



**RESOURCES OF QUARTZ**

As per the NMI database, based on UNFC system as on 1.4.2015, the total reserves/resources of quartz and silica sand in the country have been estimated at 3,907.95 million tonnes out of which 647.53 million tonnes (17%) are placed under reserves category and 3,260.42 million tonnes (83%) are placed under remaining resources category. Resources by grades reflect foundry & moulding grade at 735.59 million tonnes (19%), glass at 649.77 million tonnes (17%), ceramic & pottery grade at 438.44 million tonnes (11%) and ferro-silicon grade at 183.96 million tonnes (5%).

State-wise Haryana alone accounts for 1,653.65 million tonnes (42%) resources, followed by Rajasthan at 740.46 million tonnes (19%), Andhra Pradesh 236.69 million tonnes (6%), Tamil Nadu 201.49 million tonnes (5%), Maharashtra 179.72 million tonnes (4.60%), Jharkhand 151.19 million tonnes (4%), Uttar Pradesh 140.72 million tonnes (3.60%), Gujarat 132.42 million tonnes (3.39%), Kerala 128.48 million tonnes (3.28%), Karnataka 95 million tonnes (2.43%), Telangana 80.07 million tonnes (2.05%) etc.

**EXPLORATION AND DEVELOPMENT**

Exploration for quartz and silica minerals was conducted by Geological Survey of India and Directorate of Mines & Geology, Rajasthan during the year 2015-16.

**MINING**

Mining for silica minerals is carried out by manual opencast method. Quartz produced in the form of lump along with other associated minerals is invariably hammered to pieces and manually sorted before it is despatched to the consuming industries. It is sometimes crushed and marketed. Glass sand is generally screened and washed to remove all the deleterious constituents for its use in glass industry.

**HEALTH HAZARDS**

Respirable silica is still a cause of major concern to miners and consumers since many minerals, especially industrial sand and gravel contain crystalline silica. There is a potential threat of workers getting subjected to "silicosis" in quartz, silica sand and gravel mines. Occupational safety measures & regulations to monitor the levels of crystalline silica in these mines are mandatory.

**QUARTZ CRYSTAL MANUFACTURING PROCESS**

[www.jauch.com](http://www.jauch.com)

1. Autoclave is filled with natural quartz SiO2 and alkaline solvent
2. Quartz seeds are fixed in a carrier in upper part of autoclave
3. Saturated solvent of SiO2 crystallizes on the surface of the quartz seeds
4. Growth of the crystal is controlled by temperature gradient
5. The growing process duration is 40 and 60 days
6. Z-plane of the quartz bar is grinded
7. Quartz bars are cut into lumbers
8. Quartz crystal seed is removed
9. Lumbered bars are cut into wafers
10. Wafers are separated into blanks
11. Cutting blanks to final size
12. Sorting of cutting angle by X-ray inspection
13. Lapping, polishing, bevelling of blanks
14. Blank washing and cleaning
15. Electrode evaporation with silver or gold in vacuum chamber (sputtering)
16. Blanks are positioned and contacted
17. Final frequency adjustment at specified load capacitance
18. Package sealing under nitrogen atmosphere
19. Marking
20. 100% final test, packaging

**DIFFERENT FORMS OF QUARTZ**

**CRYSTALLINE VARITIES**: The important varieties of crystalline quartz are vein quartz (massive crystalline quartz); milky quartz (white, translucent to opaque); ferruginous quartz (containing brown limonite and red haematite and almost opaque); aventurine quartz (containing glistening flakes of mica or haematite); cat's eye (opalescent greenish quartz with fibrous structure); rock crystal (clear, colourless, well-crystallised transparent quartz); amethyst (clear-purple or violetblue), transparent quartz; rose quartz; smoky quartz; etc. Occurrences of massive crystalline quartz in veins or pegmatites have been recorded in almost all the states.

**CLASTIC OR GRANULAR VARITIES**: These varieties include sand consisting largely of unconsolidated quartzose grains (0.06 mm to 2 mm diameter), gravel consisting largely of unconsolidated coarse quartzose grains or pebbles (2 mm to 8 mm in diameter), sandstone and quartzite. Quartzite is a granulose metamorphic rock consisting essentially of quartz and sandstone cemented by silica which has grown in optical continuity around each grain. Occurrences are reported from Andhra Pradesh, Bihar, Delhi, Haryana, Karnataka, Kerala, Madhya Pradesh, Rajasthan, Tamil Nadu, Uttar Pradesh, etc. The silica sand from Naini area in Allahabad district, Uttar Pradesh is of a very high quality.

**CRYPTOCRYSTALLINE VARITIES**: This group includes chalcedony, agate, jasper, onyx, flint and chert. These varieties appear non- crystalline (amorphous) in hand specimens, but under microscope show double refraction which reveals their concealed crystalline nature. These varieties are reported from Gujarat, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Maharashtra, Madhya Pradesh, Karnataka and Punjab. The most important occurrences of agate are in Gujarat.

**Rock crystal quartz:** Transparent "rock crystal" quartz.

**Amethyst quartz:** Purple crystalline quartz is known as "amethyst." When transparent and of high quality, it is often cut as a gemstone

**Flint:** Flint is a variety of microcrystalline or cryptocrystalline quartz. It occurs as nodules and concretionary masses and less frequently as a layered deposit. It breaks consistently with a conchoidal fracture and was one of the first materials used to make tools by early people. They used it to make cutting tools. After thousands of years, people continue to use it. It is presently used as the cutting edge in some of the finest surgical tools.

**Quartz glass sand:** High-purity quartz sandstone suitable for the manufacture of high-quality glass. "Glass sand" is a sandstone that is composed almost entirely of quartz grains

**Jasper beads:** Quartz is often used in jewellery or as a gemstone. These jasper beads are an example of quartz used as a gemstone.

**Blue aventurine quartz:** Aventurine is colourful variety of quartz that contains abundant shiny inclusions of minerals such as mica or hematite. It is often cut and polished for use as an ornamental stone. Common colours for aventurine are green, orange, and blue

**Silicified wood:** Silicified "petrified" wood is formed when buried plant debris is infiltrated with mineral-bearing waters which precipitate quartz. This quartz in fills the cavities within the wood and often replaces the woody tissues.

**Chert:** Chert is a microcrystalline or cryptocrystalline quartz. It occurs as nodules and concretionary masses and less frequently as a layered deposit

**Novaculite** is a dense, cryptocrystalline variety of quartz with a fine-grained and very uniform texture. As quartz, it has a hardness of 7 (harder than steel) and is used as a "whetstone" for sharpening knives.

**SYNTHETIC QUARTZ**

Synthetic quartz, sometimes called artificial marble, has very favourable chemical and physical properties including resistance to acids, corrosion, high temperatures, wear, impact, compression, bending and infiltration. It is also very easy to install and keep clean. Synthetic quartz can be manufactured in many patterns including simulated marble or granite, can be given features like a natural marble-like smoothness, granitic strength, and ceramic lustre, and can be formed into many shapes. Handsome and practical synthetic quartz is an ideal modern architectural decorative material.

The major raw materials generally used in the production of synthetic quartz under current production techniques are quartz, quartz powder and resin. Resin is used to combine all the materials into a very strong and solid finished product. Resins commonly used are unsaturated polyester resin, epoxy, phenolic resin, acrylic resin and polyurethane resin.

Despite its many advantages, studies have found that synthetic quartz manufactured according to existing formulas and technologies does not meet ASTM International (ASTM) quality standards for natural quartz such as for tensile strength, compressive strength and flexural strength. Consequently, applications for synthetic quartz have heretofore been limited.

**USES OF QUARTZ**

Quartz, quartzite and silica sand are used in various industries like glass, refractory, foundry, ceramic, cosmetic, electrical, abrasives, paints, etc. The primary use of silica is in the manufacture of virtually all types of glassware, ceramics and ceramic glazes. Other major uses are in metallurgy, (where silica is used as a refractory, foundry mould, fluxes and as a source of silicon for the production of silicon metal and ferro-silicon and other ferro-alloys), silicon carbide manufacture, chemical & construction sectors and as a natural abrasive. Known for its piezoelectric properties, high quality quartz crystal is used in electronic devices, multiple telephone lines, depth-sounding devices, range finders, chronometers, etc.

Quartz is one of the most useful natural materials. Its usefulness can be linked to its physical and chemical properties. It has a hardness of seven on the Mohs Scale which makes it very durable. It is chemically inert in contact with most substances. It has electrical properties and heat resistance that make it valuable in electronic products. Its lustre, colour, and diaphaneity make it useful as a gemstone and also in the making of glass.

Flint and chert are used in abrasives and tubemill lining. Besides, chert is used in crushed form as aggregate for concrete and road surfacing. Rounded pebbles of chalcedony are used as balls in ball mill for finer crushing and grinding feldspar, calcite and barytes. The different cryptocrystalline varieties of transparent and translucent chalcedony are valued as semiprecious stones and are carved out into a variety of ornaments and used for making different ornamental wares or articles of decoration. Agate pieces after cutting and polishing are sold as semiprecious stones. Big pieces are used in making mortars and pestles for laboratory use. Agate cut into requisite shapes is also used as fulcra of scientific balances and in making edges, planes and bearings of precision instruments.

* GLASS MAKING

Main use of silica minerals is in the manufacture of different types of glasses, i.e. glass containers, bottles, amber glass containers, clear flint glass, vacuum bottles and other glasswares. Most of the glass demand in India currently comes from container glass, which accounts for 50% of the country's glass consumption by value. Most of them are located in Gujarat, Mumbai, Kolkata, Bengaluru and Hyderabad.

* CERAMIC INDUSTRY

Ceramic industry comprises ceramic tiles, sanitaryware and crockeryware items. These products are manufactured both in large and small scale sectors.

* QUARTZ AS AN ABRASIVE

The high hardness of quartz, seven on the Mohs Scale, makes it harder than most other natural substances. As such it is an excellent abrasive material. Quartz sands and finely ground silica sand are used for sand blasting, scouring cleansers, grinding media, and grit for sanding and sawing.

* FOUNDRY SAND

Quartz is very resistant to both chemicals and heat. It is therefore often used as a foundry sand. With a melting temperature higher than most metals, it can be used for the moulds and cores of common foundry work. Refractory bricks are often made of quartz sand because of its high heat resistance. Quartz sand is also used as a flux in the smelting of metals.

* REFRACTORY

Quartz and quartzite are used in the manufacture of refractory silica bricks. However, recently these bricks are being replaced by basic linings of magnesite, dolomite or natural types such as bauxite, etc. in LD basic oxygen and electric furnaces. silica bricks continue to be used in coke ovens, ceramic kilns, glass tank crowns and as blast furnace chequers in some steel mills. Silica bricks have excellent load resistance capacity at high temperature.

* FLUXES

Massive quartz, quartzite, sandstone and unconsolidated sands are the main sources of silica that get used as flux in smelting base metal ores where iron and basic oxides are slagged as silicates. Silica is also used to balance the lime and silica ratio of the blast furnace mix.

* SEMICONDUCTOR INDUSTRY

The electrical and electronic features of silicon (Si) are unusual: At high temperatures, acts as a metal, that is as a good conductor of electricity, but at low temperatures, acts as an insulator. Similar materials are called semiconductors. This unusual property has made silicon the perfect item to promote the global technology first to the transistor world, then to the world of integrated circuits, and, finally, in today's world of computer chips.

* OPTICAL FIBRES

The scientific field of fibre lasers utilizes quartz as a window, as well as prisms, optical filters and timing devices. Smaller amounts of high quality quartz crystal are used for prisms and lenses in optical instruments. Scientists are experimenting with quartz rods to focus sunlight into solar energy applications.

* PETROLEUM INDUSTRY

Quartz sand has a high resistance to being crushed. In the petroleum industry, sand slurries are forced down oil and gas wells under very high pressures in a process known as hydraulic fracturing. This high pressure fractures the reservoir rocks, and the sandy slurry injects into the fractures. The durable sand grains hold the fractures open after the pressure is released. These open fractures facilitate the flow of natural gas into the well bore.

* GEM STONE

Quartz makes an excellent gemstone. It is hard, durable, and usually accepts a brilliant polish. Popular varieties of quartz that are widely used as gems include: amethyst, citrine, rose quartz, smoky quartz, and aventurine. Agate and jasper are also varieties of quartz with a microcrystalline structure.

**SOME INDUSTRIES INVOLVED IN THE MANUFACTURE OF QUARTZ**

* Skyt minerals, Gujarat
* Prash Minerals Pvt Ltd, Udaipur, Rajasthan
* Rajasthan Minerals
* Sun Minerals, Rajasthan
* Unique Crystal Minerals, Rajasthan
* R K Ceramin
* B R G Ceramine

**CONCLUSION**

According to its suitability for different purposes, quartz & silica minerals are named as building sand, paving sand, moulding or foundry sand, refractory sand or furnace sand and glass sand, etc. The future market demand of quartz and silica minerals will depend on its application. However, the main use of silica minerals is in manufacture of different types of glasses, natural silica sand being the preferred material in the glass industry.

In India, quartz, quartzite and silica sand are used mainly in glass, foundry, ferro-alloys, refractory industries and also as building materials. Silica sand is used in the oil industry for the hydraulic fracturing process as it helps in the extraction of gases. The market demand of silica minerals may very high due to horizontal well drilling by oil companies.

The demand for quartz, silica sand, moulding sand and quartzite is increasing over the years to cater to the requirement of ferro-silicon, silicomanganese, silico-chrome, silica refractories, glass and for moulding and casting purposes. The requirements of these products are linked up directly with iron and steel industry including alloy steel production. Further, setting up foundries and enhancing their capacities are also linked with metallurgical industry.

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