Silica and High Purity Quartz

Industry and Product Background Briefing Note

Silica, or more correctly silicon dioxide SiO_2, is one of the most abundant compounds on the surface of the Earth, being most obvious as quartz and common sand. Silica has a multitude of uses depending on the degree of purity. Grades up to 99.5% SiO_2 are used in the manufacture of glass, optical fibres and ceramics.

There are various definitions of High Purity Quartz (HPQ) relative to the total and elemental contamination. Whilst modern processing methods can remove much of the contamination, it is the substitutional elements such as aluminium, titanium and lithium which are impossible remove if they are structurally bound to the silica, that constrain the ultimate purity of the silica. Naturally-occurring ultra-pure SiO_2 (greater than 99.997%) which is suitable for production of high-purity fillers, silicon metal and use in solar panels and semi-conductors is geologically rare and commands a significant premium over the price of lower grader material. As shown below (Table 1), prices for low to medium grade HPQ material are typically about US$300-US$500/t. The very best processed silica rock can sell for in excess of US$5,000/t. Deposits of this chemical quality and composition are rare and the largest known occurrence is in Alaskite igneous rocks near Spruce Pine, North Carolina, USA.

Type or Application	SiO_2 minimum %	Other Elements maximum %	Other Elements maximum ppm	Market Size Mtpa	Typical price US$/tonne
Clear glass-grade sand	99.5	0.5	5,000	>70	$30
Semiconductor filler, LCD and optical glass	99.8	0.2	2,000	2	$150
'Low grade' HPQ	99.95	0.05	500	0.75	$300
'Medium grade' HPQ	99.99	0.01	100	0.25	$500
'High grade' HPQ*	99.997	0.003	30	<0.1	>$5,000

Notes

*'High grade' high purity quartz with <30 ppm, is the standard high purity material produced by Unimin Corp and TQC at Spruce Pine
Limits can vary according to the composition of other raw materials in the application

Table 1. Typical silica sand and quartz specifications by market. Modified from Richard Flook and *Industrial Minerals* December 2013 p25.

HPQ is normally expressed relative to an industry-standard benchmark called IOTA®. Reference to this standard can be found at www.iotaquartz.com. The previous best deposits in Australia have been unable to meet the IOTA® standards even after processing. For example, the IOTA-STD® standard for processed silica is less than 14 ppm aluminium, 1.2 ppm titanium and less than 0.5 ppm lithium.

As can be seen from the table above, the markets for the HPQ products are relatively small but potentially valuable. Moreover, growth in demand for solar panels, semiconductors and other high tech and green requirements for silicon metal and high tech glass will no doubt underpin demand and growth and the need for new high quality silica deposits to be discovered and exploited.

Some categories of HPQ are considered a strategic mineral in the US National Defense Stockpile.

High Purity Quartz Applications

Semiconductors | Fibre Optics | High End Lighting | Solar Panels

Figure 1. Uses of HPQ.

Mining and Processing

The processing required to produce HPQ depends on the amount and type of impurities present and may include crushing, screening, floatation, acid-washes using hydrofluoric acid (which is a waste product from a phosphoric acid plant), magnetic separation and/or other physical, chemical and thermal techniques. Obviously, the lower the level of transitional elements and the more pure the material that is extracted from the ground, the less processing is required to produce a valuable product. With the deposits generally occurring at the surface, as is the case with the Dingo Hole Silica, mining the material is more akin to a rock quarry and therefore relatively low cost. The more limited the processing requirements, the lower the total costs of production.

The global industry is dominated by a small number of players that are integrated from the mine through to the high end downstream processing. A good example is the Quartz Corporation that mines at Spruce Pine in the USA, crushes, screens and mills the material to sand prior to flotation at the mine site before sending the material to Norway for the final high end processing steps that remove the remaining unwanted deleterious elements. Their corporate video at www.thequartzcorp.com provides a good explanation of the processing steps.

Figure 2. IOTA® Alaskite from Spruce Pine. Image from: http://www.iotaquartz.com/geology.cfm

In addition to Spruce Pine, other High Purity Quartz deposits of various geological types are present elsewhere in the USA, Mauritania, Russia, Germany, and Norway. Companies involved are listed below.

Company	Location
I-Minerals	Helmer-Bovill, NW Idaho, USA
Mauritanian Minerals Co	Oum Agueneina, Mauritania
Momentive Performance Materials Inc	Geesthacht, Germany; Hebron, Ohio, USA
Nordic Mining	Kvinnherad, Hordaland, Norway
Polar Quartz, OJSC, RUSNANO	Yugra, western Siberia, Russia
The Quartz Corp	Spruce Pine, North Carolina, USA
Russia Quartz LLC, RUSNANO, KGOK JSC	Kyshtym, Chelyabinsk, Russia
Unimin Corp/Sibelco	Spruce Pine, North Carolina, USA

Table 2. Companies involved in the High Purity Quartz industry. This list is not exhaustive. Excerpt from *Industrial Minerals* December 2013 p23.