



## Respirable Crystalline Silica in Air

### EXPOSURE TO SILICA IN THE WORKPLACE

Silica (silicon dioxide), is a naturally occurring widely abundant mineral that forms the major component of many rocks and soils. Silica can occur in either non-crystalline or crystalline form and exposure to airborne silica dust can occur in many occupational environments, particularly industries involved in mining, manufacturing, construction, drilling and quarrying.

Although in Australia, occupational exposure limits apply to both non-crystalline and crystalline forms, crystalline forms of silica are the primary concern in determining the health risk. Exposure limits for crystalline silica are orders of magnitude lower than for the non-crystalline forms. Crystalline silica can accumulate in the lungs and cause silicosis, a disease of the respiratory system. Silicosis is an irreversible and progressive condition. Crystalline silica has also been classified as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC)<sup>(3)</sup>

*Silicosis damages your lungs and makes it hard to breathe, increases your risk of lung infections, and may lead to heart failure. Silica may also cause cancer. Silicosis can be prevented but not cured.<sup>(1)</sup>*

Very small particles of Crystalline Silica which penetrate deep into the lung are termed Respirable and represent the highest risk to human health

ALS now offers NATA accredited Respirable Crystalline Silica analysis, including speciation of  **$\alpha$ -Quartz and Cristobalite**, allowing assessment of risks and comparison with exposure limits as required under occupational legislation.

### LIMITS OF REPORTING

Crystalline Silica	5 $\mu\text{g}/\text{filter}$ ( $\alpha$ -Quartz plus Cristobalite)
$\alpha$ -Quartz	5 $\mu\text{g}/\text{filter}$
Cristobalite	20 $\mu\text{g}/\text{filter}$

### ALS PACKAGE INFORMATION

EA202: Crystalline Silica in Respirable Airborne Dust  
EA203: Crystalline Silica in Coal Mine Dust with Ashing and Redeposition

### OCCUPATIONAL EXPOSURE LIMITS

The National Occupational Health and Safety Commission (NOHSC) and subsequently SafeWork Australia (2013) have established 8 hour Time Weighted Average (TWA) exposure limits for specific forms of Respirable Crystalline Silica, including  $\alpha$ -Quartz and Cristobalite.

Crystalline Silica Form	CAS No.	Respirable fraction
$\alpha$ -Quartz	[14808-60-7]	0.1 $\text{mg}/\text{m}^3$
Cristobalite	[14464-46-1]	0.1 $\text{mg}/\text{m}^3$

Under the federal Work Health and Safety (WHS) Regulations, all reasonably practicable steps must be taken to eliminate or minimise exposure to a level below the exposure standard.

### OCCURRENCE AND POLYMORPHS OF SILICA

Although silica has only one chemical formula ( $\text{SiO}_2$ ), it occurs in a wide variety of forms as a result of different crystallisation geometries. The amorphous forms of silica have no consistent arrangement of atoms. Whilst various forms of crystalline silica are known to be associated with silicosis and suspected of causing some forms of cancer, the non-crystalline form of silica does not cause this kind of damage.

Crystalline Silica may include Quartz, Cristobalite and Tridymite. Quartz is second most abundant mineral in the Earth's crust and a common component of soil, rocks, sand, mortar, cement, fluxes, abrasives, glass, porcelain, paints and brick. Cristobalite is less common and found in volcanic rocks and soils, and can be formed in high temperature processes such as foundry processes, brick manufacturing, ceramic manufacturing and silicon carbide production. Tridymite is rarely encountered, but is present in some volcanic rocks.

Amorphous silica can, however, be transformed into crystalline forms like cristobalite by heating. Typically, the temperatures required for this transformation are in excess of  $800^\circ\text{C}$ , however under certain conditions such as calcining in the presence of sodium carbonate or sodium chloride flux, the temperature required may be as low as  $450^\circ\text{C}$ . Assessment of exposure risks should therefore consider the potential for crystallisation of silica in industrial processes and include assessment of other forms of RCS in addition to  $\alpha$ -Quartz.



Image 1: Cyclonic sampling device

Ref: SKC Inc

## RESPIRABLE DUSTS

The risks associated with airborne silica depend heavily on the nature and size of the dust particles. Only the fine fraction of particles with a median diameter of 3.5-5µm penetrate deep within the lung to the lower bronchioles and alveolar regions. These particles are termed 'respirable'. Unlike other 'inhalable' particles entering the mouth and nose during normal breathing, respirable particles are not easily eliminated by the body and may bio-accumulate, compounding the risks associated with repeated exposures over time.

The 'Respirable' fraction of airborne dusts can be determined after separation during sampling, through the use of size fractionation in a cyclonic sampling device (Image 1). This size selective sampling device and sampling procedures are described in AS 2985-2009: Workplace atmospheres - Method for sampling and gravimetric determination of respirable dust.

## CRYSTALLINE SILICA ANALYSIS BY FTIR

SafeWork Australia specifies NHMRC conference proceedings from 1984 as the required method for Respirable Crystalline Silica (RCS) analysis. These conference proceedings describe a method for Measurement of Quartz in Respirable Airborne Dust by Infrared Spectroscopy and X-Ray Diffractometry. Like the more recent 2005 UK HSE method MDHS101, the ALS analytical method is based on, but adapted from this direct on filter IR approach, for measurement using Fourier Transform Infrared Spectroscopy (FTIR). This method is non-destructive and allows rapid, accurate RCS analyses whilst retaining the filter intact for further chemical testing if required.

For samples that are high in interfering organic matter, such as Coal Mine dusts, ALS has adopted the sample cleanup procedures of NIOSH 7603. This cleanup removes organic interferences via ashing and redeposition, with subsequent analysis as per the NHMRC procedure.

The result of analysis may be reported either as Crystalline Silica, composed of the sum of both  $\alpha$ -Quartz and Cristobalite, or as the speciated crystalline components. The same filters may be analysed for Respirable Dusts (including amorphous silica) if these are preweighed and supplied by ALS.

The concentration of Crystalline Silica in air can be calculated using the measured amount on the filter and sample volume. Where sampling is carried out in accordance with AS 2985 by accredited qualified Occupational Hygienists or consultants, results are reported as Respirable. Calculated concentrations can then be compared to TWA exposure limits for risk assessment.

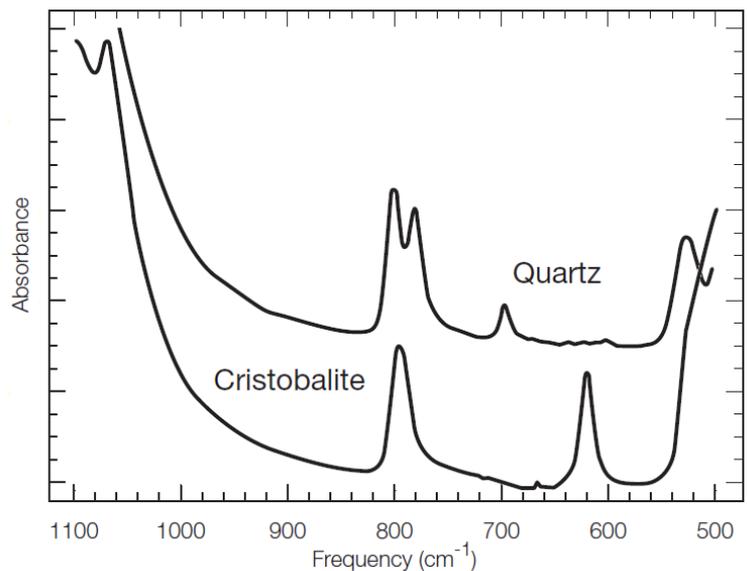


Image 2: Infrared spectra of Quartz and Cristobalite

Ref: MDHS 101

## SUPPLY AND SUBMISSION OF FILTERS

ALS provides uniquely identified, pre-weighed 25mm PVC filters for RCS analysis. Filters may be pre-loaded in client supplied cassettes with filter transport clips or supplied in labelled petri dishes. With prior notice, ALS can also provide certain types of preloaded filter cassettes as required for specific projects. After sampling, filters should be returned to any ALS laboratory in the same labelled container or cassette that they were supplied in.

## REFERENCES

1. National Institute for Occupational Safety and Health (NIOSH), 1998 *Silica...It's Not Just Dust: Silica Dust Causes Silicosis - What rock drillers can do to protect their lungs from silica dust.*
2. SafeWork Australia 2013. *Guidance on the Interpretation of Workplace Exposure Standards for Airborne Contaminants*
3. SafeWork Australia *CRYSTALLINE SILICA - Safe Work Australia Guide | Hazardous Chemicals Requiring Health Monitoring*
4. NHMRC, 1984, *Measurement of Quartz in Respirable Airborne Dust by Infrared Spectroscopy and X-Ray Diffractometry*
5. MDHS101 2005, *Measurement of Quartz in Respirable Airborne Dust by Infrared Spectroscopy and X-Ray Diffractometry*
6. NIOSH 7603 2003, *Quartz in coal mine dust, by IR (redeposition)*

Brisbane, Sydney, Melbourne (Springvale), Perth, Newcastle, Roma, Darwin, Adelaide, Townsville, Mackay, Gladstone, Wollongong, Nowra, Mudgee, Chinchilla, Emerald Water Resources Group: Canberra, Bendigo, Geelong, Melbourne (Scoresby), Wangaratta, Traralgon