

# LCS Laboratory Inc.



## Crystalline Silica, Exposure Assessment and Analysis

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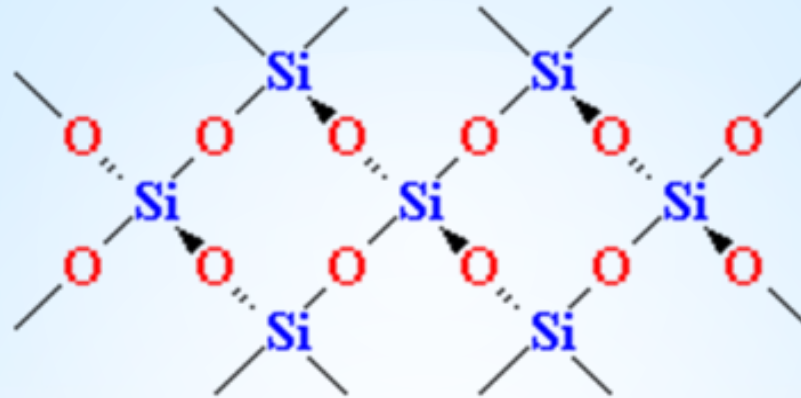
# PRESENTATION OVERVIEW:

- What is silica?
- Chemistry and structure of silica
- Why should we worry about silica exposure?
- Source of crystalline silica
- Routes of exposure to crystalline silica
- Respirable silica exposure limit
- Sampling procedure
- Introduction into chemical analysis



Quartz Cristal

# What is Silica ?



Quartz Sand

- Word “silica” is synonymous with silicon dioxide (**SiO<sub>2</sub>**) - the chemical compound that is composed of one **silicon (Si)** atom and two **oxygen (O)** atoms.
- Silicon and oxygen are the two most abundant elements in the earth’s crust
- Silica – is one of the most common compound in the earth

# Types of Silica

Silica exists in two forms:

**Crystalline silica:**

quartz

tridymite

cristobalite

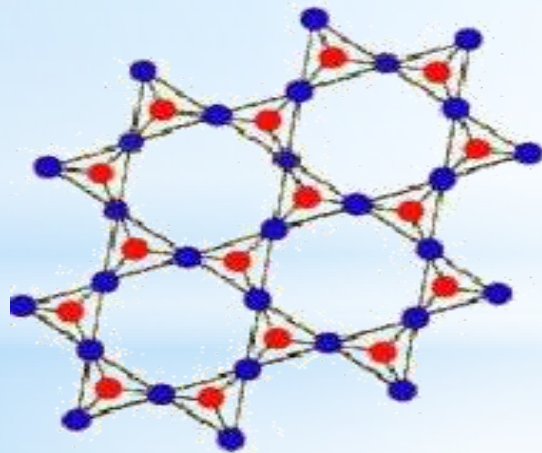
**Non-crystalline Silica:**

diatomaceous earth

diatomite

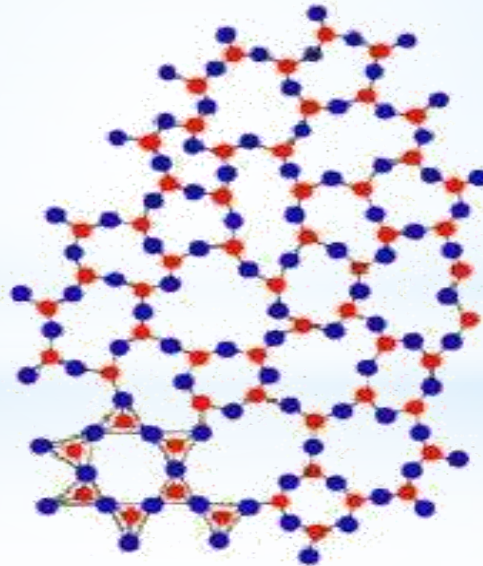
silica gel

**Crystalline SiO<sub>2</sub>**  
**(Quartz)**



● Si ● O

**Amorphous SiO<sub>2</sub>**  
**(Glass)**



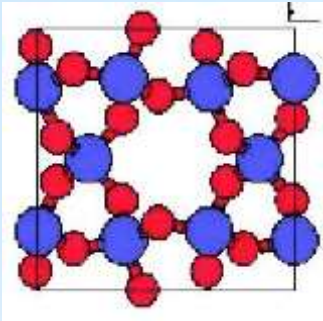
Amorphous silica has the same chemical formula as crystalline silica, but has irregular structure





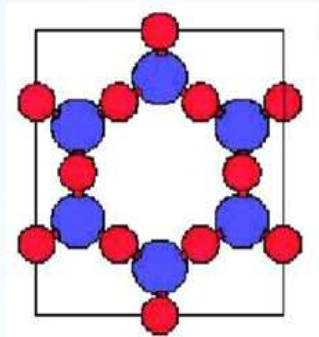
# The relationships between the polymorphic forms of Crystalline Silica

Silica is polymorphic: it can co-exist in different crystalline forms.



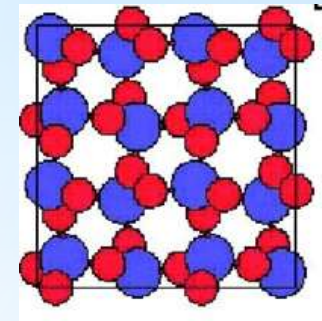
Quartz -  
hexagonal

867 °C



Tridymite -  
rhombohedral

1470 °C



Cristobalite - cubic  
or tetragonal

# Silica may cause silicosis

- Silicosis is lung disease caused by breathing in dust that contains silica particles
- Center for Disease Control (USA), MOL (Ontario), OSHA (USA), and all authorities around the Globe, see Airborn Silica Dust as hazardous to our health
- The damage caused by silica inhalation is permanent and irreversible. Symptoms can take years to develop
- Mechanism of silicosis is not well understood. Possibly:
  - Mechanical blockage of lungs
  - Abnormal hardness of Quartz that causes tissue damage
  - Abnormal inertness, that prevents enzymes from it dissolution and excretion



# Industrial sources of crystalline silica:

- ✓ All construction materials that contain natural sand
  - Concrete
  - Brick
  - Grout and mortar
  - Ceramic and porcelain tiles
- ✓ Granit and Quartz containing minerals
  - Composite materials
  - Aggregate
- ✓ Refractory fibres
- ✓ Refractory bricks
- ✓ Moulding sand



# People do not recognize danger of silica

- “This is just sand and dust”
  - Crystalline silica is chemically inert
  - It is naturally occurring
- Word “Silica” does not sound as alarming as “Lead” or “Asbestos”
- It is not common to label silica products as “carcinogenic”
- Silica can appear from “nowhere”



For example:

- ✓ Burning of agricultural waste or products such as rice hulls may cause amorphous silica or Quartz to become Cristobalite
- ✓ Refractory fibres after years of use at high temperature become Quartz and Cristobalite





# Respirable Crystalline Silica Exposure Limits:

- ✓ **MOL OEL** regulation (O. Reg. 490/09) is:
  - 100  $\mu\text{g}/\text{m}^3$  for Quartz and Tripoli
  - 50  $\mu\text{g}/\text{m}^3$  for Cristobalite
- ✓ **OSHA** Permissible Exposure Limit (PEL) is 50  $\mu\text{g}/\text{m}^3$  of respirable **crystalline silica**, 8-hour average
- **ACGIH** threshold limit value (TLV) is 25  $\mu\text{g}/\text{m}^3$

Silica is always regulated as **Respirable Fraction** and must be collected as Respirable Dust (<10 microns)

# Sampling and Monitoring

- Several standard methods are available: NIOSH (USA), OSHA (USA), and MDHS (UK)
  - All methods use personal sampling pumps
  - All methods use cyclones to separate Respirable Fraction
  - Difference between the methods is in type of filter used, sample preparation and analysis



# LCS Laboratory recommends NIOSH 7602

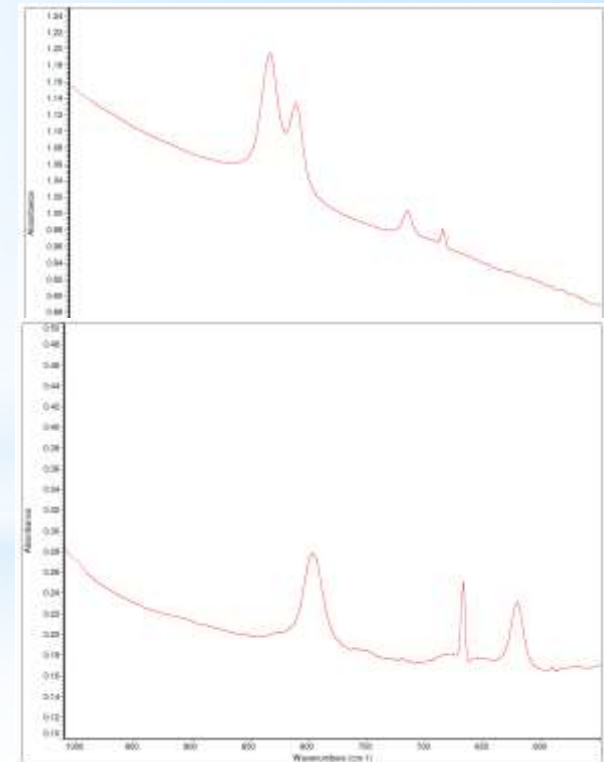
- Samples are collected on 3-piece 37 mm diameter cassette
- Dust is filtrated on PVC membrane with 5 micron pore size
- Respirable fraction of dust is separated with a cyclone
- Air is collected using laboratory calibrated, portable, sampling pump
- Sample can be collected anywhere from 2 to 10 hours
- Sample can be collected as “Personal” or “Area” samples
- Samples should be returned to LCS Lab for analysis.



# How we analyze your sample



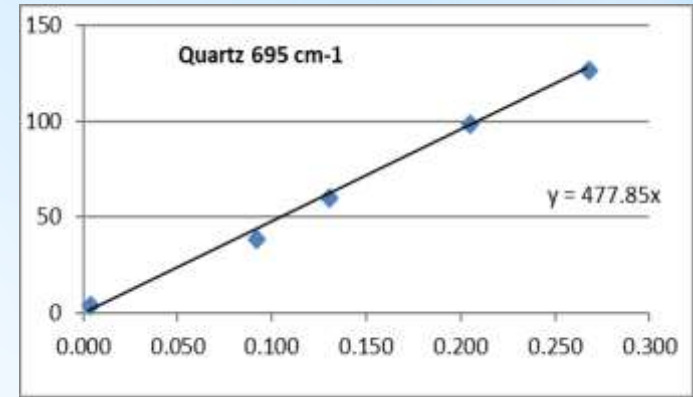
- We extract filter with accumulated dust from the cassette
- We wash the dust to remove alkaline impurities, which may react with quartz and turn it into silicates (glass)
- We ash the filter at 500°C to remove the filter itself and any organic impurities
- We mix the residual dust with potassium bromide, and make 13 mm disks
- We calibrate our instrument with set of Quartz and Cristobalite samples of known concentration





# How we calculate and report the results

- We measure signal at different wavelengths
- We recalculate signal strength into Quartz and Cristobalite concentration in micrograms per sample
- We calculate volume of air that you collected in liters
- We calculate and report you our findings in form of formal certificate of analysis
- The results can be compared against MOL OEL, to see if you are in compliance



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**LCS**  
LABORATORY INC.

**CERTIFICATE OF ANALYSIS**

Client: ABC Mine	Work Order: 16ABC999
Requested by: John Travolta	Date Received: June 30, 2016
Client's reference: ABC 2016	Date Analyzed: July 07, 2016
	Date Reported: July 08, 2016
	Analysis: Quartz, Cristobalite
	Reference Procedure: FT-IR, NIOSH 7602

Results:

Clients Sample ID #	Laboratory Sample ID #	Volume L	Quartz		Cristobalite	
			ug	mg/m <sup>3</sup>	ug	mg/m <sup>3</sup>
16P46-19	16ABC999-1	819	<RL	<0.006	<RL	<0.006
16P46-20	16ABC999-2	1000	12	0.012	5	-
<b>Reporting Limit (RL)</b>			<b>RL=5</b>			
16P46-23blk	16ABC999-3	0	<RL	<0.006	<RL	<0.006

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			ug	mg/m <sup>3</sup>
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16P46-23blk	16ABC999-3	0	<RL	-

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## *We want to work for you*



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