Artificial stone associated silicosis: A rapidly emerging occupational lung disease

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Silica
Silica ($SiO_2$) is a naturally occurring mineral
59% of the earth's crust is silica
Silica is the main constituent of sand and 95% of rocks
Lung disease can occur when workers are exposed to fine silica dust, historically primary source of exposure cutting through naturally occurring silica containing stone
Miners, quarry workers, tunnellers
Silicosis

Silicosis is a scarring disease of the lungs that is frequently progressive, even after leaving work. Early stages of disease there will be no symptoms.

Simple silicosis

As disease progresses more lung tissue becomes irreversibly scarred.

Symptoms of cough, shortness of breath, weight loss.

Complicated silicosis—also known as Progressive Massive Fibrosis.

No treatment for silicosis

Progressively causes more disability and can lead to death

Accelerated Silicosis (= Progressive Massive Fibrosis)

Progressive Massive Fibrosis (PMF): Treatment will depend on severity of illness. Detailed treatment plan will be outlined in the chapter on Silicosis. Based on data from the American Journal of Respiratory and Critical Care Medicine.
Silicosis associated with artificial stone

Over the last 3 years doctors in Australia have identified several workers with severe progressive silicosis associated with working with artificial stone products.

International reports since 2011

Stone benchtop fabricators – kitchen and bathroom benchtops

Workers cut slabs of artificial stone to size and create inserts for sinks, taps and appliances

Case series

7 cases of artificial stone associated silicosis

- All cases presented to doctors due to onset of respiratory symptoms - cough and shortness of breath
- None detected through surveillance
- Lung function decline 20 times more rapidly than expected
- Six with radiological features of progressive massive fibrosis
- One has undergone lung transplantation and others being considered
Artificial (engineered) stone

Various tradenames – CaesarStone, Essa Stone, Silestone, smartstone.
Developed in late 1980s and available in Australia since 2001.
Cheaper than marble
Wider range of colours
Non-porous, scratch and stain resistant
4 times flexural strength and double impact resistance of granite

Source: www.caesarstone.com

Artificial stone production

- Feeding & Mixing: Raw materials are inspected, then fed into mixers and blended together.
- Molding: The mixture is then poured into a mold and formed into slab sizes of 300x144 cm or 12x57 inches.
- Pressing: The slab is then compacted by a special vacuum and vibration process at a pressure of 100 tons.
- Curing: The slabs are moved to the curing kilns and heated to 90°C for 45 minutes which gives them the ultimate strength.
- Polishing: Slabs are then gauged, calibrated and polished to a perfect finish in a wide range of colors and designs in various thicknesses.

Source: www.caesarstone.com
Artificial Stone

<table>
<thead>
<tr>
<th>Approximate crystalline silica content of different materials</th>
<th>Artificial Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandstone</td>
<td>70–90%</td>
</tr>
<tr>
<td>Concrete, mortar</td>
<td>25–70%</td>
</tr>
<tr>
<td>Tile</td>
<td>30–45%</td>
</tr>
<tr>
<td>Granite</td>
<td>20–45%, typically 30%</td>
</tr>
<tr>
<td>Slate</td>
<td>20–40%</td>
</tr>
<tr>
<td>Brick</td>
<td>Up to 30%</td>
</tr>
<tr>
<td>Limestone</td>
<td>2%</td>
</tr>
<tr>
<td>Marble</td>
<td>2%</td>
</tr>
</tbody>
</table>

Dust control measures

Respirable crystalline silica is classified as a hazardous chemical by SafeWork Australia and an occupational carcinogen by International Agency for Research on Cancer. Australian standard for exposure is 0.1mg/m³ 8 hour TWA.

**Due to very high silica content and lack of studies, little known about effectiveness of control measures cutting artificial stone**

Dust control measures include:
- Control dust at source: wet cutting
- Cutting in isolation of workers: automated/robotic cutting
- Ventilation: local exhaust ventilation, use of extraction hoods
- Personal protective equipment: appropriate selection, fit testing, education, maintenance.
Respirable Silica Dust Suppression During Artificial Stone Countertop Cutting
Jared H. Cooper, David L. Johnson* and Margaret L. Phillips

![Diagram](image1)

**Recommended limit:**
- 30 minute exposure: 0.3mg/m³
- Single short term exposure: not to exceed 0.5mg/m³

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Table 2. Respirable silica dust concentrations (mg m⁻³) averaged over nominal 30-min sampling period

<table>
<thead>
<tr>
<th>Replicate</th>
<th>Wetted blade only</th>
<th>Wetted blade + water curtain</th>
<th>Wetted blade + LEV</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.846</td>
<td>2.944</td>
<td>ND³</td>
<td>44.37</td>
</tr>
<tr>
<td>2</td>
<td>2.563</td>
<td>0.920</td>
<td>0.139⁴</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.874</td>
<td>3.405</td>
<td>0.201⁴</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2.209</td>
<td>1.373</td>
<td>0.669</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>4.934</td>
<td>3.813</td>
<td>0.604</td>
<td></td>
</tr>
<tr>
<td>SEM</td>
<td>0.923</td>
<td>1.018</td>
<td>0.225</td>
<td></td>
</tr>
</tbody>
</table>

ND, not detected.
*Measured silica mass from which this concentration was calculated was < LOQ.
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1 A secondary water flow provided a fan shaped water curtain sprayed normal to the path of the ejected stone dust. The secondary flow was shut off during LEV and wetted blade-only trials. The LEV cord was attached only during LEV trials.

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Respirable silica dust particles may not be visible in the air. Only air testing will effectively assess the amount of silica present.

<table>
<thead>
<tr>
<th>Particle Size</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5 - 9.2 microns</td>
<td>Lodge in nose and throat</td>
</tr>
<tr>
<td>3.3 - 5.5 microns</td>
<td>Main breathing passages</td>
</tr>
<tr>
<td>2.0 - 3.3 microns</td>
<td>Small breathing passages</td>
</tr>
<tr>
<td>1.0 - 2.0 microns</td>
<td>Bronchi</td>
</tr>
<tr>
<td>0.3 - 1.0 microns</td>
<td>Air sacs</td>
</tr>
</tbody>
</table>

PM 10 refers to particulate matter that is less than 10 microns in size.

HAZARDOUS CHEMICALS REQUIRING HEALTH MONITORING

CRystalline silica
Health surveillance of silica dust exposed workers

Early stages of silicosis workers will have no symptoms.

Australian Institute of Occupational Hygienists (AIIOH) recommend that health monitoring should be implemented if RCS likely to meet or exceed 0.05 mg/m³ 8 hour TWA.

Employers of silica exposed workers have obligation to arrange health surveillance
- Baseline medical examination
- Annual review with lung function testing performed according to ATS/ERS standards
- Chest x-ray at baseline and at least every 5 years. Reported in accordance with International Labour Organisation (ILO) classification

Artificial stone associated silicosis

Recently identified workers with silicosis are very likely to be tip of iceberg

No knowledge about number of workers exposed in construction and benchtop fabrication industry, and the level of silica dust exposure

Simple, early silicosis has no symptoms and will only be detected by chest x-ray

Workers who are exposed to potentially hazardous levels of silica should be screened to detect early stage disease

Very limited information about effectiveness of dust control measures with artificial stone
- No studies to assess the 8 hour silica dust exposure of workers under normal workplace conditions
- Dry cutting/grinding artificial stone is associated with extremely high silica dust levels
- Silica dust levels at workplaces cutting stone should be routinely measured