Crystallisation - no health risk from exposure to crystalline silica in after use fibre

Some users have expressed concern about possible health effects associated with the crystalline silica, which may be formed when Superwool® fibres are heated to temperatures above 900°C (1652°F). This manual therefore presents a clear answer to these concerns, including the latest research results, which were completed by the Fraunhofer Institute for Experimental Medicine (ITEM) in 2006.

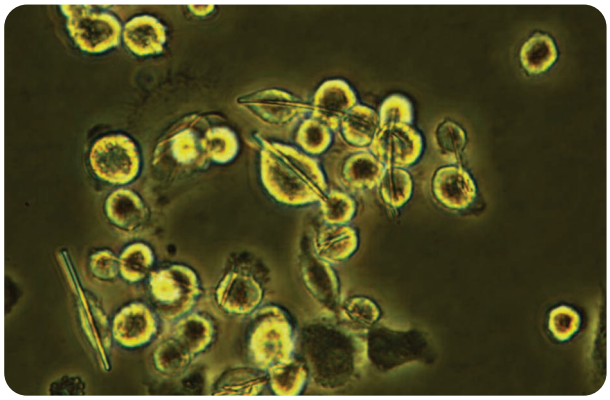
The Fraunhofer results show that Superwool® fibres, when crystallised by heating right up to classification temperature, display no hazardous activity related to any silica they may contain. This result, coupled with the very low crystalline silica exposures measured during furnace maintenance and wrecking, means that there is unlikely to be any risk of crystalline silica related diseases resulting from employment in these activities.

In our everyday lives, all of us are exposed to dusts containing crystalline silica and suffer no ill effects as a result. However, exposure to silica which is fine enough to enter the lung (respirable crystalline silica) has been observed to cause disease in specific industrial situations.

Examples are the silica dust produced during mining, quarrying, stone masonry and sand blasting, which can cause various lung diseases including lung cancer. When vitreous fibres, including both RCF and Superwool®, are heated close to their classification temperature, they will start to crystallise. In this case the components present in the glassy structure may rearrange, allowing various crystalline compounds to form within the fibre.

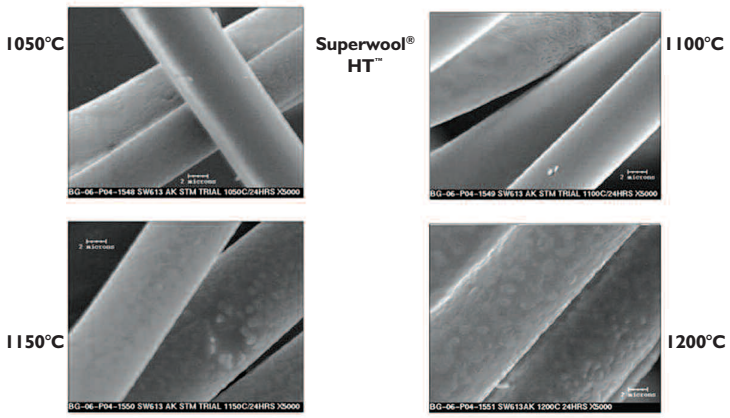
The exact nature of these compounds will depend on the type of fibre and also the temperature cycle that the fibres experienced. Crystalline silica is usually one of the forms produced, but is never the main crystalline form.

In a typical furnace application, devitrification will occur only in the layer nearest to the hot face of the insulation and so the fibres concerned normally represent a small part of the complete furnace lining.



Macrophage cells in contact with Superwool fibres

For this reason, attempts to measure crystalline silica in the air during furnace wrecking often fail, as the levels are too low to be detectable. This information offers some degree of reassurance; however it was the view of Thermal Ceramics that direct testing of heated Superwool® fibres was also necessary to ensure that the dust produced during furnace wrecking did not show any effects similar to those associated with free crystalline silica.



When RCF was tested in animal experiments in the 1980s, the main focus was on the effects of the fibres in their vitreous state. However, the researchers did include a sample of heated (crystallised) RCF to mimic after use fibre.

It was an unexpected but important result that this sample caused fewer lung effects than any other sample tested. A second group of independent scientists in Edinburgh found this sample to be inert when injected into rats[1].

These early results with RCF already gave an indication that crystallised end of life fibres did not constitute a health hazard.

There are ethical and legal reasons for trying to avoid further experimentation on live animals, and so Thermal Ceramics was keen to undertake further tests on Superwool® fibres using proven "in-vitro" techniques. The most reliable technique available was to study the effect of fibrous dust on macrophage cells, of the type which are responsible for clearing the dust from the deepest parts of the lung.

It is well known that toxic forms of crystalline silica have been found both to kill macrophages in-vitro and to cause disease in animals. The investigation chosen therefore was to observe the effect of heated Superwool® fibres on macrophage cells. The experimenters have therefore searched for any effect produced by the Superwool® fibre, which was similar to that produced by toxic crystalline silica.

Such an experiment requires considerable expertise to produce reliable results. For this reason the Fraunhofer ITEM was contracted to design and carry out the macrophage experiments.

Samples of Superwool® 607®, Superwool® 607® Max™ and Superwool® 607® HT™ were heated to 150°C below their classification temperature and also to classification temperature in order to simulate fibres which had been used near the hot face of a furnace insulation. Unheated fibres were also produced as controls.

Suitable samples of each type were then supplied to Fraunhofer ITEM for the experimental programme. Since fibres can also cause damage to cultured cells simply through their shape, it was necessary to use a method to distinguish such non-specific toxicity from the effects of silica. This was accomplished using aluminium lactate. This is a proven compound which binds to silica and renders it non-toxic but has no effect on other activities.

All samples were therefore tested both alone and with a very low concentration of aluminium lactate; the difference in the measured effects between the two samples was then a direct measure of silica activity (see results table). A standard quartz (crystalline silica) sample (DQ12) known to be toxic was used as a reference to verify that the methods worked.

Two measures of toxic activity were used. Firstly, the ability of the fibres to cause the cells to leak was determined by measuring the amount of an enzyme (lactate dehydrogenase) normally found inside the cells that had leaked into the medium outside. Secondly, the amount of DNA (chromosome) damage was measured using an assay in which the number of strand breaks in the DNA from individual cells is quantified. The standard active quartz sample (DQ12) was clearly positive in both these assays; however, none of the heated fibres showed significant silica activity.

We can conclude that heated Superwool® fibres display no hazardous activity related to any silica they may contain. This result, coupled with the very low crystalline silica exposures during furnace maintenance and wrecking, means that there is unlikely to be any risk of crystalline silica related diseases from employment in these activities.

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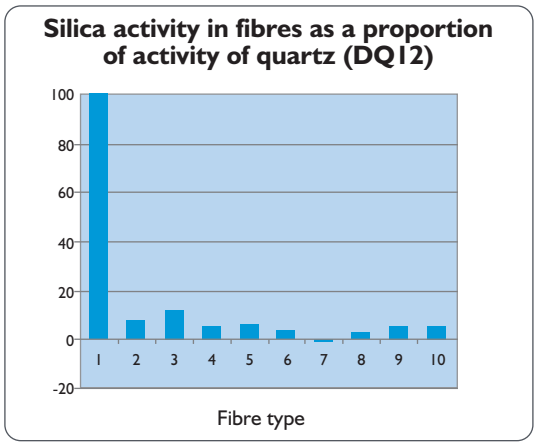
[1] Miller BG, Searl A, Davis JMG, Donaldson K, Cullen RT, Bolton RE, Buchanan D, Soutar CA 1999 Influence of fiber length, dissolution and low biopersistence on the production of mesothelioma in the rat peritoneal cavity Ann Occup Hyg; 43:155-66



Key to results:

1:	DQ12 quartz (Crystalline silica positive control)	
2:	Superwool® 607® & **Plus**	1100°C for 7 days
3:	Superwool® 607® & **Plus**	950°C for 28 days
4:	Superwool® 607® Max™	1050°C for 28 days
5:	Superwool® 607® Max™	1200°C for 7 days
6:	Superwool® 607® HT™	1150°C for 28 days
7:	Superwool® 607® HT™	1300°C for 7 days
8:	Superwool® 607® & **Plus**	unheated
9:	Superwool® 607® Max™	unheated
10:	Superwool® 607® HT™	unheated