Industrial implementation of processes to render RCS safer in manufacturing processes

SILICOAT

Objectives

Crystalline silica is an essential raw material for the production of most of the goods of everyday life. Hence, a vast number of European workers are potentially exposed to Respirable Crystalline Silica (RCS) at their workplace. The ceramics industry is particularly concerned, since its products are based on silicates and include considerable amounts of quartz, which is indispensable for the manufacturing process. Some substances can virtually nullify the toxicity of quartz, by coating RCS particles.

The main objective of the SILICOAT project is the industrial implementation of these substances in the ceramic manufacturing processes, thus transforming the quartz-containing raw materials into intrinsically safe products.

Partnership

PORTUGAL
APICER (SME-AG)

SPAIN
ASCER (SME-AG)
ATOMIZADORA (SME)
PORVASAL (SME)
ITC (RTD)

ITALY
FLAMINIA (SME)
CCB (RTD)

GERMANY
ZIEGEL (SME-AG)
BVKI (SME-AG)
WALKÜRE (SME)
ITEM (RTD)

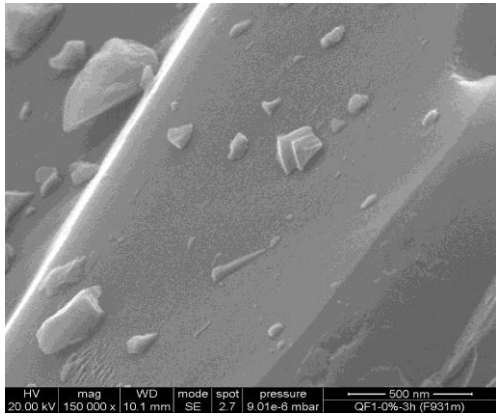
The Consortium gathers 11 partners, including Small and Medium-sized Enterprises (SME), SME Association/Groupings (SME-AG), and Research and Technological Development centres (RTD). The project targets the whole traditional ceramics sector, being represented by SMEs and SME-AGs of 4 of the main European ceramic countries.

Previous studies

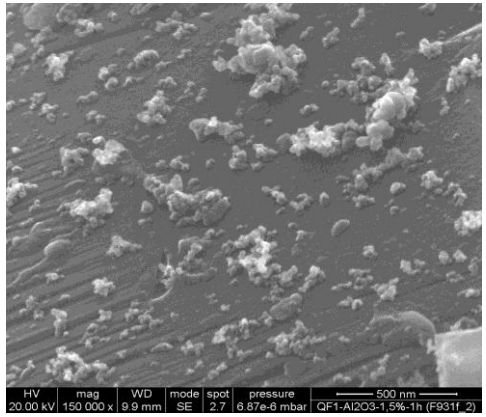
A RCS coating technology was explored for traditional ceramic sectors: red-firing porous wall tile body, porcelain tableware body, vitreous china sanitary ware and raw glaze for porcelain tableware.

With a view to establishing a selection of candidate additives, the following criteria were used: a) The additive should be available in industrial quantities; b) Its current price for large quantities should not exceed 5 €/kg; c) It should not have foreseeable adverse effects on the process.

Some instrumental technologies (TG, SEM, XPS, etc.) were used to define the best coating treatments in terms of coating agents, proportioned quantities and reaction times, in which a balance was sought between coating quality and the cost and ease of implementation in the industry. Two organosilanes with different functional groups were chosen. Nano-alumina was also deemed a possible additive for reducing quartz toxicity.



Original quartz particle surface



Coated quartz particle surface

Full-scale trials

Once the effectiveness of the coatings had been verified, the feasibility of the integration of these treatments in the selected ceramic processes was examined.

Aqueous suspensions are common to many ceramic subsectors and represent the early stages of the ceramic process. These suspensions are ideal media for the dispersion of additives and the subsequent interaction with the quartz particles.

Therefore, the technology needed for coating was quite simple, because it could be incorporated as part of existing processes.

The coating treatment was fully integrated in the current manufacturing processes.

Two coating agents were used in the trials. The influence on the processes conditions and the main final product properties were controlled with satisfactory results.

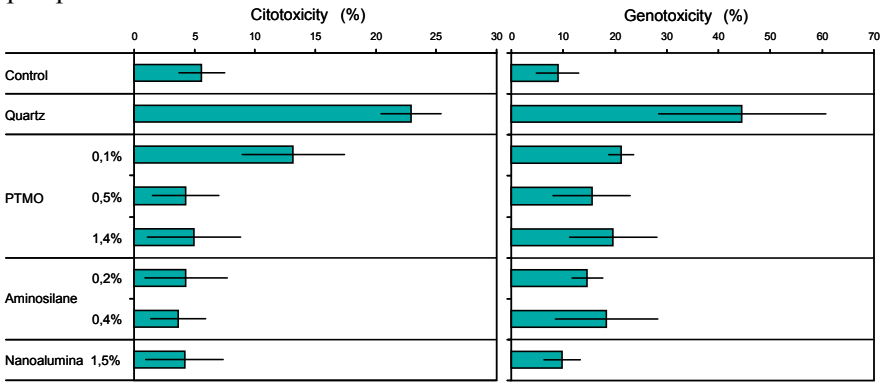
Toxicological effects

In vitro

For characterisation of quartz toxicity lactate dehydrogenase (LDH) and alkaline comet assay analyses were performed (± aluminium lactate, a quencher of quartz toxicity). After screening and identification of the most active quartz the protective efficiency of the coating agent candidates was studied at various concentrations. The coatings resulted in an evident reduction of quartz toxicity.

In vivo

In the rat model *in vitro* results could be validated; in addition, stability of the quartz surface coating under physiological conditions was confirmed for a mid-term perspective.



Economic impact assessment

The cost increment of the coating treatments was calculated, which ranged from 2 to 4 € per ton of composition. For many compositions, this will involve a cost increment of less than 3%.

Conclusions

- A coating process has been developed to render RCS safer.
- Several coating agents have demonstrated their efficiency from the toxicological viewpoint.
- Good results were obtained in industrial trials in different ceramic manufacturing companies.
- The developed process is a promising candidate to be included in the "NEPSI Good practices Guide"