ORGANOSILANE COATING OF QUARTZ PARTICLES BY DRY MIXING

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1. ABSTRACT

Workers in sectors that use quartz can be exposed to respirable crystalline silica (RCS) released during handling of quartz in their workplaces and, in some cases, this exposure could lead to pathologies such as silicosis. It is well known that the toxicity of quartz by RCS is conditioned by the surface chemistry of the quartz particles, especially by the density and abundance of silanol groups (Si-OH). In a previous research project (FP7-SME-2011-285787-SILICOAT) the effectiveness of adding substances such as organosilanes to block silanol groups was proven, and the toxicity of RCS contained in wet-processed raw materials of traditional ceramic industries could be virtually nullified.

The main objective of the SILIFE project (LIFE14 ENV/ES/000238) is the production of commercial quartz powders that show very little or no RCS toxicity, extrapolating the process developed in SILICOAT to other industrial sectors which use quartz in their dry processes. In this document, the main results achieved up to now in the SILIFE project will be shown. First, some industrial quartz powders were dry-mixed with a selection of organosilanes, using a laboratory mixer with good results. The reaction of the silanes with the quartz silanol groups was verified by analytical methods and the coated quartzes proved to be less toxic (by *in vitro* and *in vivo* assays). A pilot plant was then designed and the laboratory results have been satisfactorily reproduced with it. In all the tests performed, the amount of silane anchored to the surface of the quartz particles after treatment in the industrial mixer was similar to that obtained in the laboratory mixer. The next step will be to produce treated quartzes at industrial scale, to verify their behaviour in different industrial sectors.

2. INTRODUCTION

Project SILICOAT (FP7-SME-2011-285787) probed the effectiveness of adding substances like nanoalumina or organosilanes to block the silanol groups present on the surface of the quartz particles, virtually nullifying the toxicity of the RCS contained in the wet-processed raw materials of traditional ceramic industries.

The ongoing project (SILIFE) extrapolates this technology to the production of coated quartz powder by a dry method, to prevent the exposure to toxic RCS in industrial sectors where there is no wet stage.

3. PRELIMINARY RESULTS

3.1. DRY COATING VERSUS WET COATING

Some industrial quartz powders were dry-mixed with a selection of organosilanes, using a laboratory mixer (Figure 1) with good results. The reaction of the silanes with the quartz silanol groups was verified by analytical methods, proving that the coating effectiveness of wet and dry coating is similar (Figure 2).

Figure 1. *Silane feeding and shear plow mixer*

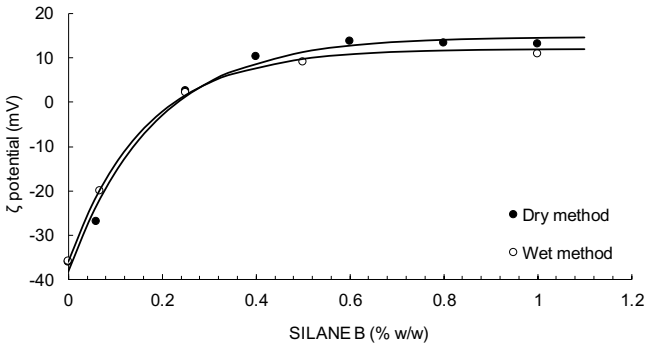

Figure 2. *Comparison between wet and dry coating process*

3.2. TOXICOLOGICAL ASSESSMENT

The toxicity of coated quartzes has been assessed by means of "in vitro" and "in vivo" tests. As an example, the reduction of the toxicity of two quartzes (Q1 and Q2) after being coated with some silanes in different proportions is shown in Figure 3.

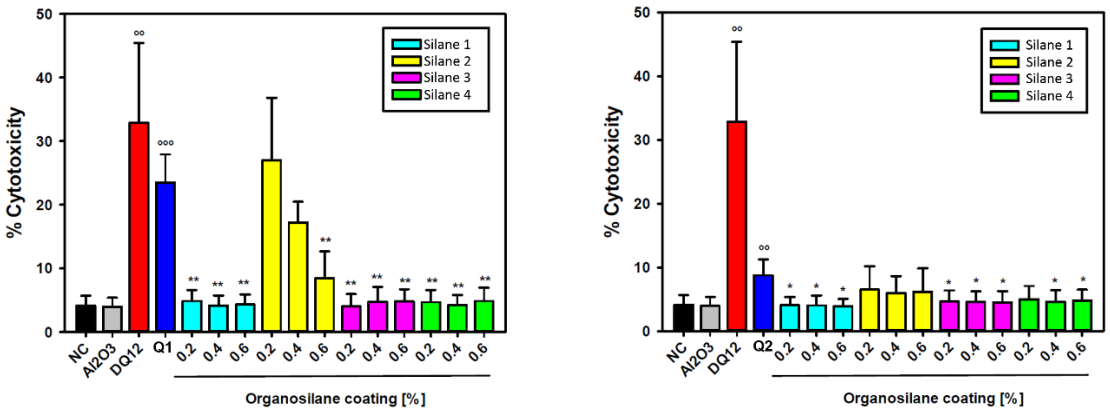

Figure 3. *Effect of the silane coatings on quartzes (Q1 and Q2) with different toxicity (in vitro LDH assay). Al_2O_3 is used as negative control and DQ12 as positive control.*

3.3. SCALING UP DRY COATING TECHNOLOGY

After these promising results, a pilot plant (Figure 4) was designed to produce higher quantities of coated quartz. The laboratory results have been satisfactorily reproduced with it in all the tests performed.

The amount of silane anchored to the surface of the quartz particles after treatment in the industrial mixer was similar to that obtained in the laboratory mixer (Figure 5).

Figure 4*. Pilot plant mixer*

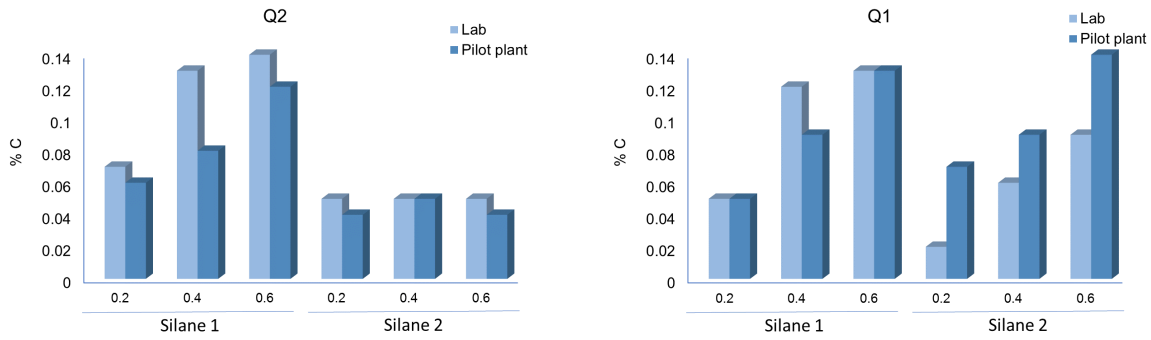

Figure 5. *Comparison between lab and pilot scale coating effectiveness.*

4. SUBSEQUENT ACTIONS: INDUSTRIAL VALIDATION

The pilot plant has been installed in the quartz processor's plant, where quartzes used by the end users involved will be treated to verify them by performing industrial trials in different sectors involved in the project (Figure 6).

Figure 6. *Sectors involved in the SILIFE project where the coated quartzes will be tested.*

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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