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Nearly free surface silanols: from silica towards a new paradigm for particle toxicity

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Respirable crystalline silica (RCS) is the leading cause of occupational respiratory diseases worldwide. RCS is associated with inflammatory lung reactions, which can lead to silicosis, cancer, and autoimmune diseases. The extreme variability of silica specimens, including its amorphous forms, the surface heterogeneity, and variable toxicity effects, generated one of the most intriguing enigmas in particle toxicology, i.e., deciphering which physico-chemical features explain and predict the variable hazard of silica.

Using a set of ad hoc prepared synthetic and natural quartz particles, we have identified a unique subfamily of surface silanols as a key initiator of the toxicity of silica particles. These moieties, namely the "nearly-free silanols" (NFS), appear on the surface of quartz when crystals are fractured, and their amount can be modulated by physico-chemical processes. The peculiar spatial arrangement of NFS was demonstrated as the most energetically favorable and selective for interacting zwitterionic phospholipids that make up cell membranes. The toxic activity of NFS was also confirmed with amorphous nanosilica synthesized at high temperatures, and our recent findings suggest that NFS could impart toxic properties to other silica polymorphs and hydroxylated surfaces, including aluminosilicates and engineered stones. Overall, NFS occurrence accounts for the origin and variability of the toxicity of silica, opening perspectives for controlling RCS hazard, and may contribute to understand other important interfacial phenomena of hydroxylated materials.

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Biography

Dr. Cristina Pavan is postdoctoral research fellow at the Department of Chemistry and “G. Scansetti” Interdepartmental Centre for Studies on Asbestos and Other Toxic Particulates, University of Turin (Italy), and Scientific Collaborator at the Institute of Experimental and Clinical Research (IREC), Université catholique de Louvain (Belgium). She graduated in Drug Chemistry and Technology in 2012 and obtained a PhD degree in Pharmaceutical and Biomolecular Sciences at the University of Turin in 2016, under the supervision of Prof. Bice Fubini. She has been visiting student at the University College Dublin (Ireland) and postdoctoral researcher for three years at the Louvain Centre for Toxicology and Applied Pharmacology, Université catholique de Louvain, under the supervision of Prof. Dominique Lison. Her research interests concern the surface/interfacial chemistry regulating the interactions of inorganic solids with biological systems.

