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Doctoral dissertation: **A study of the interaction of dusts containing metals and their compounds, present in the working environment, with a model pulmonary surfactant**

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Abstract

The aim of the study was to identify physicochemical phenomena that accompany the interaction of dusts containing metals and their compounds, which are present in the working environment, with a model pulmonary surfactant.

Dusts emitted at workstations for cutting, grinding and melting metal parts were studied. Also studied were aluminum silicate nanopowders dispensed during the mixing of components of polymer nanocomposites at a workstation for mechanical homogenization. Samples of dusts emitted during metal working were collected and then separated into three fractions at a custom-built test stand for generating dust.

Identification of dust involved microscopic analysis, measurement of specific surface area, analysis of particle size distribution, gravimetric analysis and chemical analysis in terms of metal content in the samples.

The study investigated (a) the impact of dust collected at workstations on the surface activity of a model pulmonary surfactant under conditions simulating processes in the alveoli during a respiratory cycle and (b) surface properties of a monolayer of the main lipid component of a pulmonary surfactant, i.e., DPPC, during isothermal compression in the presence of the dust particles under study. The experiments were conducted at different concentrations of dusts determined on the basis of a new methodology for calculating the concentration of dust in a model pulmonary surfactant in relation to the concentration of dust in the air inhaled at the workstation and the size of dust particles.

The study showed that all of the tested dusts influenced the surface properties of the model pulmonary surfactant and DPPC. Dust particles from workstations for cutting, grinding and melting metal parts, and aluminosilicate nanoparticles without surface modification from a workstation for mechanical homogenization of polymer nanocomposites weakened the surface activity of the model pulmonary surfactant. The surface-modified nanoparticles of aluminosilicates reinforced the surface-active effects in the tested systems. Nanoparticles of bentonite and montmorillonite surface-modified with an addition of octadecylamine, which

had the highest surface area in their groups, had a particularly great impact on changes in the surface properties of the model pulmonary surfactant. The dust particles affected the organization of surfactant molecules on the interfacial surface and the rheological properties (compressibility) of the interface. These changes were particularly evident for the nanoparticles of the dust collected at the workstation for mechanical homogenization of polymer nanocomposites. They depended on the type and the concentration of nanoparticles, their specific surface area, and the presence and type of the surface-modifying agent. The results of the experiments were used in presenting and explaining the physicochemical mechanism of the interaction of the dusts with a model pulmonary surfactant.

The results of this dissertation demonstrate the usefulness of dynamic tensiometry methods in studying the surface activity of a pulmonary surfactant. It is possible to alter the surface-active properties of a pulmonary surfactant contaminated (while breathing) with dust particles containing metals and their compounds. This dissertation adds to the knowledge on the influence of dusts in the working environment on the human respiratory system. The proposed solutions can be used to assess the impact of other factors on a pulmonary surfactant; they contribute to an improvement of occupational safety and health and, thus, to a reduction in the incidence of occupational diseases among workers exposed to dust particles.