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Computational simulation of the lung doses of air-borne fine and ultrafine particles inhaled by humans at industrial workplaces

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Title:

Computational Simulation of the Lung Doses of Air-borne Fine and Ultrafine Particles Inhaled by Humans at Industrial Workplaces

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ABSTRACT

This study correlates computational predictions with in-vivo experimental results of inhaled fine and ultrafine particulate matters (PMs) transport, dissemination, and deposition in the human respiratory airways. Epidemiological studies suggest that workplace exposure of anthropogenic pollutant PMs as a risk factor for increased susceptibility to acute broncho-pulmonary infections. However, investigations on detailed human inhalation and PM transport processes are restrictive from time, cost, and ethical perspectives. To overcome this problem, computational simulation of particle deposition based on the Multiple Path Particle Dosimetry (MPPD) model was employed. Here, the physical, mechanical, and electrical properties of PMs of carbon black and nanoparticles from wire-cut electrical discharge machining (WEDM), with mass median aerodynamic diameter in the range of 1 to 2500 nm were used as input parameters of MPPD. Additionally, it mimicked occupational workers oronasal - combinational of nose and mouth breathing exposure. The deposition results were compared with several *in vivo* experimental data reported in literature; and satisfactory agreements were found. For example, total lung dose of carbon black PMs of 100 nm size is the highest (28%) while 450 nm size is the lowest (14%). Then, the deposition again increases with particle size and reaches 21% for 1000 nm (1.0 μm). In case of WEDM nanoparticles, 98% of all 1.0 nm inhaled particles deposit or retain the lung. Thereafter, deposition dose decreases with the particle size and it reaches up to 28% for 100 nm size, a similar pattern that has shown by carbon black PMs.

Key Words or Tags: ultrafine particle, aerosol, mice, inhalation, aerodynamic size, electrical charge

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