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Aerosolization System for Experimental Inhalation Studies of Carbon-Based Nanomaterials.

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Abstract:
Assessing the human health risks associated with engineered nanomaterials is challenging because of the wide range of plausible exposure scenarios. While exposure to nanomaterials may occur through a number of pathways, inhalation is likely one of the most significant potential routes of exposure in industrial settings. An aerosolization system was developed to administer carbon nanomaterials from a dry bulk medium into airborne particles for delivery into a nose-only inhalation system. Utilization of a cannula-based feed system, diamond-coated wheel, aerosolization chamber, and krypton-85 source allows for delivery of otherwise difficult to produce respirable-sized particles. The particle size distribution (aerodynamic and actual) and morphology were characterized for different aerosolized carbon-based nanomaterials (e.g., single-walled carbon nanotubes and ultrafine carbon black). Airborne particles represented a range of size and morphological characteristics, all of which were agglomerated particles spanning in actual size from the nanosize range (<0.1 μm) to sizes greater than 5 and 10 μm for the particle's largest dimension. At a mass concentration of 1000 μg/m3, the size distribution as measured by the inertial impactor ranged from 1.3 to 1.7 μm with a σ_g between 1.2 and 1.4 for all nanomaterial types. Because the aerodynamic size distribution is similar across different particle types, this system offers an opportunity to explore mechanisms by which different nanomaterial physicochemical characteristics impart different health effects while theoretically maintaining comparable deposition patterns in the lungs. This sys- Received 25 August 2010; accepted 30 March 2011. Research was funded by NIH grants RC1 ES018232 and U01ES020127, US EPA Star grants R831714, R832414, and R82215, NIOSH grant 0H07550, and Student Fellowship from the University of California Toxic Substances Research and Teaching Program of the University of California, Davis. We acknowledge the laboratory of Dr. Alexandra Navrotsky and the Nanomaterials in the Enviornment, Agriculture and Technology (NEAT) Organized Research Unit at the University of California, Davis for graciously providing the BET analysis of nanomaterials used in this study. Address correspondence to Amy K. Madl, Center for Health and the Environment, University of California, One Shields Avenue, Davis, California 95616, USA. E-mail: akmadl@ucdavis.edu tem utilizes relatively small amounts of dry material (<0.05 g/h), which may be beneficial when working with limited quantity or costly nanomaterials.