Comprehensive Characterization Strategies for Ultrafine Particles: Lessons from Beryllium Health and Safety Studies.

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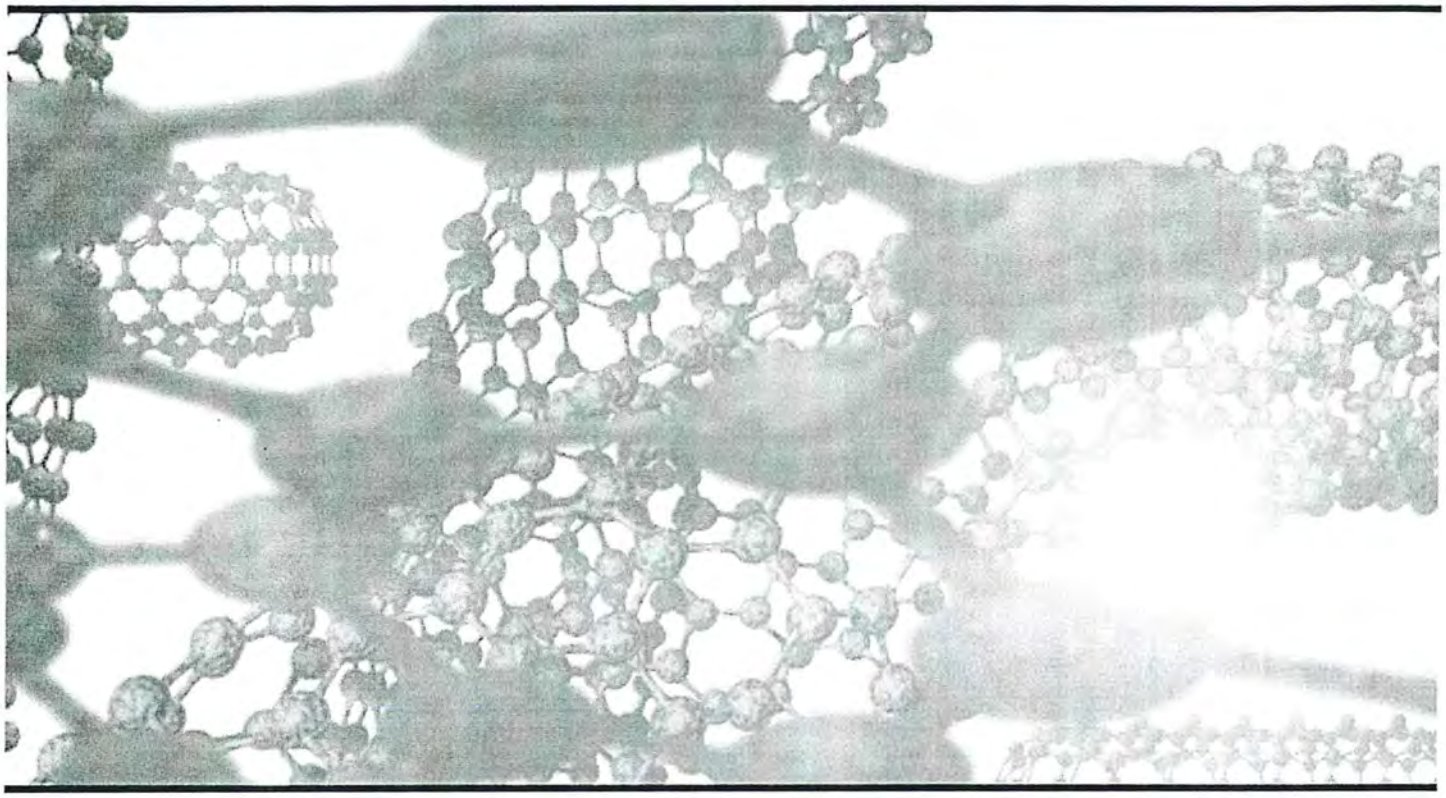
Information on the physicochemical and bioavailability properties of nanoparticles is needed to help identify appropriate metrics of exposure (e.g., airborne mass, particle size, surface area, and/or chemical composition) for protecting worker health. Knowledge of appropriate exposure metrics would aid in developing exposure limits based on bioavailability through the inhalation and dermal routes of exposure. Thus, a suite of standard analytical techniques for characterization of properties of nanoparticles would be of value. Experience from studies of ultrafine beryllium aerosols demonstrate the capabilities and limitations of physicochemical and bioavailability characterization techniques as well as practical considerations for analysis.

Traditional analytical techniques and methodologies for ultrafine particles (e.g., microscopy, electron and x-ray analyses, surface area, and spectroscopy) are applicable for nanoparticles. Care must be taken to ensure that particle properties measured in the laboratory are representative of the particle properties in their native environment. These considerations would include the type of test (destructive or nondestructive), and influence of sample preparation (heating, drying, etc.) and analysis (e.g., beam probe-particle interaction) on the particle sample.

Appropriate cell-free in vitro models are needed to study bioavailability of a material in a target biological compartment. Standard dissolution solvents include serum ultrafiltrate (SUF), a simulant of extracellular lung fluid having neutral pH; artificial sweat, a simulant of skin surface fluid having pH 6.5; and phagolysosomal simulant fluid (PSF), a simulant of the macrophage phagolysosome having pH 4.5. Traditional dissolution techniques, e.g., static, flow-through, etc. are applicable for nanoparticles. Note that use of membrane filters having pore sizes of 0.025 μm or greater to separate the particle sample from the dissolution solvent in these techniques may not always be feasible for nanoparticles. Thus, alternative approaches to preventing solid material from migrating into the solvent to bias dissolved mass measurements may be needed, e.g., isolating via centrifugation, ultrafiltration, or using density gradient separation.

Nanomaterials

a risk to health at work?



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