NANOTECHNOLOGY AN EMERGING INDUSTRIAL HYGIENE ISSUE

APPLICATION NOTE ITI-098

Occupational health risk associated with nanoparticle exposure is a hot topic in industrial hygiene today. Health agencies and leading technology companies are extremely concerned about worker-related health risks and potential legal liabilities that may ensue from worker exposure to such nanoparticles. At this time, there are no government regulations or workplace exposure limits that exist for exposure to nanoparticles.

A June 2004 article posted on the NIOSH web site, states that in 2000 in the U.S. an estimated 2 million workers were exposed to nanometer diameter particles on a regular basis. It estimated that an additional 2 million workers will be required globally within the nanotechnology-related industries in order to meet predicted demand for products over the next decade.

The British Health and Safety Executive (HSE), the equivalent of Federal OSHA, published a report titled *Nanoparticles: An Occupational Hygiene Review* (Oct. 11, 2004). HSE estimates that there are currently 2000 people working in British universities and private sectors that may be exposed to nanoparticles. HSE expects that number to double in the next 5 years. In addition, HSE estimates that more than one million workers in the U.K. may be exposed to ultrafine particles through various jobs such as welding and refining.

There is no doubt that the nanotechnology industry and hence nanoparticle exposure is an emerging issue for industrial hygienists today. The occupational health risks associated with manufacturing and using nanomaterials are not clearly understood. Many nanomaterials are formed from nanoparticles that are initially produced as aerosols or colloidal suspensions. Researchers have found that matter at this tiny scale often behaves very differently. Nanomaterials pay little heed to Newtonian Physics and physical chemistry and exhibit startling new properties. Exposure to these nanomaterials may occur through inhalation, dermal contact and ingestion. Traditionally, workplace aerosol exposure limits are based on mass per unit volume (e. g., mg/m^3 or $\mu g/m^3$). However, a growing number of experts argue that the surface area of nanoparticles should be measured instead of their mass because nanoparticles have far greater surface area as the same mass of larger particles. Greater particle surface area increases the chance the particle may react with other chemicals in the body or target areas. As a result, a need has arisen to assess workplace conditions and personal exposure based on the measurement of nanoparticle surface area.

Soon Industrial Hygienists will be called upon to anticipate, recognize, evaluate, measure and control nanotechnology applications. TSI currently has instruments that measure nanoparticle surface area, particle count and size distribution. For additional information on this emerging industrial hygiene issue contact TSI Customer Service at 1-800-874-2811; by e-mail: answers@tsi.com or by going to our website at www.tsi.com .

For more information on nanoparticle health investigations, a list of selected publications is shown below:

1) Donaldson, K. *et al.* Ultrafine (Nanometer) Particle Mediated Lung Injury, *J. Aerosol Science* 29(5/6):553-560 (1998).

2) Lam C.W. *et al*. Pulmonary toxicity of single-wall carbon nanotubes in mice 7 and 90 days after intratracheal instillation, *Toxicological Sciences* 77 (1): 126-134 (2004).

3) Li N. *et al.* Ultrafine particulate pollutants induce oxidative stress and mitochondrial damage, *Environmental Health Perspectives* 111:455-460 (2003).

4) Nemmar A. *et al.* Passage of inhaled particles into the blood circulation in humans, *Circulation* 105:411-414 (2002).

5) Oberdörster E. Manufactured nanomaterials (Fullerenes, C-60) induce oxidative stress in the brain of juvenile largemouth bass, *Environmental Health perspectives* 112 (10): 1058-1062 (2004).

6) Oberdörster G. Pulmonary effects of inhaled ultrafine particles. International Archives of Occupational and Environmental Health 74:1-8 (2001).

7) Oberdörster, G. Significance of Particle Parameters in the Evaluation of Exposure-Dose-Response Relationships of Inhaled Particles, *Particulate Science and Technology* 14(2):135-151 (1996).

8) Oberdörster, G. *et al* Association of particulate air pollution and acute mortality: involvement of ultrafine particles? *Inhalation Toxicology* 7:111-124 (1995).

9) Penttinen P. *et al.* Number concentration and size of particles in urban air: effects on spirometric lung function in adult asthmatic subjects, *Environmental Health Perspectives* 109:319-323 (2001).

10) Shanbhag, A. S. *et al.* Macrophage/Particle Interactions: Effect of Size, Composition and Surface Area, *Journal of Biomedical Materials Research* 28(1):81-90 (1994).

11) Utell M.J. *et al*. Acute health effects of ambient air pollution: the ultrafine particle hypothesis. *Journal of Aerosol Medicine* 13:355-359 (2000).

12) Warheit D. B. *et al.* Comparative Pulmonary Toxicity Assessment of Single-wall Carbon Nanotubes in Rats, *Toxicological Sciences* 77 (1): 117-125 (2004).

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