# Understanding and Monitoring Nanoparticles

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*The Ultimate Measurements*

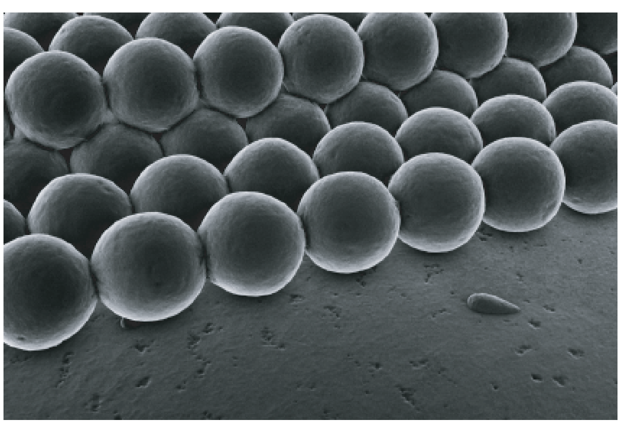
## Application Note

One of the most significant technological advances in modern manufacturing has been the development of nanotechnology. In fact, many people refer to nanotechnology as the next industrial revolution. In today's world, engineered nanomaterials are not science-fiction. They are a very real and are being used to enhance the properties and performance of many industrial and consumer products from paint, electronics, medical devices, and drugs to toothpaste and bowling balls. Even if an industrial facility does not manufacture the source nanomaterial, chances are they will have some nano-enabled products on site.

Through nanotechnology, scientists can manipulate material at the atomic level to produce products with unique applications and properties. But these nanoparticles may also produce unique health effects still being studied by health professionals.

So what exactly is a nanoparticle and why are they becoming an increasing health concern?

A nanoparticle is an extremely small particle. In order to be considered nano-sized a particle must have at least one dimension between 1 and 100 nanometers (0.001-0.1 microns). To put this into perspective consider the diameter of a human hair; usually between 17 and 180 microns1. The largest nanoparticle is 170 times smaller in diameter than a 17 micron human hair. Because of their size nanoparticles don't behave like a liquid or a solid, they diffuse like a vapor or gas.



Because of these physical properties, nanoparticles are dangerous to humans. Nanoparticles have a greater surface area than larger particles (to illustrate this, picture a block of ice, than picture the same block of ice crushed into tiny pieces). Because of this greater surface area the nano-sized particles cause greater lung inflammation and other toxic effects that a larger sized particle of the same material. They also may be able to circumvent the human body's natural defenses and be distributed to various organs because of their small size. Once inhaled into the lungs the nanoparticles can travel to the brain, heart or vasculature causing toxicological effects.

Because nanoparticles are such a new technology, guidelines and regulations for exposure limits are currently very limited. Currently NIOSH has published exposure limits for carbon nanotubes and nanofibers and nano-sized titanium dioxide. The NIOSH Nanotechnology Research Center (Cincinnati, OH) is partnering with industrial facilities throughout the country to study the effects of nanoparticles so they can develop recommended exposure limits for more compounds in the nano-size range. In the absence of specific exposure limits NIOSH suggests a safety factor of 10 be applied to existing exposure limits when dealing with nano-sized materials. You can read more information online at www.cdc.gov/niosh/topics/nanotech/safenano.

Air sampling is the primary way to monitor the release of nanoparticles into the air and to assess the effectiveness of control measures. Particle counters are particularly useful in that they provide an instantaneous readout of airborne particles of a designated size range. NIOSH and other health and other professionals are using particle counters to display the amount of nano-sized particles present at various work processes. This data can then be compared to background levels in control zones to determine if the amount of nanoparticles released are at an acceptable level.

If elevated counts are detected the particle counter can help pinpoint the source or activity that's generating the particles and can then determine if implemented control measures have been effective in reducing exposure to the nanoparticles. Aside from safety concerns there is also an element of waste prevention involved in monitoring nanoparticles. Because they are expensive to manufacture it is desirable to ensure the particles are not escaping from the production process into the work environment.

Particles counts should be taken at several areas to determine the background level of particulates before measuring at the source of the nanoparticles. Samples should be taken with the materials at rest and then again during the material processing or handling procedures. It is important to note that in additional to airborne nanoparticles from engineered nanomaterials on-site, exposures to incidental nanoparticles can result from combustion activities such as welding and the nanoparticles can be circulated by the ventilation system.

Condensation particle counters (CPCs) are the primary tool for measurement of nanoparticles as they can detect particles as small as 15 nm and as large as 1 um. Traditional optical particle counters (OPCs) are also useful tools for nanoparticle studies as they can detect larger agglomerated nanoparticles not seen with the CPC.

Handheld CPC Model 3800

To further characterize nanoparticle exposures, NIOSH recommends supplementing data from particle counters with traditional industrial hygiene filter sampling with lab analysis. Qualified laboratories can provide detailed information on size, morphology, and elemental analysis on filter samples for nanoparticles. For specific details of this procedure please refer to DHHS (NIOSH) Publication No. 2009-125 March 2009

Kanomax's Model 3800 condensation particle counter is an excellent tool for this. It can measure particles from 0.015 to 1 micron up to concentrations of 100,000 particles per cubic centimeter. With multiple ways to measure (repeat, program, or real-time count) and the capability to store up to 10,000 records the instrument is a great choice for nanoparticle applications. A USB interface and included software make it easy to store and analyze your data.

Once you've identified a problem with elevated nano levels, filter sampling and lab analysis can provide further information about the particles. The good news is that traditional controls can be effective in mitigating or stopping the release of nanoparticles. These include: local exhaust ventilation, laminar flow hoods, HEPA filters, glove boxes, etc.

1 Ley, Brian (1999), "Diameter of a Human Hair".Archived from the original on 2010-06-28.Retrieved 2010-06-28.

2 DHHS (NIOSH) Publication No. 2009-125 March 2009

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