Nanoparticle powders are dusty and their addition to paint, lacquer and plaster can change the concentration of sanding dust

The potential level of exposure to dust of manufactured nanoparticles varies considerably depending on the type of nanoparticle powder handled in the production. Addition of nanoparticles to paint, lacquer and plaster may change the amount of dust particles generated during sanding of these materials. In contrast, the particle-size distribution of the sanding dust rarely changes.

Manufactured nanoparticles are already added to paints, lacquers and plasters, because they can improve the products in different ways. For example, nanoparticles can make the products water repellent as well as increase their scratch resistance and durability. The paint and lacquer industry is one of the industries with increasing use of nanoparticles in the production.

There is evidence that inhalation of some nanoparticles cause adverse health effects including inflammation and DNA damage in mice. The handling of nanoparticles can therefore potentially pose a health problem for both professionals and non-professionals who produce, apply, or mechanically modify materials containing nanoparticles.

Scientists from the National Research Centre for the Working Environment in Denmark have studied:

- the extent to which employees may be exposed to dust containing engineered nanoparticles while handling their powders in production of paints and lacquers
- whether there is a difference between particle size distributions and the concentrations of sanding released during sanding of paints, lacquers and plaster with or without manufactured nanoparticles.

Exposure potential of manufactured nanoparticle powders

Seven different types of manufactured nanoparticle powders were selected in collaboration with the Danish Paint and Adhesives Industry. Four of these (RDI-S, UV Titan L 181, ASP-90, and Flammrüss 101) were powders and tested for their dustiness using a miniaturized EN15051 rotating drum dustiness tester. Testing of both single-drop and one minute rotating drum testing (33 drops) were conducted during online monitoring of the particle concentrations and size distributions in the dust. The inhalable dust was collected on a filter in order to determine the dustiness index for each powder (mg dust/kg powder). The dustiness index is a simple measure of the ability of the powder to generate dust. Consequently, the potential occupational exposure level increases with increasing dustiness index.

Big difference in the dustiness of nanoparticle powders

The results show that:

- UV-Titan L 181 (anatase) has a very high dustiness index of 6.728 mg/kg
- Flammrüss 101 (carbon black) has a low dustiness index of 401 mg/kg
- RDI-S (pigment rutile) and ASP G90 (kaolinite) have very low dustiness indices of 97 mg/kg and 185 mg/kg, respectively
- The tested nanoparticle powders quickly deliver their dust as they had almost the same dustiness index in the single-drop and rotating drum testing
- The dust particles from nanoparticle powders were very fine with the highest concentration in the size range between 100 and 500 nm.
Thus, the possibility of being exposed to the fine dust with nanoparticles varies from very low to very high, depending on the specific powders. Furthermore, the highest concentration of particles is in the particle size range where most mechanical filters have the lowest particle collection efficiency. This should be noted in relation to the choice of respiratory protection equipments in the working environment.

Analysis of dust
The researchers also analysed the formation of dust from thirteen different products with and without nanoparticles
- PVA paint (polyvinyl acetate) – three versions containing nanoparticles and a reference
- acrylic paint for indoor use – two versions containing nanoparticles and a reference
- acrylic paint for outdoor use – a version containing nanoparticles and a reference

Seven different nanoparticles were used in the thirteen products. The Danish Paint and Adhesives Industries produced all of the products, applied them onto wooden boards and delivered the boards to the NRCWE for further investigation. The researchers sanded each product using a handheld orbital sander. During sanding, the particle number concentration and size distribution in the dust was measured in a flow-through mixing chamber. Electron microscopy was used to examine the particles from the sanding dust from each of the thirteen products.

No clear difference between sanding dust with or without added nanoparticles
The results show that
- by number, most of the particles in the sanding dust were between 100-300 nm in size
- most of the dust mass and surface area is present in the particles coarser than 1 µm
- the dust contained five different size modes – three particles modes smaller than 1 µm, and two micron-size modes at approx. 1 and 2 µm
- the number of particles in the five size modes varied greatly from product to product, but there were no systematics in the change induced by addition of nanoparticles to the product
- the average diameter of the five size modes varied only slightly in sanding dust from nanoparticle products as compared to reference products.

The results suggest that the size distribution of airborne dust rarely changes when adding nanoparticles to paint, lacquer and plaster. However, the amount of dust generated may change. Hence, the results suggest that the type of paint, lacquer or plaster, i.e. the matrix material is a stronger determinant for the size distribution of sanding dust, whereas addition of manufactured nanoparticles (particle plaster) may affect the amount of dust.

Research project behind the results
- The results originate from the research project ‘Nanoparticles in the paint industry. Exposure and toxic properties – NANOKEM’.
- The study was conducted by researchers from the The National Research Centre for the Working Environment and University of Copenhagen.
- The Working Environment Research Fund supported the project financially.