Working in the nanoworld: who knows who is exposed?

Manufacture of and with nanomaterials is a growing industry. Workers run a risk of exposure at some stage in the production of nanomaterials, but more so in the manufacture of products that include nanomaterials, and in the transport, storage or treatment of waste. The lack of detailed, robust data to identify exposed workers at all points in the production chain is a real obstacle to risk prevention.

Aída Maria Ponce Del Castillo
ETUI

It is not known how many industries use nanotechnologies, which makes it hard to say how many workers may be in contact with nanomaterials. As things stand, there is no detailed picture of the state of workers' exposure, but it is bound to increase in the years ahead as nano-developments increase. A reasonable idea of the numbers of workers involved would be helpful in developing specific risk assessments for nanotechnologies.

A few countries have put out figures, which have been published in the reports briefly reviewed here; but the data presented below only gives an approximate picture of the potential scenario in these countries. This article aims to show how scant the information on worker exposure is, and how more detailed information is urgently needed.

The big risk of exposure to nano-materials, according to the literature review produced by the European Agency for Safety and Health at Work (EU-OSHA), is concentrated in construction, health care, energy conversion and use, the automobile and aerospace industry, chemical industry, textiles, defence, manufacturing of instruments and tools, as well as in electronics and communications[1].

International research done by the University of California for the International Council on Nanotechnology[2] has collected information on the number and locations of organizations working with nanomaterials around the world.

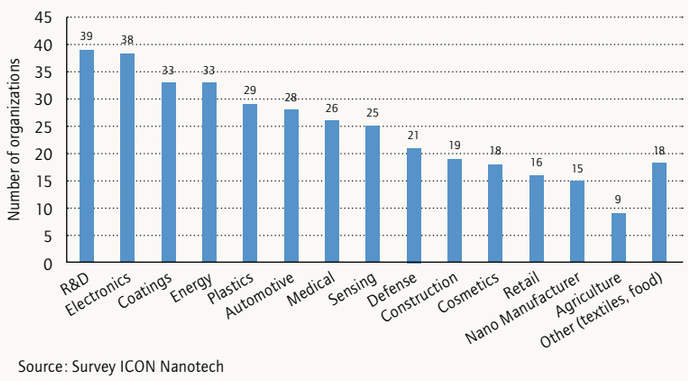
A total of 337 organizations were contacted, and 64 responded to the survey. The response rate was highest in Asia (30%), while North America and Europe returned similar response rates (14% and 16%, respectively). Most of the respondent organizations were small in size.

As far as workforce sizes go, most of the organizations had fewer than 50 employees handling nanomaterials, while 26 had one to nine employees and 29 had 10 to 49 employees. Only four of the respondents had more than 250 employees handling nanomaterials. Although larger organizations had many employees, only a small percentage of these handled nanomaterials. Of the organizations with more than 100,000 employees, one had 1-9 employees handling nanomaterials, two had 10 to 49, one had 50 to 250 and only one had 250 or more employees handling nanomaterials.

1. European Agency for Health and Safety at work 2009, *Literature review – Workplace exposure to nanoparticles*, Bilbao, p. 21.

2. Gerritzen, G, Li-Chin, H et al. 2006, *A review of current practices in the nanotechnology industry. Phase two report: survey of current practices in the nanotechnology workplace*, The International Council on Nanotechnology, Santa Barbara, California.

The most common customer industries operating with nanomaterials



Source: Survey ICON Nanotech

The most common customer industries operating with nanomaterials are R&D, electronics, energy, coatings, plastics, automotive, and medical, as shown in the figure.

Some European countries have attempted to quantify the number of workers exposed to nanoparticles in certain sectors through surveys. Limited though these studies are, they provide a good starting point. The baseline picture is as follows.

France

A 2007 study by the National Research and Safety Institute (INRS) reported between 2000 and 4000 workers involved in nanoparticle production. This figure does not include workers employed by companies using or processing nanoparticles or goods that contain them, laboratory workers or employees of outside companies[3].

Germany

Germany has a big role in nanotechnologies. It has taken the lead in the European Union in nanotech research and patent registration. But there is still too little published information on worker exposure in Germany. According to the nanotechnology expert from Kooperationsstelle Hamburg, Dr. Henning Wriedt, "for Germany it can be predicted that trade union activities with regard to nanotechnologies will remain rather limited unless forced to expand by the societal debate at large if that debate gains considerable momentum and develops a completely new quality"[4].

The Federal Institute for Occupational Health and Safety (BAuA), and the Chemical Industry Association (VCI) did a joint survey, but the way the questionnaire criteria were framed classed only 45 companies as performing activities involving nanomaterials. For this article's purposes, the data provided by BAuA cannot be treated as representative given Germany's huge role in the research and development of nanotechnologies in Europe.

Switzerland

In 2008, Switzerland published the Nano-Inventory study aimed at estimating the prevalence and extent of nanoparticles in Swiss industry and the potential exposure of the Swiss working population to engineered nanoparticles, and to provide accurate figures[5]. A pilot survey was done in collaboration with the University of Lausanne's Institute for Work and Health and SUVA, the Swiss Accident Insurance Fund. The study looked at Swiss companies from all branches of industry to estimate the number of companies using nanoparticles, as well as the number of workers potentially exposed at their workplaces from either handling nanoparticles, or their presence in the room as a nanoparticle application.

A total of 947 companies answered the survey. An average of 2 workers per company were directly involved with nanoparticle applications. The extrapolated finding was that 1,309 workers in the Swiss production sector were potentially directly exposed to nanoparticles.

The chemical industry showed the highest percentage of companies with a nanoparticle application (21.2% of surveyed companies in this branch) and also a higher percentage of potentially exposed workers (0.5% of the workers in these companies).

The Netherlands

37 institutions or companies took part in a survey funded by the employment and environment ministries. They included 26 companies and 11 academic or research organizations.

The most frequent use of nanoparticles was found in surface and coating technology, including ink and paints. The nanoparticles used in the biggest quantities (more than 10 tpa) are carbon black, amorphous silica and aluminium oxides. Other engineered nanoparticles (carbon nanotubes, nanosilver, iron oxides) were used only in small quantities.

3. " Production et utilisation industrielle des particules nanostructurées" , *Hygiène et Sécurité du Travail – Cahiers de notes documentaires* 2007, 4th quarter, INRS.

4. The Kooperationsstelle Hamburg is a part of the Ministry of Science and Research for the city of Hamburg.

5. Schmid, K, Danuser, B, Riedike, M 2008, *Swiss Nano Inventory, an assessment of the usage of nanoparticles in Swiss industry*, Lausanne, Institut universitaire romand de santé au travail.

Nanomaterials are gradually coming out of the laboratories and invading workplaces, where knowledge and control of the risks are certainly lower.
Image: © Nanocyl, Th. Strickaert

Nanoparticle-induced lung disease among Chinese workers

A study published in the August 2009 issue of *European Respiratory Journal* reports that nanoparticles may be linked to illness and 2 deaths among a group of workers in China [a].

The study by scientists at Beijing's Chaoyang Hospital describes the case of 7 young female workers who were exposed without protection to nanoparticles consisting of polyacrylic ester for a period of 5 to 13 months in a print plant.

All presented within the same period with shortness of breath, granulomas of the pleura, and an excessive volume of discoloured fluid in the lung lining. Particles around 30 nanometres in diameter were found in lung fluid and tissue. The workers were sent to the hospital for tests and examinations.

The patients had been working in a workshop where white paint was sprayed onto polystyrene slabs. The spraying, heating and drying of the slabs were automated; the workers' job, using a large scoop, was to load the machine with adhesive paint made up of polyacrylic esters and handle the slabs. The researchers learned that, in the months leading up to the workers' illness, the 70 sq. m. workshop had been very poorly ventilated. It was windowless, the door was kept closed because of the cold, and the ventilation system had broken down five months earlier.

They acknowledge that their study is limited by the absence of environmental monitoring data of the workplace and the unknown composition of the nanoparticles. However, they write, "the detailed description of their working, the duration of daily exposure, the dosage of the material used everyday, the space of their workplace and the serious results of long-term exposure give us some important information that the concentrations of the polyacrylate nanoparticles that the workers were exposed to may be very high."

Although there is no doubt that nanoparticles were present, expert opinion is divided. Some contend that the symptoms which the workers presented were 'similar' to those seen in animals exposed to nanoparticles. Others argue that the symptoms are more consistent with a chemical exposure to the fumes and the poor working conditions. With the data available, it is hard to identify the main cause of the illness [b].

This case raises serious concerns about work with nanoparticles. It may be the first study on clinical toxicity in humans due to long-term exposure to nanoparticles, and a perfect illustration of why working conditions must be adapted where nanomaterials are involved.

a. Song, Y, et al. 2009, Exposure to nanoparticles is related to pleural effusion, pulmonary fibrosis and granuloma, *Eur Respir J*; 34, p. 559–567.

b. Maynard, A 2009, Nanoparticle exposure and occupational lung disease – six expert perspectives on a new clinical study, <http://community.safenano.org/blogs/andrew_maynard>.

Of a total workforce of 41,000 employed by all participants, only 400 were in regular contact with nanoparticles, and about half of them were handling carbon black, amorphous silica and metal oxides or combinations of these. In the academic and research sector, a total of 137 workers were handling different nanoparticles in experimental stages[6].

In only 8% of cases was any kind of exposure monitoring done, usually as a single time measurement.

Spain

In 2003, the Spanish government founded NanoSpain – a platform of 273 members from government, industry and academia set up to promote and intensify nanotechnology-related activities.

Researchers and laboratory staff have the greatest risk of exposure to nanomaterials in Spain. There are as yet no figures on workplace exposure, although NanoSpain has an Industrial Working Group whose aims include identifying the number of industries working with nanomaterials.

A Spanish government press release reports that the National Institute for Occupational Safety and Health will be working specifically on identifying nanoparticles at the workplace in 2009[7].

Norway

The Labour Inspection Authority is running a project entitled A descriptive study on the use and production of nanotechnology products in Norwegian employment in order to get an overview of potential occupational exposure to nanomaterials/nanoparticles at different Norwegian workplaces.

The project will do a representative survey of the types of nanomaterials, types of product (numbers), quantities of nanomaterials produced, imported and used, and the companies, industries, and R&D institutions who are producing and working with nanomaterials.

What does this tell us?

All this points to a need to further investigate workers' direct exposure; an international inventory of companies working on nanotechnologies is needed for a better understanding of the bigger picture and the implementation of specific risk assessment measures. Whatever else, there is a strong case for implementing methods of measuring and assessing workplace exposure to nanoparticles and to protect workers from exposure, as well as providing education and training of workers in the proper handling of nanomaterials. ●

6. Borm, P, Houba, R, Linker, F 2008, *Omgaan met nanodeeltjes op de werkvloer. Survey naar goede praktijken in omgaan met nanomaterialen in de Nederlandse industrie en kennisinstellingen*, 74 p., <www.arbo.nl/downloads/Omgaan%20met%20nanomaterialen-final%20version11%2007%2008.pdf/view>.

7. Ministerio de Trabajo e Inmigración 2009, *Boletín Oficial del Estado. Otras disposiciones*, Num 61, Sec. III, p. 25055.