Risk assessment of airborne engineered nanomaterials

A. J. Koivisto[1], A.-K. Viitanen[1], T. Hussein[2], T. Kanerva[1], T. Tuomi[1], H. Stockmann-Juvala[1], K. Hämeri[2]

[1]Nanosafety Research Centre, Finnish Institute of Occupational Health, Helsinki, Topeliuksenkatu 41 a A, FI-00250, Finland

[2]Department of Physics, University of Helsinki, Helsinki, PO Box 64, FI-00014, Finland

Keywords: nanomaterial, exposure, dose, risk.

Presenting author email: joonas.koivisto@ttl.fi

Introduction

Risk is defined as the probability that the exposure to a hazard will lead to adverse health effect. In work environment, indoor air may contain pollution from various sources which potential toxicities may differ significantly. Such exposure scenario may occur in production and use of engineered nanomaterials (ENMs). This is because ENMs have been shown to be potentially more toxic for human health than for example incidentally emitted background particles (BPs). Thus, in risk assessment, exposure should be examined separately for ENMs and BPs.

Methods

We measured ENM exposure concentrations and defined inhaled doses in three different workplaces: NP synthesis (Koivisto *et al.*, 2012a), packing of nanoscale titanium dioxide (Koivisto *et al.*, 2012b), and handling of nanodiamonds (to be published). Risk was estimated by using recommended occupational exposure limits (RELs) for nanomaterials and by using inhaled dose and extrapolated dose-biological response from mice to humans (Reagan-Shaw *et al.*, 2008).

Results

Figure 1 shows an example how a worker was exposed in TiO_2 ENM in packing process. During pouring processes, the TiO_2 concentration was 450 cm^{-3} and 1.5 mg m^{-3}. The calculated inhaled TiO_2 dose during 10 minute exposure was 36×10^6 particles with a mass dose of 310 μg. Calculated estimate showed that 89% of the TiO_2 particles were deposited in head-airways.

The RELs for TiO_2 ENM is either 40 000 cm^{-3} (IFA 2012) or 0.3 mg m^{-3} (NIOSH 2011) as time-weighted average concentrations for up to 10 h per day during a 40-h work week. Thus, here the RELs in mass concentration was exceeded only momentarily. Lindberg *et al* (2012) showed that TiO_2 particles do not cause genotoxic effects at retained dose of 84 μg in mice, which human equivalent dose would be 20 mg in human lungs. Thus, there should not be a risk for genotoxic effects in this case.

Discussion and conclusions

This study shows an example how to estimate the risk from measured exposure concentrations and doses respectively by using RELs or dose-biological responses.

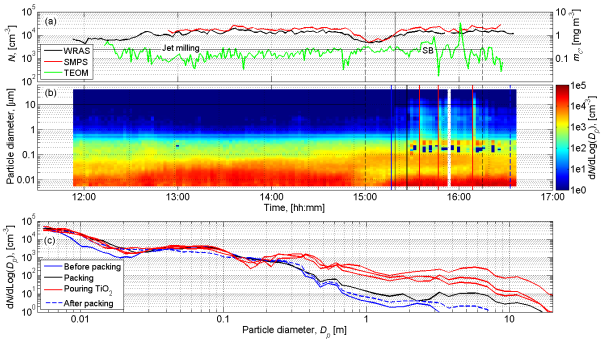

Figure 1: Particle concentrations during jet milling and packing of TiO_2: (a) shows the particle and mass concentration time series, (b) shows the particle size distribution time series, and (c) shows the selected particle size distributions which are plotted with the respective line color and style in (b).

This work was supported by the Graduate School in Environmental Health (SYTYKE).

Koivisto, A.J.,Aromaa, M., Mäkelä, J.M., Pasanen, P., Hussein, T. and Hämeri, K. (2012a). *ACS Nano* **6**, 1195–1203.

Koivisto, A.J., Lyyränen, J., Auvinen, A., Vanhala, E., Hämeri, K., Tuomi, T., Jokiniemi, J. (2012b). *Inhal. Toxicol.* **24**, 839–849.

Reagan-Shaw, S., Nihal, M., Ahmad, N. (2008). *FASEB J.* **22**, 659–661.

Lindberg, H.K., Falck, G.C.-M., Catalán, J., Koivisto, A.J., Suhonen, S., Järventaus, H., Rossi, E.M., Nykäsenoja, H., Peltonen, Y., Morenoc, C., Alenius, H., Tuomi, T., Savolainen, K.M., Norppa, H. (2012). *Mutat. Res.* **745**, 58–64.

IFA (2010). http://www.dguv.de/ifa/en/fac/nanopartikel/beurteilungsmassstaebe/index.jsp.

NIOSH (2011). NIOSH publication No. 2011–160.