Chemical Safety Management

Information Sheet : Nanomaterials

Purpose

The purpose of this information sheet is to guide workers and supervisors in general precautions and emergency responses for nanomaterials. The information should be read in conjunction with the Chemical Safety Management chapter of the HSW Handbook.

Q1 What are nanomaterials and why do they warrant special care?

- A nanomaterial is a material that contains particles in an unbound state or as an aggregate or agglomerate. They can be natural and exist in nature, be manufactured, or may result as a by-product.
- Engineered nanomaterials are defined as materials purposefully produced with at least one dimension between 1 and 100 nanometres (1 x10^{-6} mm = 1 nanometre).
- Nanomaterials can have unique toxicological properties and can be more toxic than their bulk materials. Physiochemical characteristics of particles can influence their effects in biological systems. These characteristics include particle size, shape, surface area, charge, chemical properties, solubility, oxidant generation potential, and degree of agglomeration (build up).

They warrant special care as:

- studies in both tissue cultures and laboratory animals have shown that seemingly slight changes to the surface chemistry of nanomaterials can result in significant changes in their toxicity. Subsequently a generic approach to risk assessment is not possible. Note if you are making nanomaterials you have to use a generic approach until you can test the materials toxicity; and
- nanomaterial research is an emerging field which is currently specifically un regulated. As the field is currently evolving there is no sound scientific research information on hazards associated with nanomaterials and the toxicological effects.

Q2 What should be considered before starting any experiment with nanomaterials

- Managers/supervisors must review current literature to find out what is known about the nanomaterials being used (or similar/related nanomaterials if designing new nanomaterial), including physical and chemical property data, toxicology, or health-effects data (in accordance with the Chemical Safety Management Handbook Chapter)
- A risk assessment must be conducted (in accordance with the Hazard Management Handbook chapter) and the Hierarchy of Controls used to minimise hazards based on what is known about the material and or related materials. If you are a student you must obtain approval/sign-off by your Manager/Supervisor on the risk assessment before you undertake the activity.
- If no information is available, managers/supervisors must take the "as low as reasonably practical" approach to the hazard management process, again employing the Hierarchy of Controls to minimise the potential hazards.
- If you are using carbon nanotubes please refer to Safe handling and use of carbon nanotubes workplace information sheet (SafeWork Australia) and Classification of carbon nanotubes hazardous chemicals (SafeWork Australia).

Q3 What should be considered when conducting a risk assessment on nanomaterials?

Please refer to the HSW Handbook chapter - Hazard management for information on the process and template.
The following information will provide you with assistance in completing the process.

Hazard Identification

The major hazard associated with nanoparticles is inhalation. Other hazards include ingestion and absorption.
Start by identifying the type of nanomaterials you will be working with and in what state they will be at the start of the process.

Continued

Q3 What should be considered when conducting a risk assessment on nanomaterials? Continued

Hazard Identification (continued)

Identify if they are considered a Category 1 (carcinogenic), Category 2A (probably carcinogenic) or other as per the WHO - IARC determination and identify the tasks which can increase the risk of exposure to nanomaterials such as:

- Working with nanomaterials in liquid media without adequate protection (e.g. appropriate gloves).
- Working with nanomaterials in liquid during pouring or mixing operations, or where a high degree of agitation is involved (e.g. risk of producing aerosols/vapour).
- Generating nanomaterials in non-enclosed systems.
- Handling (e.g. weighing, blending, spraying) powders of nanomaterials.
- Maintenance on equipment and processes used to produce or fabricate nanomaterials.
- Cleaning up of spills and waste material containing nanomaterials.
- Cleaning of dust collection systems used to capture nanomaterials.
- Machining, sanding, drilling, or other mechanical disruptions of materials containing nanomaterials where there is a risk that they may be released from the matrix.
- Although insufficient information exists to predict the fire and explosion risk associated with powders of nanomaterials, nano-scale combustible material could present a higher risk than coarser material with a similar mass concentration, given its increased particle surface area and potentially unique properties.
- Some nanomaterials may initiate or speed up catalytic reactions depending on their composition and structure that would not otherwise be anticipated based on their chemical composition.

The Risk Assessment

When conducting a risk assessment the level of risk for each activity will be affected by:

- How much material is being used.
- How often it is being used.
- What materials are being used.

Hierarchy of Controls

Assuming that elimination and substitution is not applicable for your experiments the following controls are to be considered to minimise the risk from the hazards.

Engineering

- Nanomaterial aerosols are highly mobile and have gas-like dynamics, therefore ventilation systems such as fume cupboards and biological safety cabinets with HEPA filters should be considered for removing aerosols of nanomaterials from the workplace and environmental emissions.
- Class III biological safety cabinets will offer workers the highest level of protection but such a level of protection is only required for extremely toxic nanomaterials and class II is usually considered sufficient.
- Laminar flow cabinets are not appropriate because they blow potentially contaminated air from the sample towards the operator, leading to a higher risk of exposure
- Only fully compliant fume cupboards or fully-tested cabinets are to be used with nanomaterials.
- Room air flow such as negative pressure could be considered to keep nanomaterials isolated in the instance of dust generation
- The use of intrinsically safe electrical equipment should be considered to minimise the risk of fire or explosion in the instance of dust generation
- Wet cutting of items that may produce nanomaterials

UNSW Sydney has detail on all of the above including a decision flow chart and risk control banding checklist that can assist in this instance, please refer to Nanomaterials risk banding checklist on the nanomaterials page at the following link https://safety.unsw.edu.au/nanomaterials.

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Q3 What should be considered when conducting a risk assessment on nanomaterials? (Continue)

Administration

- Materials to be stored in double sealed containers
- Use of absorbent or sticky mats to capture spillage
- Wipe down of work surfaces with wet absorbent paper towels
- Consider the use of safe operating procedure (SOP) for the use of nanomaterials including the controls identified in the risk assessment and have workers trained.
- When developing a SOP use good work practices to minimise worker exposures to nanomaterials e.g. cleaning of work areas using HEPA vacuum pickup and wet wiping methods, preventing the consumption of food or beverages in workplaces where nanomaterials are handled, providing hand-washing facilities, and providing facilities for showering and changing clothes.
- A contingency plan in the event of something going wrong, such as a spill or fire should be in place and all workers trained to respond appropriately.

Personal Protective Equipment (PPE)

- Clothing: There are still many uncertainties concerning the absorption of nanomaterials through the skin. Therefore workers should wear protective clothing that covers all areas of the skin and protective footwear (e.g. disposable shoe covers or neoprene shoes and lab coats). Disposable clothing is recommended when using or manufacturing nanomaterials. This clothing is to be double bagged and disposed of via Cleaning and Waste Collection Request Form. The use of protective clothing will limit the dermal exposure of workers. Some clothing standards incorporate testing with nanometre-sized particles and therefore provide some indication of the effectiveness of protective clothing.
- Gloves: It is not yet known to what extent gloves are an effective barrier against nanomaterials, nor which glove material affords most protection. For example, nitrile and polypropylene polymer gloves have a smaller pore size and may provide greater protection than latex gloves. It is recommended at this time that two pairs of gloves should be worn, with extra protection from gloves made from different materials (e.g. nitrile or polypropylene over the top of latex). Furthermore, continued flexing of the gloves during use can lead to cracks and holes that nanomaterials could penetrate, therefore disposable gloves should be changed on a regular basis throughout the day.
- Safety glasses, also consider using safety goggles refer to the Safety Data Sheet (SDS) and the risk assessment to determine Personal Protective equipment requirements.
- Respirators: Should only be used as a last resort if other engineering controls are not available. Air-purifying respirators protect workers by removing harmful dusts, fumes, chemical vapours and gases by filtering the contaminated air through either a fibrous membrane or resin. They are only effective if they are properly fitted and workers need to be trained in their use. The respirators used in nanotechnology facilities should comply to the Australian Standard AS/NZS 1716:2012 (Respiratory protective equipment) and more information concerning the use and choice of respirators for a specific workplace can be found in the Australian Standard AS/NZS 1715 2009 (Selection, use and maintenance of respiratory protective devices), which discuss protection against particulate matter. It is believed that nanoparticles are removed from the air by diffusing onto the filtering fibres of the respirator, while large particles (i.e. >300nm) will be physically blocked by the filter fibres. The current advice being provided to the nanotechnology industry by occupational hygiene experts is that certified HEPA respirators will be effective in protecting workers from nanomaterials, e.g. P100 and N100 respirators are expected to remove at least 99.9% of particles.

Q4 Is there health surveillance available for nanomaterials?

Until instrumentation to measure doses is readily available and dose limits have been determined, medical screening of workers potentially exposed to nanomaterials is not yet practical. Research is currently ongoing into toxicology and dose limits, and managers/supervisors using nanomaterials should monitor the research to ensure safest handling of their nanomaterials.

Q5 How should I label nanomaterial?

A label for **nanomaterials (**when the hazards are known) shall at a minimum:

- be legible and in English,
- contain the product identifier (name or number found on the suppliers label or in the SDS),
- have a pictogram or hazard statement consistent with the chemical, and
- the full name (or staff/student number) of the worker who made, collected or decanted the nanomaterial.

A label for **nanomaterials (**when the hazards are not fully characterised) shall at a minimum:

- be legible and in English,
- include a statement of hazard "contains engineered/manufactured nanomaterials. Caution Hazard unknown", and
- include the full name (or staff/student number) of the worker who made, collected or decanted the nanomaterial.

Q6 How should I record nanomaterials being used

Nanomaterials should be included on the chemical register for the area in the same way as any other hazardous chemical is registered and also indicate that it is a nanomaterial.

Q7 What should you do in the event of an emergency with nanomaterials

Clean up and Spills

The maintenance and cleaning of nanotechnology facilities during normal operations or after an accidental spill represent scenarios where worker exposure could be significantly increased.

- It is recommended that facilities are cleaned using only HEPA filter vacuum cleaners that comply with the Australian Standards AS 3544-1988 (Industrial vacuum cleaners for particulates hazardous to health) and AS 4260-1997 (High Efficiency Particulate Air Filters (HEPA) – Classification, Construction and Performance). Household vacuum cleaners **should never be used** even if they have a HEPA filter installed in them.
- Alternatively, nanotechnology workplaces can be cleaned using wet-wiping methods. Whichever method is chosen should be conducted in a manner that limits the inhalational and dermal exposure of workers.

Q8 How do I dispose of nanomaterials?

- The fate of nanomaterials released into the environment is not yet known. There are currently no guidelines for the disposal of many nanomaterials but efforts should be taken to contain them and presently they should be handled as hazardous waste.
- Precautions should be taken when disposing of nanomaterials. At the very least nano-waste should be double-bagged, enclosed in a rigid impermeable container and disposed of via the Cleaning and Waste Collection Request Form.

Q9 What are other universities doing to manage the risk of working with nanomaterials?

Please refer to the UNSW Sydney Nanomaterial risk banding checklist document for some additional information https://safety.unsw.edu.au/nanomaterials.

Q10 Where do I obtain further information on nanomaterials?

If you require further information, please contact a member of the local HSW Team**.**