3.19 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.

Q1 What are nanomaterials?

- Engineered nanomaterials are defined as materials purposefully produced with at least one dimension between 1 and 100 nanometres (1 $x10^{-6}$ mm = 1 nanometre).

Q2 Why do nanomaterials warrant special care?

- Nanomaterials research involves working with a potentially hazardous substance when there are no proven rules by which to do it safely. This is because nanotechnology is an emerging field and the scientific research which will eventually form the knowledge base behind future safety legislation is still being conducted. What we do know about nanomaterials indicates they can be hazardous in certain situations, but it's not yet clear how hazardous, how certain factors affect its hazardousness, and how effective traditional hazard control measures might be.
- Nanomaterials can have unique toxicological properties and can be more toxic than their bulk materials. The physiochemical characteristics of particles can also influence their effects in biological systems, including particle size, shape, surface area, charge, chemical properties, solubility, oxidant generation potential, and degree of agglomeration (build up).
- Overall, there is consensus that engineered nanomaterials (ENMs) cannot be collectively or categorically considered either intrinsically benign or harmful. Rather, hazard and risk assessments should be conducted on a case-by-case basis.[i] For these reasons we cannot mandate the safest way of working with a given material, and recommend a cautious approach to any activity involving nanomaterials based on your assessment of the best scientific information available at the time of your experiment.

Q3 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.
- A risk assessment must be conducted 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 get a staff member to sign off on this risk assessment.
- If you are using carbon nanotubes please refer to Human Health Hazard Assessment and Classification of Carbon Nanotubes by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) and Safe handling and use of carbon nanotubes.

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Q4 What should be considered when conducting a risk assessment on nanomaterials?

Please refer to the HSW Handbook chapter - Hazard Management for information on the hazard management 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, however ingestion and absorption may also be hazardous. Start by identifying 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.

The Risk Assessment

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

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

Hierarchy of Controls

Assuming that elimination and substitution is not applicable for your experiments, the following controls are examples of how you may be able to minimise the risk from the hazards. However you will need to decide what is most appropriate for your particular setup.

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 this is only required for extremely toxic nanomaterials. 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.

Administration

- A documented procedure is often appropriate for hazardous work, and in such cases a safe operating procedure (SOP) for the use of nanomaterials including the controls identified in the risk assessment must be developed and all 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.
- We strongly recommend a contingency plan be developed and documented in the event of something going wrong, such as a spill or fire, and all workers trained to respond appropriately.

Continued

Q4 What should be considered when conducting a risk assessment on nanomaterials? (Continued)

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). 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 to wear two pairs of gloves 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:** As with the use of all hazardous materials, safety glasses (preferably goggles) should be worn.
- **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.

Q5 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 latest research to ensure safest handling of their nanomaterials and any developments in the practicality of air monitoring.

Q6 How should I label nanomaterials?

Where the hazards are **known**, a label 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
- include the full name (or staff/student number) of the worker who made, collected or decanted the nanomaterial.

Where the hazards are **not fully characterised**, a label shall at a minimum:

- be legible and in English,
- contain 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.

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?

- As with all aspects of chemical management, efforts should be taken to minimise the amount of waste generated.
- 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.

Further information

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

[i] Safe Work Australia - Engineered Nanomaterials - an update on the Toxicology and Work Health Hazards page 4