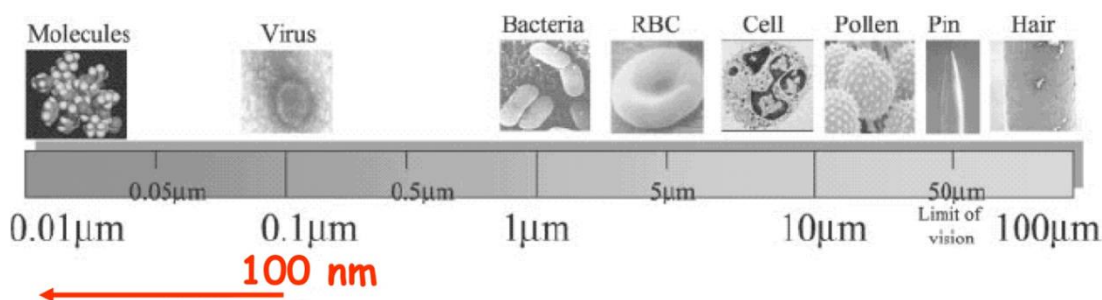




SOP: NANOPARTICLES

Due to their extremely small size, to all intents and purposes, nanoparticles (NPs) are “new” matter that displays new properties unassociated with the original source matter. NPs are normal chemical elements which are “ground” or “cut” up into very small pieces equal or smaller than one tenth of a micrometer ($0.1 \mu\text{m}$), otherwise indicated as being in the one to one hundred nanometer range ($1 - 100 \text{ nm}$), hence their name. They can have various geometric shapes such as spheres, rods, tubes and more.



IMPORTANT ISSUES TO REMEMBER ABOUT NANOPARTICLES

- Toxicity increases as particle size decreases.
- Chemical composition and other particle properties can also influence toxicity.
- A greater proportion of inhaled NPs will deposit in the respiratory tract as compared to larger particles.
- NPs have several systemic effects on different organ systems when exposed – includes the immune, inflammatory and cardiovascular systems.
- NPs can cross cell membranes (internally & externally) and interact with sub cellular structures causing oxidative damage and impair cell functions.
- NPs cause adverse lung effects including pulmonary fibrosis.
- NPs have a higher risk to cause pulmonary inflammation and lung tumours.
- NPs have an influence on free-cell systems' oxidant generation properties and cytotoxicity.

WORK OPERATING PROCEDURES IN THE CHEMISTRY LABORATORY

1. Post signs to communicate appropriate warnings and precautions.
2. A warning poster about the nanoparticle work area should be placed at all entrances of the lab, glove box/es and fume hood/s used for such work.
3. Contact details of persons' involved in NP research must be put up at entrances and equipment.
 1. Wear PPE - Lab coat, nitrile gloves, safety glasses, close-toed shoes
 2. Specialized respirators must also be worn at any stage where NP “dust” can be inhaled during the synthesis, weighing of dry NPs as well as when making a solution using dry NPs.
 3. Label all chemical containers with the identity of the contents and include the term "nano" in descriptor + hazard warning + chemical concentration.
 4. Ensure there is negative pressure between NP areas & passages.
 5. Where NP powder is used, use HEPA-filtered local capture/extraction hoods preferably enclosed glove box/es.
 6. Can also work in fume hoods set aside for NP work.



7. A small spill kit must be in close vicinity of the fume hood. It **MUST** at least include absorbent pads, a spare 100 μ m thick collection bag and cable tie. Store all articles in a 25L tightly closable plastic drum that can be used as disposal container.
8. Invest in easily cleanable disposable bench covers such as that of Benchkote in both the fume hood and on the working bench.
9. Wash hands frequently – using the proper washing method.
10. Remove gloves when leaving the laboratory or to use telephone.
11. Remove overall/shoe covers in anti-room.
12. Only make up small amount of solution/s – ideal will be ≤ 10 ml.
13. Automatic pipettes will be used and the tips disposed of in a container (can be a used cleaned chemical container) specially labelled for used NP tips.
14. Never lay pipette on its side and use proper Gilson pipette usage techniques.
15. Where you need to transport cuvettes, eppendorfs, vials or solutions – always use a secondary container.
16. Store NPs in a well-sealed container that can be opened with minimal agitation of the contents. Best when stored in secondary container in a glove box.
17. The NPs and any samples/solutions made **WILL** be stored in a cupboard or fridge **MUST** be in a properly sealed NP hazard labelled container as well as in a NP hazard labelled secondary container.
18. Indicate a contact person name on all containers.
19. Disposal methods:
 - a "Nanoparticle waste" chemical plastic bottle **WILL** be placed at the vicinity of work space and in the fume hood or glove box being used for NP work/research. All the washings of the glassware used and the solutions that were made **WILL** be disposed of in this container.
 - The liquid waste will be disposed of as per Vissershok disposal method give via the hazardous waste disposal company.
 - A plastic container **WILL** be used for all smaller dry waste such as eppendorfs, tips etc.
 - Both containers may be recycled washed chemical bottles.
 - Glass/broken glass (rinsed) goes in a normal yellow "Broken Glass" drum.
20. If you dispose of gloves or any contaminated paper:
 - It is suggested that the gloves are turned inside out – as per accepted working practice in biological labs.
 - any tissue paper, filters, gloves goes first in a smaller container (25L drum/bucket) with a 100 μ m thick bag liner and that is kept close by (with lid always covering it when not in use). When it is full tag the bag, take it out and place it in lab RUC for disposal.
 - Dispose of the full plastic (lid closed) container in a lab RUC - thus do not just empty the contents into the RUC.
 - Clean-up from a spillage - collect clean-up materials in the 100 μ m thick bag of disposal kit, tag it with cable tie, place in a 25L tightly closable plastic drum – handle as hazardous waste. If contaminated with other chemicals it is **NOT** to be disposed of via incineration **BUT** Vissershok. **Label container with "Hazard Nanoparticles"**. Contact the Chemical Safety Officer x4549 to assist with disposal arrangement.



HEALTH & SAFETY ISSUES

- Health exposure by inhalation, dermal contact, ingestion, injection. NPs when absorbed can be transported to other areas, organs and systems in the body.
- Exposure can take place during:
 - Handling (weighing, blending, spraying) powders of NPs
 - Cleaning-up of spills and waste material containing NPs
 - Cleaning out of dust collection systems used to capture NPs
 - Working with NPs without adequate protection
 - Opening & manual handling of bulk nanomaterials
 - Pouring or mixing of liquid NPs solutions or where a high degree of agitation is involved
 - Generating NPs in non-enclosed systems
 - Maintenance on equipment and processes used to produce or fabricate nanomaterials – disturbing NPs “dust”
 - Machining, sanding, drilling or other mechanical disruptions of materials containing NPs
- High Probability of inhalation – wear a respirator appropriate for nanoparticles:
 - Generating nanoparticles in the gas phase or in aerosol (spill or liquid)
 - Manipulation of nanoparticles in gas stream
 - Manipulating nanoparticle powders
- One can exhaust/spread NPs from labs to passages when opening entrance/exit doors
- High-energy processes such as milling, sonication, grinding, and high-speed blending may cause release of NPs
- May cause outside atmospheric pollution
- May cause catalytic effects, fire or explosions if NPs initiate catalytic reactions previously not anticipated
- Explosion risk of some metals increase significantly as particle size decreases.

SOLUTIONS:

1. Assume all NPs are toxic – until studies shows otherwise – some non-toxic NPs may even become toxic even if not previously - avoid working alone during high-risk operations
2. Set up Standard Operating Procedures for each activity and equipment to be used with NPs
3. Wear proper PPE (nitrile gloves {double}, closed chemical protection overall, safety protection glasses, respirator with proper cartridges, shoe covers)
4. Annually or when introducing a new NP - conduct a potential hazard identification on the technique/procedures of activities and waste disposal.
5. No cellphones to be used in area.
6. Prevent ingestion – eating, drinking are not allowed in areas.
7. Clean & maintain all equipment & areas/benches/floors regularly – daily or after use (vacuum up the area with a HEPA-filtered vacuum or wet wipe the area with paper towels, or a combination of the two)
8. Clean spills immediately
9. Ensure a proper maintenance schedule of equipment is set up and ensure it is followed.
10. When purchasing commercially obtain the Safety Data Sheet (SDS) of the NPs & share info. Keep it on file.



11. Best to work with NPs in solutions, or attached to substrates so that dry material is not released easily
12. Label all chemical containers with the identity of the contents & include term "nano" in descriptor + hazard warning and chemical concentration.
13. Store NPs in a well-sealed container that can be opened with minimal agitation to the contents.
14. Prepare the minimal amount possible to use in experiment/reactions.
15. Post signs to communicate appropriate warnings and precautions.
16. Ensure there is negative pressure between NP areas & passages.
17. Use HEPA-filtered local capture/extraction hoods. Can also work in fume hoods or enclosed glove boxes.
18. Weigh and work in a negatively pressured glove box.
19. Wash hands frequently – proper washing method.
20. Remove gloves when leaving the laboratory or use telephone – remove overall/shoe covers in anti-room.