Safety Alert March 2024

Subject/Topic: Prevention of fires from energetic materials.

Background: The UNSW Safety team are issuing this safety alert as a reminder about the possible spontaneous oxidation of energetic materials (such as reactive metals) in air.

Incident with context. An incident occurred where thin film metal flakes removed during routine maintenance of a physical vapour deposition system spontaneously reacted with air and became an ignition source, resulting in a small fire in a waste bin.

The incident investigation found that:

- A very small metallic flake removed from a vapour deposition system during routine maintenance had been tapped from the tip of a vacuum cleaner into a domestic waste bin.
- The metallic waste was a mixture of high purity aluminium, titanium, and palladium.
- The bin also contained a few polyester/cellulose cleanroom wipes which had been wetted with isopropanol from a squirt bottle.
- Shortly after the flake was tipped into the bin a popping noise was heard by lab users who realised that there had been a small fire in the bin which was already extinguished.
- The most likely cause of the fire was identified to be either:
  - Material oxidation (or nitridation) of finely divided titanium particles resulting in spontaneous ignition of vapours emanating from the isopropanol wetted wipes, or
  - Exothermic reaction between high purity titanium and high purity aluminium resulting in an ignition that propagated to the isopropanol wetted wipes.

Summary of injury/damage: The plastic bin liner in the waste bin had caught fire and melted, and the contents of the bin were charred.

Actions Required.

- Where reactive metals (such as titanium, aluminium, nickel, but possibly also others) are in use, the possibility of spontaneous reaction of reactive metals with nitrogen or oxygen in air should be considered in the Risk Management Form and controls implemented and documented in the Safe Work Procedure.
- Consider how these materials and waste products need to be handled and stored, especially in relation to material compatibility. Waste materials can still carry the risk of the original material.

- Consider what type of fire extinguisher(s) are most appropriate based on the risks present in the laboratory and document this in the Risk Management Form.
- Be aware that different vacuum systems may result in different types of waste/by-products which may require more precautions even if they are from the same source. For example, a load lock system vacuum tool may allow the buildup of high purity metals and films relative to systems where the chamber is constantly exposed to air.
- Waste containers should be prepared and labelled before starting the cleaning process.
- Reactive metal waste should be segregated from other waste streams and kept in a metal container.
- The metal waste should be regularly removed into another fireproof container.
- Bins which are more resistant to fires should be considered in locations where combustion risk has been identified.
- Tissues soaked with isopropanol or similar solvents should not be discarded into a closed bin, but need to be disposed of in such a way that vapours cannot be accumulated.
- When undertaking a cleaning task requiring a vacuum cleaner, check that the vacuum is compatible with the material to be cleaned.

- Lab users must be fully trained in emergency response including for metal fires in areas where this has been identified as a risk.

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