Introduction:

All nanomaterial and powder processing in ATAMI non-tenant labs require completion of this SOP and sign-off by the associated PI before they can be completed.

Refer to the Nanotoolkit for Working Safetly with Engineered Nanomaterials in Academic Research Setting guidelines publish by the California Nanosafety Consortium of Higher Education for additional SOP and procedure guidance.

This also ensures that we meet the SOP requirements of section 14.14 of the OSU Laboratory Chemical Hygiene Plan.

Requirements:

- All students running experiments must fill out this SOP completely, before processing materials.
- The SOP must be updated and revised for each new process outside of the parameters in the original SOP.
- Follow the "Instructions for completing Process Review", posted on the ATAMI website to initiate and complete SOP reviews.
- **The SOP must be printed, signed and available at the tool at all times when a student is running the process.**

Background Information: *Fill in each of the boxes below.*

Name of Procedure:	
Date of Procedure:	
SOP revision:	
Names of all students or technicians using the SOP:	
PI name:	
Location of work:	
Name of Tool:	*Supply the Manufacturer and model name of the tool being used for powder or nanomaterial processing.*
Start date:	*Expected start date for doing this.*
End date:	*When do you think you will be done with this process?*
Expected frequency:	*How often do you expect this to run? – daily, weekly, one time,…*
Expected Average duration of each Procedure:	*How long do you think it will take to conduct one cycle of the proposed process.*
Purpose of experiment and expected output:	*Describe the purpose of the physical object to be produced. Describe the data that will be collected during processing or post processing metrology.*
Material Composition and particle size distributions for all materials used:	*List each nanoparticle material used for the experiment and the size distribution description.*
Approximate size of printed objects and number of layers:	*Lateral dimensions (x,y,z). Expected number of layers if 3D printing.*
Brief Description of the Procedure:	*Provide a quick overview of the procedure. Details will be defined below.*

Materials: *Include all materials – including powders, nanomaterials, IPA, other solvents or chemicals*

Material Name	Description	Expected volume of material	Storage Location	SDS CAS number	In SciShied Chemical Inventory? (Y/N)

Materials Hazard Assessment: *Be as thorough as possible in describing the potential hazards associated with the process. The SDS listed hazards are the minimum.*

Identify potential chemical and safety hazards using the material safety data sheet (sds) for the nanomaterial or parent compound. The toxicity of the nanomaterials may be greater than the parent compound. Special consideration should be given to the high reactivity of some nanopowders with regard to potential fire and explosion, particularly if scaling up the process. Consider the hazards of any precursor materials in evaluating the process. **The following metals must always be treated as hazardous waste for disposal** - Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver.

Risk Assessment: (Refer to the risk assessment table on page 7 of the SOP instructions document)

Please note. All 3D metal printing and processing of powders with lasers or other heat sources at ATAMI is considered risk level 3.

Risk Level (1,2,3)	Why did you assess it at this risk level?
	Use the table in the link above to determine the risk level and provide a description of why you chose that risk level. *For 3D printing, you can just say "3D printing of nanomaterials or powders."*

Unattended Operation:

Will the tool operate without direct observation for any amount of time?

○ Yes ◉ No

- **If yes, this SOP must be reviewed by EHS.**
- Unattended operation is strongly discouraged for any Nanomaterial or powder operations, and will only be allowed in exceptional circumstances on commercial systems, with vendor controls and monitoring in place.
- Unattended operation is not allowed on OSU assembled systems.

- If necessary, this will also be reviewed by the OSU chemical safety review board.

Powder Specific Safety Descriptions: *Describe in as much detail the controls in place to prevent exposure to each of the hazards listed below. Focus on the hierarchy of controls to ensure PPE is not the primary control.*

If the Hazard does not exist for this process, put NA in the columns.

Hazard	Source of hazard	Controls Description
Laser radiation	*The tool or laser source.*	*Class rating for commercial equipment. Detailed description of containment for OSU built or modified systems.*
Thermal radiation	*Which furnace or other hot surfaces (post printing, for example)*	*Any controls for using high temp processing of any kind (gloves, etc..)*
Powder Explosion	*Describe all situations where heat, oxygen, powder, and containment can cause an explosion.*	*Describe inerting process during processing in detail. Cleanup procedures.*
Fire	*Describe all situations where heat, oxygen, powder can light up, or hot surfaces could cause a fire.*	*Describe inerting process during processing in detail. Cleanup procedures.*
Process Fumes	*Describe sources of fumes, such as welding fumes from laser sintering.*	*Containment of fumes.*
Powder dust from tool, transport, or storage	*Sources of powder dust in tool or during transport.*	*Wipedown procedures, powder release controls,*
Inert gasses	*How are inert gases used.*	*Oxygen sensors, volume limits, buddy system, etc..*
Other	*Other hazards not listed here.*	*Controls for those hazards.*

Location of Nearest Emergency Equipment:

Item:	Location:
Eyewash/Safety Shower	
First Aid Kit	
Chemical Spill Kit	
Fire Extinguisher	
Telephone	
Fire alarm manual pull station	

Exposure Response: *Verify that you fully understand exposure responses. Put a note below the table for any additional specified responses.*

Response	
I know how to use the eyewash and safety showers and how to get a buddy to help if needed.	☐
I know where the SDS sheets are for more detail.	☐
I know how to report to my PI or lab supervisor, and who to call if I cannot contact.	☐
I will be sure to report all exposures to my PI so that we can file an incident report.	☐

I will immediately stop all processes, with EMO if necessary, if I suspect a risk of exposure.	☐
I have discussed any other exposure responses with my PI and have documented them here:	☐

Spill Response: *Verify that you fully understand spill responses. Put a note below the table for any additional specified responses.*

Response	
I will notify the workers in the space and isolate the area with barriers and signage.	☐
I will immediately notify my PI and the ATAMI emergency contacts listed throughout ATAMI of any spill.	☐
If I cannot accurately assess the spill cleanup steps, I will review with my PI before proceeding.	☐
I will only use the Ruwac vacuum cleaner for any powder cleanups.	☐
I will never sweep or blow spilled dry powder with compressed air.	☐
I will never use dry towels for wiping surfaces, and understand which solvent (water, IPA, or other) to use for cleanup.	☐
I know how to label and dispose of any towels/wipes used for cleanup.	☐
I have absorbent towels staged for any wet spills.	☐

PPE:

Required		**As Needed**	
Safety Glasses	☐	Tyvek suit	☐
Long Pants	☐	3M PAPR	☐
Closed Toe Shoes	☐	Double layer gloves	☐
Lab Coat or ATAMI lab shirt	☐		
Single layer gloves	☐		

Tool Parameters: *List the range of parameters used on the tool. The list below is a starting example for laser printing.*

- Laser wavelength and power -
- Recipe name -
- O2 level for inerted operation –
- Other -

Step by Step Operations Procedure: *This section is critical. List out steps to run the operation in as much detail as possible. Include pictures if you can. You don't have to include exact step-by-step procedures related to the tool interface, but can if it will be helpful to you in the future.*

1. Transporting and loading powder into tool:
    a. x
    b. y
    c. z
2. Material processing steps:
    a. x
    b. y
    c. z
3. Unloading and cleaning the tool:
    a. x
    b. y
    c. z
4. Transport and post processing and cleaning of samples:
    a. x
    b. y
    c. z
5. Post Processing Tool and Workspace Cleanup procedures:
    a. x
    b. y
    c. z
6. Waste Disposal:
    a. x
    b. y
    c. z

Safety Sign-off Checklist:

Step	Done?
All SDS's for material used are loaded in SciShield:	☐
PI has reviewed this SOP and approved the procedure:	☐
Student has fully read and understood this SOP and has no further questions or inputs:	☐
Student has tool training and PPE training fully completed:	☐
All peripheral equipment and supplies (containers, carts, brushes, wipes) are in place in the lab before processing:	☐
Student knows the location of the appropriate fire extinguisher and has completed fire extinguisher training:	☐
All nanomaterials are properly labelled and stored per OSU guidelines:	☐

Safety Sign-off: *This SOP must be signed off by all students running the procedure and the PI responsible.*

Student – I have read and understand this SOP and will abide by all safety protocols needed for a safe and healthy laboratory work environment. I will stop operations immediately if I have any safety concerns and revise this SOP accordingly before proceeding. In understand that PPE is the lowest level and least effective safety control in the hierarchy of controls.

Student name:

Student Signature:

PI – I have read and understand this SOP and reviewed it with the student. I understand that I am fully responsible for safe operations associated with this SOP.

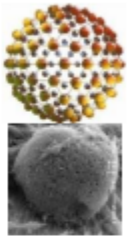
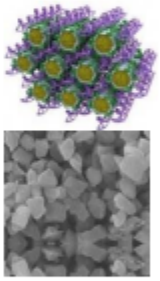
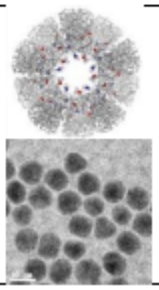
PI name:

PI Signature:

Hierarchy of Controls:

Refer to section 9.0 of ATAMI Laboratory Chemical Hazard Plan

How to Determine Risk Level: (back to Risk Assessment box)

Risk Level	Material State or Type of Use *Material State or Type of Use*	Examples	
Category 1 Lower Exposure Potential	**Material State** *No potential for airborne release (when handling)* • **Solid:** Bound in a substrate or matrix • **Liquid:** Water-based liquid suspensions or gels • **Gas:** No potential for release into air (when handling) **Type of Use** • No thermal or mechanical stress	• Non- destructive handling of solid engineered nanoparticle composites or nanoparticles permanently bonded to a substrate	
Category 2 Moderate Exposure Potential	**Material State** *Moderate potential for airborne release (when handling)* • **Solid:** Powders or Pellets • **Liquid:** Solvent-based liquid suspensions or gels • **Air:** Potential for release into air (when handling) **Type of Use** • Thermal or mechanical stress induced	• Pouring, heating ,or mixing liquid suspensions (*e.g.*, stirring or pipetting), or operations with high degree of agitation involved (*e.g.*, sonication) • Weighing or transferring powders or pellets • Changing bedding out of laboratory animal cages	
Category 3 Higher Exposure Potential	**Material State** *High potential for airborne release (when handling)* • **Solid:** Powders or Pellets with extreme potential for release into air • **Gas**: Suspended in gas	• Generating or manipulating nanomaterials in gas phase or in aerosol form • Furnace operations • Cleaning reactors • Changing filter elements • Cleaning dust collection systems used to capture nanomaterials • High speed abrading / grinding nanocomposite materials	

Source: California Nanosafety Consortium of Higher Education

Revision Control:

Revision	Date	Description/Change	Curator
0	2/9/23	New Document	Randy Greb
1	4/20/23	Updated to include details of updated review process. Removed hierarchy of controls and Risk assessment from the template, but kept it here.	Randy Greb
3	6/16/23	Added list of metals that should always be disposed of as hazardous waste. Added rev number to footer of both instructions and template docs.	Randy Greb