

# Contamination policy and General rules

Savitha

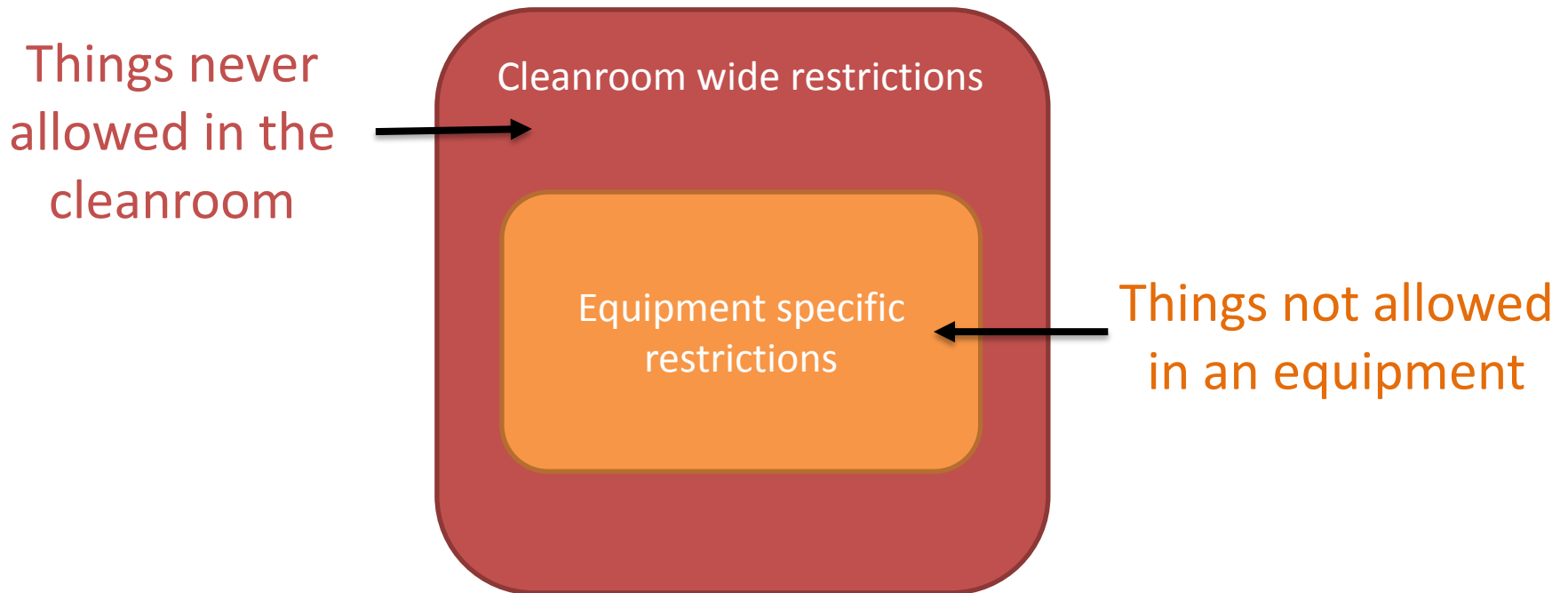
16<sup>TH</sup> Feb 2018

# Problem of Cross Contamination

- Definition:
  - Transfer of undesirable materials from one equipment to another.
- Occurs because of:
  - Incompatible process flows
    - Move from cleanest step to dirty step (downstream). Never upstream.
  - Irresponsible user behavior
    - As long as my work gets done, it is not my problem.
- Causes:
  - Poor device performance and reliability
  - Poor repeatability of processes
  - Expensive repair/downtime of equipment

# What is the Contamination Policy?

- Outlines NNFC's policy on allowed/disallowed materials in the cleanroom & each of the equipment



# Cleanroom-wide Restrictions

- Sulfur
  - Clogs the pumps and valves.
- PDMS
  - Please use PV-lab and polymer lab for processing these.
- Fast diffusing (Cu, Zn, Fe, Mn, etc.), toxic metals (Cd, Sb, Se, As, Hg, etc.), their alloys
  - Entry allowed only on a case-by-case basis
- Only approved photoresists allowed in Litho bay
  - Standard list available at FOM (purchase supplies)
- Only approved chemicals allowed at the wet bench
  - List available at FOM (purchase supplies)

# GaAs, InP and PZT

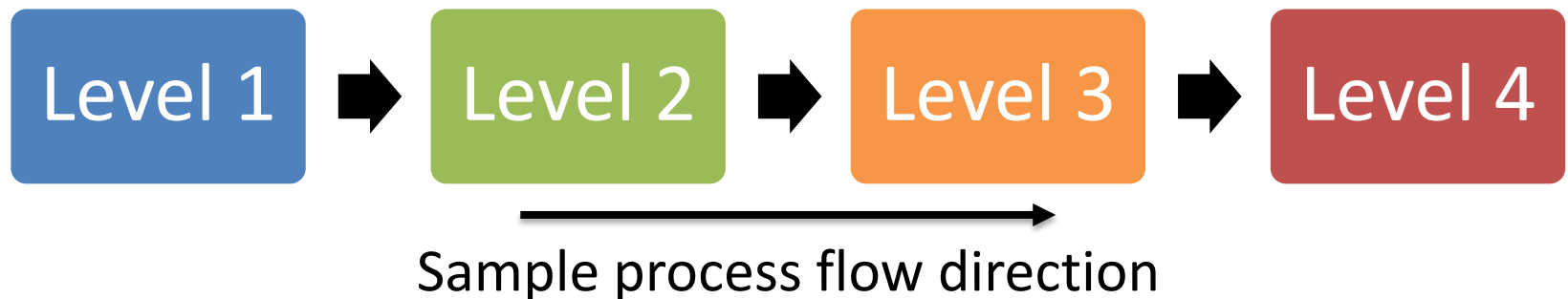
- Please use PV and Polymer lab for these materials
- If these materials need to be processed inside the cleanroom, please contact the material entry committee at [savithap@iisc.ac.in](mailto:savithap@iisc.ac.in)

# New Materials Entry




- Need special permission for non-standard chemicals/photoresists/wafers/targets etc.
  - No exceptions...
- Procedure to seek permission for bringing in new material is available at NNFC website.
  - Email Savitha (savithap@iisc.ac.in) with
    - Prior process
    - Post process
    - MSDS of the material
    - Why the cleanroom need to be used

# Equipment-Specific Restrictions

- Each equipment has a contamination level
- Based on the contamination level, entry of materials and samples are restricted.
- Basic idea
  - Sample move from low-contamination to high-contamination



# Classification of Equipment (Levels)

<p><b>LEVEL 1</b> (Color code: Light blue)</p>	<ul style="list-style-type: none"> <li>• New diced samples/wafer-pieces</li> <li>• Samples from Level 1 equipment</li> <li>• Samples after RCA clean on Level 2 wet-bench</li> <li>• No samples with metals</li> </ul>	 <p>RCA clean in level 1 wet bench</p>
<p><b>LEVEL 2</b> (Color code: Green)</p>	<ul style="list-style-type: none"> <li>• Samples processed in level 2</li> <li>• Samples from lithography</li> <li>• No samples with metals</li> </ul>	 <p>Si/SiO<sub>2</sub>/Si<sub>3</sub>N<sub>4</sub> etch in level 3a + RCA clean in level 2 wet bench</p>
<p><b>LEVEL 3a</b> (Color code: White in orange)</p>	<ul style="list-style-type: none"> <li>• Samples processed in Level 3 deposition equipment only</li> <li>• Samples with metal allowed but no exposed metal and no fast-diffusing metals.</li> </ul>	
<p><b>LEVEL 3</b> (Colour code: Orange)</p>	<ul style="list-style-type: none"> <li>• Samples with any metal</li> <li>• Fast-diffusion metals cannot be exposed and can only be processed at room temperature</li> </ul>	 <p>Not allowed</p>
<p><b>LEVEL 4</b> (Color code: Red)</p>	<ul style="list-style-type: none"> <li>• Samples processed outside NNfC (PV Lab, etc.)</li> <li>• Sample with unknown lineage.</li> </ul>	

**Please note that samples processed in Level 3 will not be accepted in level 2 or 1**



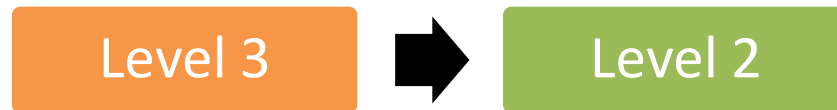
# Process Flow Rules

- Sample always move downstream
  - from a lower level to a higher level
- Exceptions: Lithography and inline characterization
  - But make sure the chuck is clean before you put samples on it
- “Dirty” substrates always assumed to be “metal-contaminated”
  - E.g. glass slides always start at level 3 or above
- Special process flows exist for “jumping” from a higher level to a lower level
  - However, “jumps” have to be evaluated on a case-by-case basis

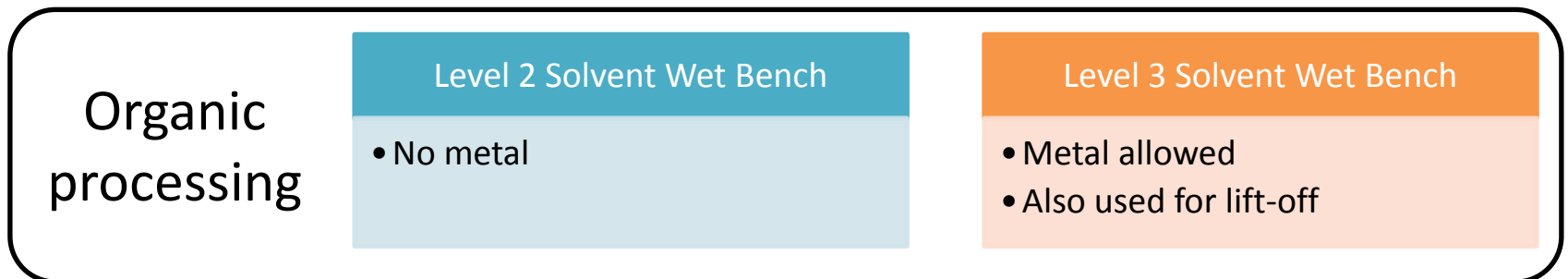
# Process Flow Rules ...

- Direct entry to FirstNano atmospheric furnaces only from Level 1 wet benches
  - Except for 1 tubes which are level 2
- Some machines have multiple levels, depending on recent history
  - E.g. PECVD.

PECVD chamber clean



- Separate wet benches for “metal-free” & “metal-contaminated” organic processing
  - Organic == involving acetone/IPA/methanol/ethanol



# Chemical Wet Benches (CWB)

Old Name	New Name	Level
Preclean bench	CWB Acid Clean (BULK process only)	1
Chemical wet bench general	CWB Acid clean	1
Chemical wetbench CMOS non-metal	CWB Acid semi-clean	2
Electroplating bench/General wet bench 2	CWB Solvents/bases semi-clean	2
Chemical wetbench MEMS non-metal (BULK processes)	CWB Acid semi-clean bulk (Metal etching allowed)	3
Chemical Wetbench CMOS metal	CWB Acid Metal	3
Solvent bench	CWB Solvent/bases	3
	CWB HF vaporiser	3

No wet bench available at Level 4

Samples from Level 4 equipment to be processed at PV or polymer processing lab

# Wet Etches with **NO METAL**

## CWB Acid clean (Level 1)

- **Usage:** Oxide, oxynitride, PSG and BSG etching + RCA and Piranha
- **Allowed Samples:** New wafers or wafers processed in Level 1 First nano furnace/RTP-2

## CWB Solvents/bases semi-clean (Level 2)

- **Usage:** Solvent processing of samples from Lithography having NO metal contamination + clean TMAH
- **Allowed samples:** To/from Level 2 equipment + Oxide/nitride from PECVD (after chamber clean)

## CWB Acid semi-clean (Level 2)

- **Usage:** RCA clean to jump from Level 3a to Level 2
- **Allowed samples:** To/from Level 2 equipment + To/from Level 3 equipment after metal etch.

# Wet Etches **with Metal**

## CWB Acid semi-clean bulk + Acid Metal (Level 3)

- **Usage:** Wet etching of metals, Electroplating of Gold, Metal Lift off, Mask clean
- **Allowed Samples:** From Level 3 tools like sputtering, e-beam evaporation, RIE-Cl

## CWB Solvent/bases (Level 3)

- **Usage:** KOH etching, TMAH etch for gold contaminated samples
- **Allowed sample:** from Level 3 tools like sputtering, e-beam evaporation, RIE-Cl

## HF Vaporizer (Level 3)

- **Usage:** Vapor etch using HF

## CPD (Level 4)

- **Usage:** Releasing MEMS structures

# Use of tweezers, gloves and glassware

- Cleanroom provides tweezers only for Level 1/2 RCA
  - User to have their own tweezer for other levels
- Only quartz glassware are allowed on Level 1 and Level 2 acid processes
  - No glass, no borosilicate glass, & no pyrex.
- Metal tweezers NOT allowed in Level 1 and Level 2 wet benches
- Use only dedicated tweezer/gloves for each level
  - DO NOT mix.
  - If you have made a mistake please inform.
- Gold processing always has to be done on separate glassware

# Levels of First Nano/RTP furnaces

## Level 1

- Si oxidation and dopant diffusion
- Drive-in/sintering
- RTP-2 for oxide and oxynitride

## Level 2

- LPCVD SiN<sub>x</sub>
- Poly and Epi Si/Ge
- Low-temperature oxides (TEOS)
- BSG & PSG
- Metal Annealing (Semi clean: Al, Ti, W only)

## Level 3

- Poly Epi-Si/Ge deposition (Nanowire growth on metal containing samples)

## Level 4

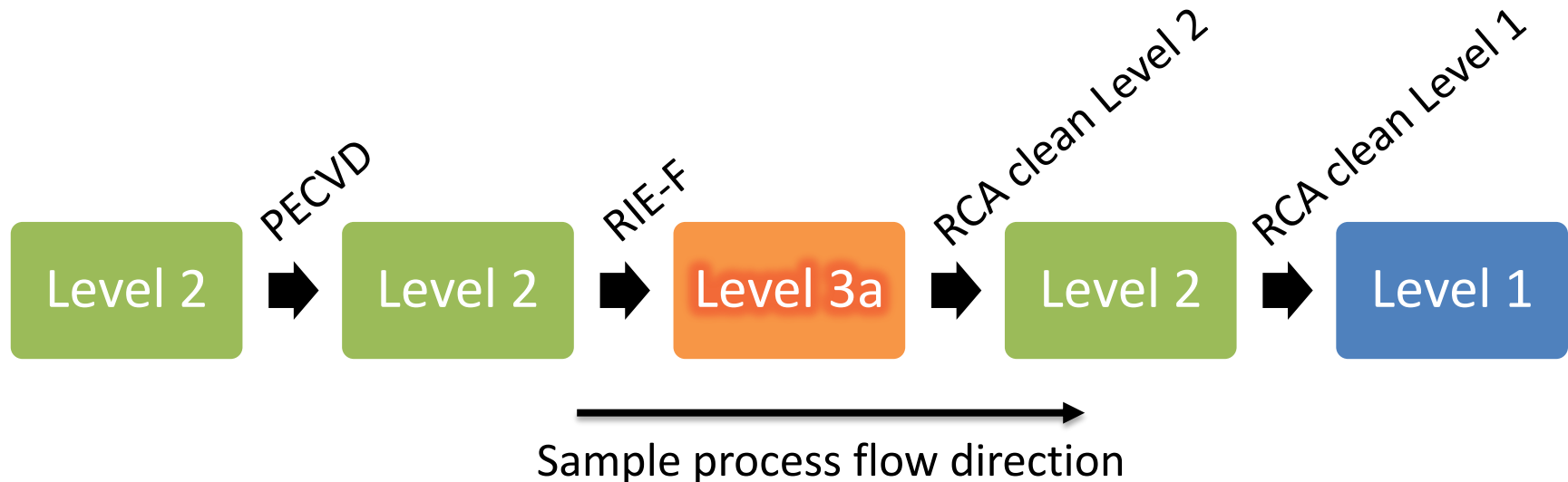
- RTP-1 for metal contact anneal

# Allowed or Not-Allowed: Example 1

- Level 2 sample
  - Nitride deposition in PECVD
  - Nitride etch in goes RIE-F
  - Anneal in First Nano furnace

Equipment	Level
PECVD	Level 2/3
RIE-F	Level 3a
Diffusion Furnace	Level 1

Do chamber-clean for Level 2 PECVD



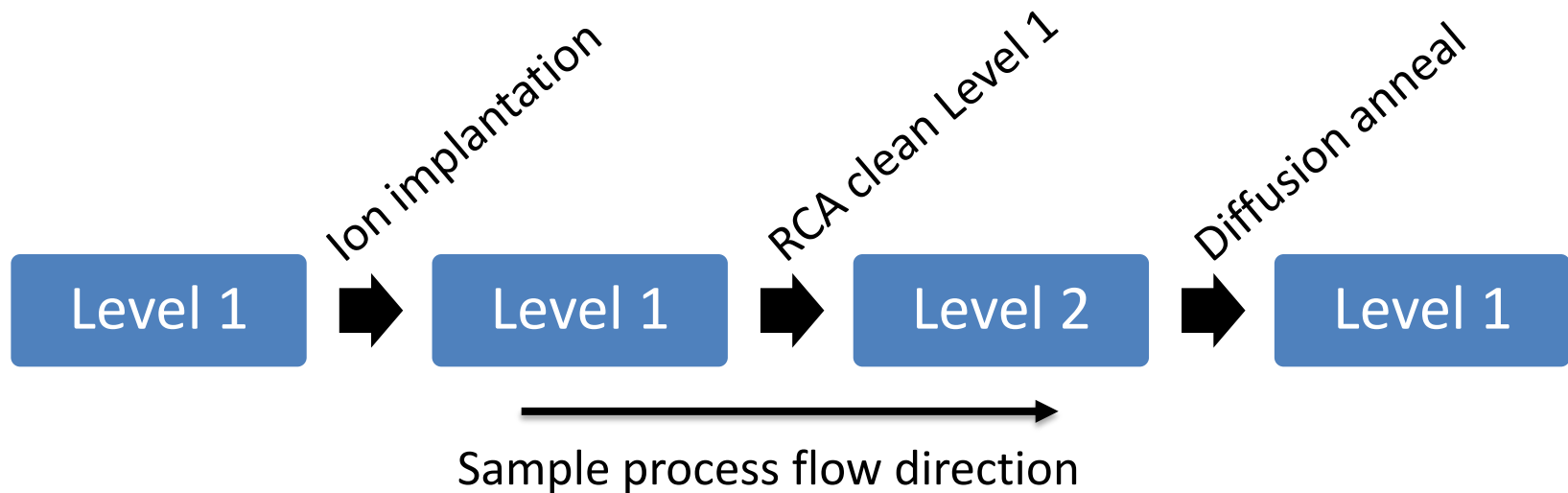


# Allowed or Not-Allowed: Example 2

- Level 1 Si sample
  - Goes out for ion implantation
  - To be annealed in FirstNano diffusion furnace

Equipment	Level
Ion-implantation	Level ?
Diffusion Furnace	Level 1

Ion implantation at reputed place is expected to be clean



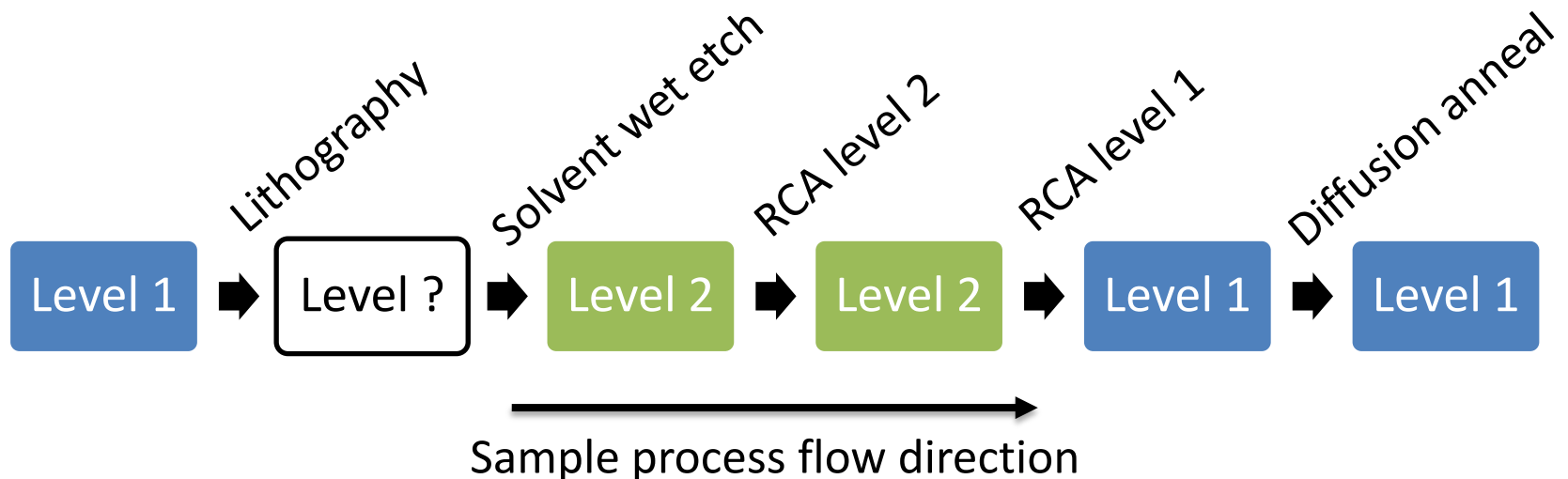
# Allowed or Not-Allowed: Example 3

- Level 1 SiO<sub>2</sub> coated Si sample
  - Goes to lithography
  - Solvent wet-bench
  - Anneal in FirstNano diffusion furnace

Equipment	Level
Lithography	Level ?
Solvent etch	Level 2
Diffusion furnace	Level 1

Lithography is level-less process.

Solvent clean is level 2. Need RCA clean to “jump up” Level 1

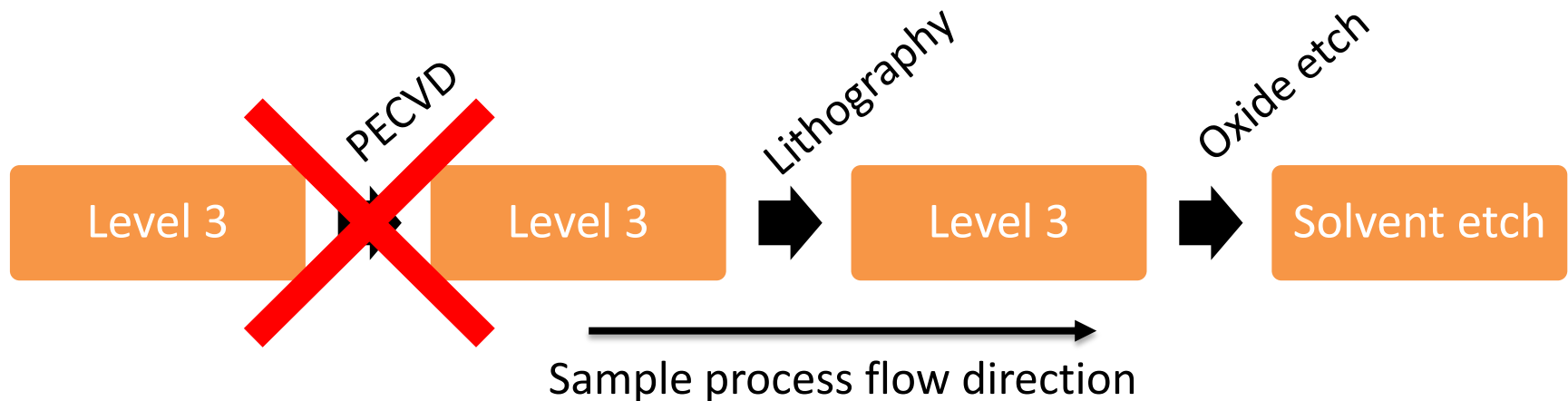


# Allowed or Not-Allowed: Example 4

- $\text{Cu}_2\text{O}$  containing sample
  - Deposit PECVD oxide on top
  - Lithography
  - Solvent etch

Equipment	Level
PECVD	Level 2/3
Lithography	Level ?
Wet Etch	Level 3

Level 3 PECVD will be exposed to Cu



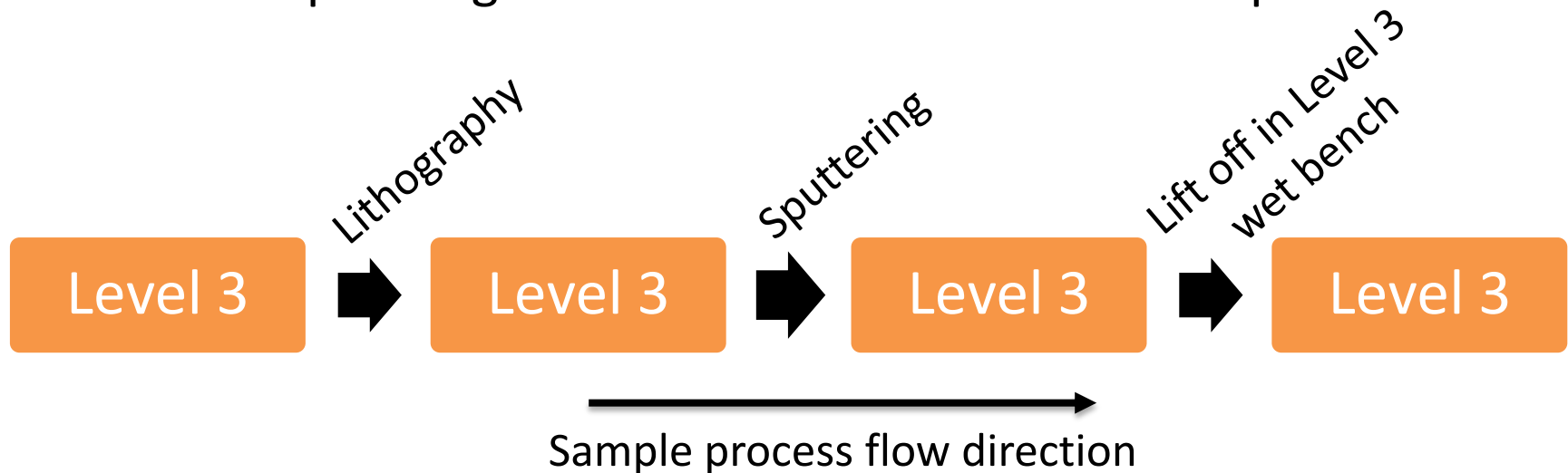
# Allowed or Not-Allowed: Example 5

- $\text{Cu}_2\text{O}$  containing sample

- Lithography
- Sputter oxide on top
- Lift-off

Equipment	Level
Lithography	Level ?
Sputter Tool	Level 3
Lift-off	Level 3

$\text{Cu}_2\text{O}$  is allowed in level 3 sputter tool. However need separate glassware for lift-off with Cu-sample



# Not sure about your process flow?

- For evaluation , please send an email to [savithap@iisc.ac.in](mailto:savithap@iisc.ac.in) with your detailed process flow
  - Need at least a 7 day advance notice to respond.
  - No last minute permissions