 NUS National University of Singapore	Department of Physics National University of Singapore		Ref. No <i>SOP/001</i>
Standard Operation Procedure Title: Chemical vapor deposition furnace		Rev. No <i>002</i>	
		Pages: <i>6</i>	
Lab: Nanomaterials & Devices Group			
Written by	Approved by	Issue date	Review date
Loh Leyi	A/Prof Eda Goki	25/12/2021	25/12/2024

1. Purpose

The objective of this SOP is to provide guidelines to all the laboratory personnel on operating chemical vapor deposition furnace.

2. Scope

The procedure is applicable to all research staff, research students and technical staff working in the laboratory.

3. Responsibility

It is the responsibility of the PI in conjunction with the laboratory I/C to ensure that all research and technical staff and students are advised, prepared and trained.


3.1. Principal Investigator

The Principal investigator is responsible for the implementation of these guidelines and takes ownership of all research and technical staff, graduate and undergraduate students under his charge in ensuring that they will carry out their activities in a reasonably practicable manner. The PI has to ensure that all the above mentioned personnel are adequately advised, prepared and trained.

3.2. Staff / Students

All research and technical staff and graduate students are under the obligation to work and behave safely and are responsible for taking care of their own health and safety and not placing themselves or others at risk of injury

4. Personal protective equipment

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At a minimum, safety glasses with side shields, long sleeved laboratory coats, chemically resistant gloves, N95 face mask and closed toed shoes should be worn. This is to be considered as minimum protection and must be upgraded if necessary.

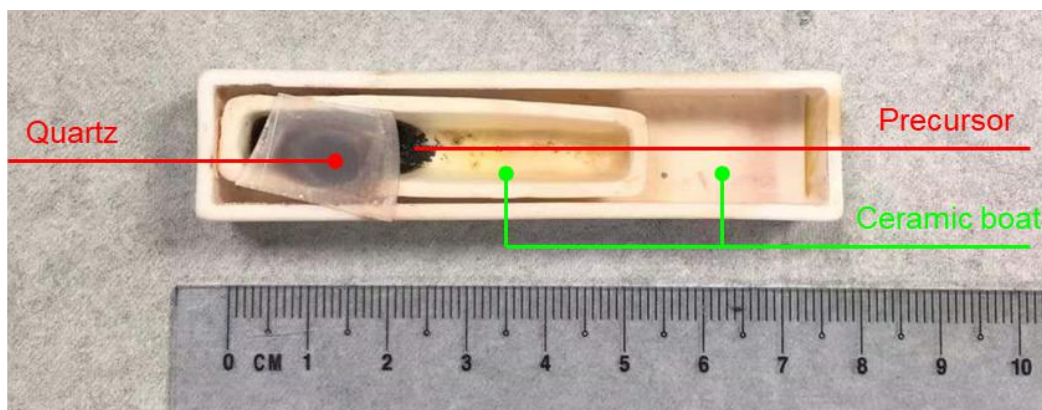
5. Safety precautions

Inspect equipment to be used and ensure all are in proper working condition. Report any equipment deficiencies prior to use.

6. Procedure

6.1. Precursor loading

- Check the quartz tube is free from any cracks or defects before using it for CVD growth process. Check the quartz tube for any contamination that can affect the quality of CVD growth process.
- Dispose cracked or defective quartz tube into the sharp bins. Cracks or defects can lead to gas leaks
- Weigh and transfer all chemical precursors onto the alumina crucible
- Wear N95 masks, lab coats, gloves and safety glasses when handling all chemical precursors to avoid inhalation or ingestion of toxic chemicals
- Place the substrate on the ceramic boat either face down or face up depending on the CVD growth technique



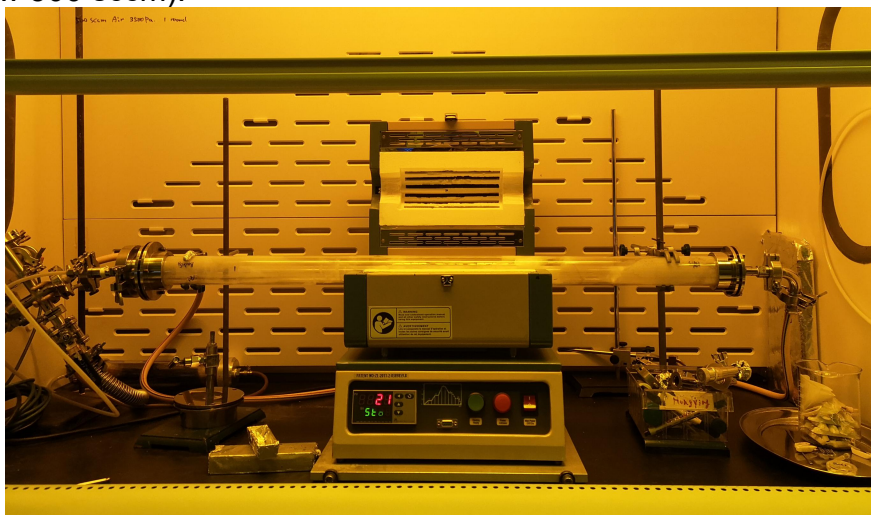
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6.2. Boats loading

- Carefully load the ceramic boats containing chemical precursors into the quartz tube
- Precaution: Alumina boats can topple during loading process resulting in chemical spills inside the quartz tube and contamination of growth substrate.

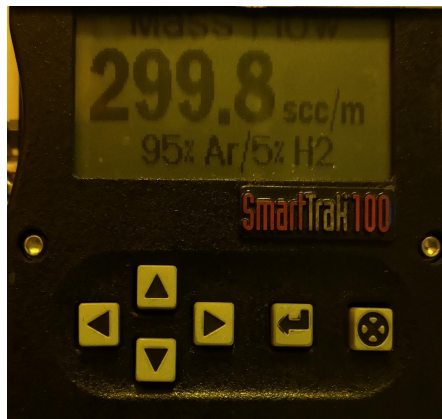
6.3. Furnace sealing

- Connect one end of the quartz tube to the pump and waste channel. Connect the other end to the gas line depending on your experiment. (N₂, Ar, Ar/H₂ (95%/5%)) are available for use). Ensure the screws and clamps are securely tightened so that both ends of the quartz tube connection are closed and sealed to avoid potential gas leaks during CVD growth process.
- Close the valve connecting the quartz tube to the waste channel and open the valve connection to the vacuum pump. Turn on the vacuum pump to remove the air from the quartz tube and purge the quartz tube with reaction gas (N₂, Ar, Ar/H₂ (95%/5%)) for 5 minutes at maximum flow 500 sccm).



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- Ensure that the valve connected to waste channel is fully closed before turning on the vacuum. Failure to do so will lead to the vacuum pump sucking the waste in the waste channel into the vacuum pump and reaction chamber.
- Precaution: The pressure inside the quartz tube should reach the minimum reading when vacuum pump is turned on with no gas flow. If the pressure does not reach minimum reading, there is a source of leaks in the setup.
- For different CVD growth atmosphere:
- If CVD growth recipe is performed at atmospheric pressure. After purging, close the vacuum valve and turn off the vacuum pump. Wait until the flowing gas reaches the atmospheric pressure. Open the waste exhaust channel to allow excess pressure and waste gas to flow out of the system during CVD growth process.
- Failure to open the waste exhaust channel will lead to gas pressure build up inside the reaction chamber and eventual explosion during CVD growth.
- If CVD growth is performed at vacuum pressure, proceed to the next step
- Set the gas flow rate into the growth range (typically between 0 and 100 sccm)



- Set the temperature process at the furnace.
- Do not exceed temperature of 1000 degree Celcius especially for heating for extended period

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- Allow the CVD process to proceed until the end
- Cool down the furnace.
- If the users wish to rapidly cool the reaction chamber by opening the furnace, ensure that users wear thermal gloves when opening the reaction chamber to the environment. Turn on the fan to assist in rapid cooling
- If the experiment is performed at vacuum environment, return the reaction chamber to atmospheric pressure before unloading the sample by following step 7A.
- Prior to opening the reaction chamber to unload the sample, purge the reaction chamber with inert gas (Ar or N₂) for 5 minutes to remove any toxic gas generated during the experiment
- Carefully unload the sample with the reaction chamber.
- Precaution: Alumina boats can topple during loading process resulting in chemical spills inside the quartz tube and contamination of growth substrate.
- Clean the quartz tube and ceramic boat after your experiment is finished.
- Dispose the toxic byproducts into the appropriate chemical waste bin

7. Operation control

7.1. Administrative control

- Only trained personnel can use CVT system
- Safety labels are pasted on fumehood

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7.2. Engineering control

- The experiment is implemented inside fume hood
- Proper person protective equipment

8. Revision History

Date Revised	Revision No.	Author	Revision Summary
20.12.2018	001	Eric Linardy	
27.12.2021	002	Chen Mingjun	Edit