

This is a shorted version that focuses mainly on the operation.

1. Scope

1.1 This document provides operating procedures and requirements to grow silicon nanowire array with the Nanowire CVD growth furnace.

1.2 System description

Nanowire CVD growth furnace is capable of growth of many different materials by using CVD (chemical vapor deposition) method. It can also be used as a reaction vessel which needs heating or vacuum.

2. Before starting: Important note

2.1 You have to be authorized by Dr. Tang and properly trained by Dr. Tang's group member before operating the furnace.

2.2 Hydrogen is very explosive; make sure the system does not leak before you run the hydrogen. Hydrogen must be shut down after you have finished your experiment.

2.3 You should change the reaction tube if you want to run a reaction different from the one before, the previous tube should be sealed and preserved carefully.

2.4 Do not run the furnace before you shut down the lid.

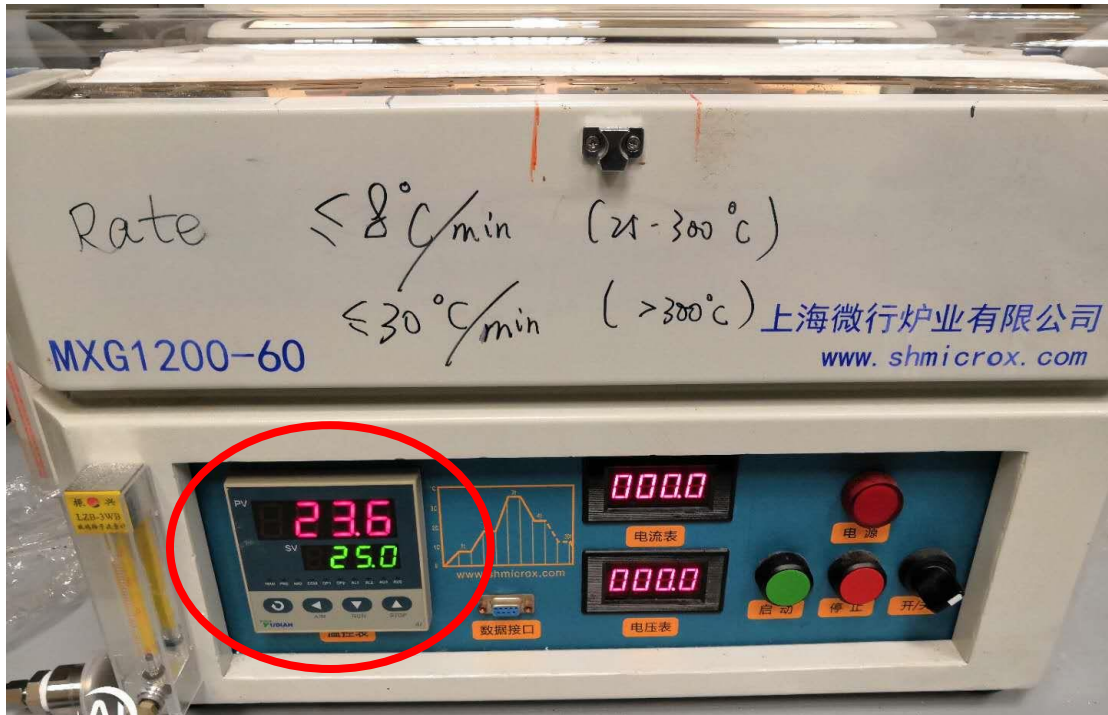
2.5 Please shut down the furnace and the gas if you hear any noise or see something unusual, never hesitate to ask our members for help.

2.6 The three gas control switches should be open in the sequence from the bottom to the top, and closed from top to the bottom.

2.7 The vacuum switch should be adjusted slowly when the system turns from normal pressure to vacuum.

3. Parameter settings

3.1 The program can be set on the control panel as shown in the red circle below.



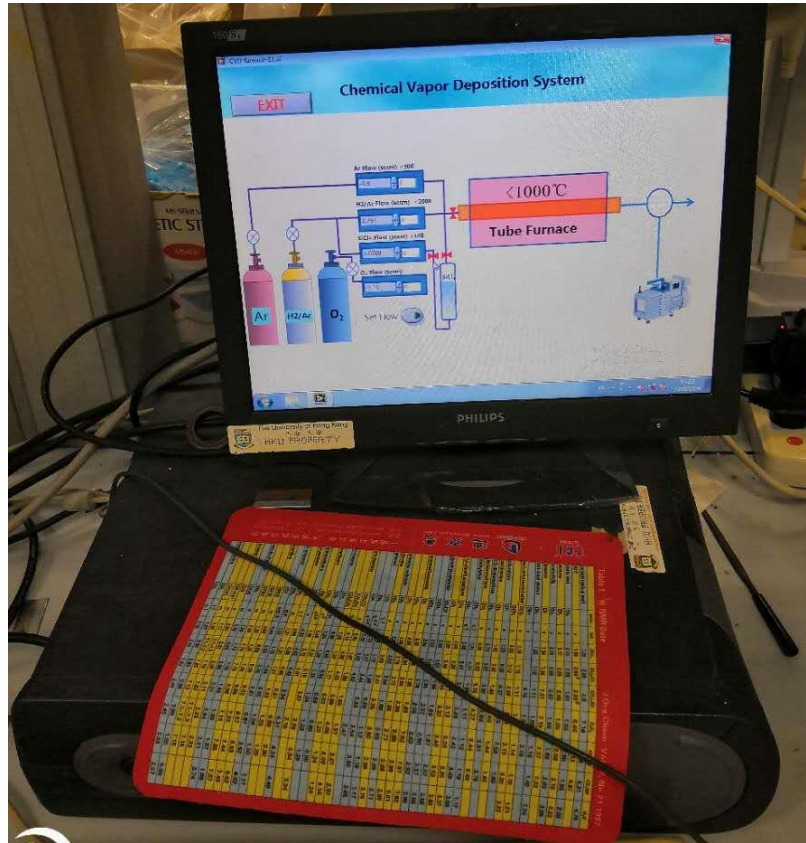
3.2. Press "A/M", you can set the temperature, then press "Enter".

And set time and "enter". The program should end with "-121". Exit edit mode by pressing both "Enter and A/M" at the same time.



3.3 The furnace will run by pressing “RUN” button for 2 second, and it will stop by pressing “STOP” button for 2 second.

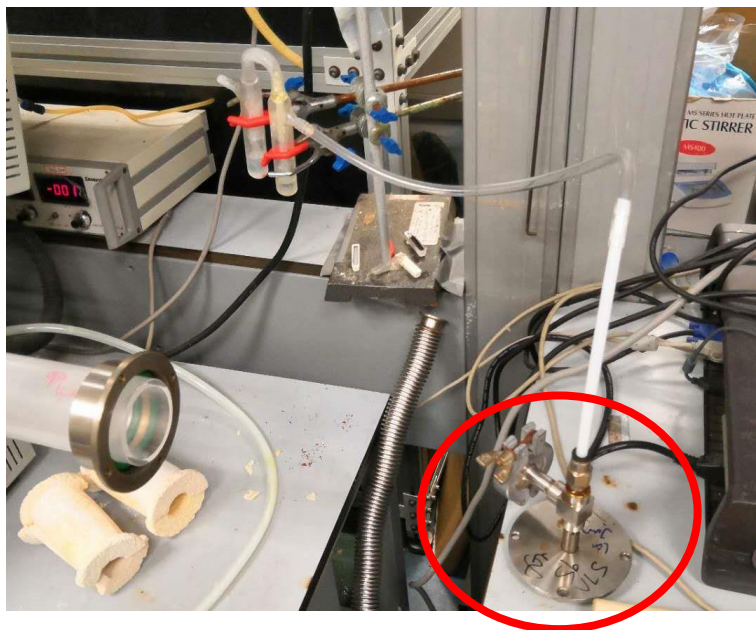
3.4 All the gas should be controlled by the mass controller:



3.5 The gas cylinder valve should be open before use and close immediately when you finish. **Do not adjust the pressure relief valve (circled in the following pictures).**



3.6 Exhaust gas should out though the tube.



Two furnace operation procedure is almost the same, for the operation detail please check the manual:



4. Growth run (using growth of silicon nanowire as an example)

1. Bake the tube under vacuum at 1000°C with 100sccm Ar and 10% H₂ for 1 hour (optional, but will stabilize your growth and is needed if the tube is open to ambient for more than 24 hours)
2. Coating tube with silicon at 950°C with 300sccm Ar and 10% H₂ and 300sccm SiCl₄ for 30 min (optional, but will stabilize your growth and is needed if the tube is open to ambient for more than 24 hours).
3. Conditioning the tube: use your growth condition without sample for 20 min (needed at the beginning of the day)
4. Fix the Argon (can start with 300sccm or 400sccm) and temperature, change SiCl₄ flow in 20sccm interval and find best vertical condition
5. Fix the SiCl₄ flow as the number got in step 4 and change the Argon flow rate at 10sccm interval, and find the best condition
6. Check good sample in SEM for smoothness

7. Go back to step 4, and change the flow rate proportionally for best condition.
8. System idle, pump system into vacuum with 50sccm H₂/Argon and temperature 400 °C (this is good to keep condition relatively unchanged overnight, which makes you skip step 1 and 2)

Questions:

1. How to set the temperature controlling program?
2. How to change the gas rate?
3. How to deal with the exhaust gas?