



## Usage Policies Notebook for 2 inch Nano Furnace

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## Emergency Plan for 2 inch Nano Furnace

### Standard Operating Procedures for Emergencies

#### Contact information

Person	Phone number
Lab Manager	Jake Hes, 949-824-8239 (day), 562-522-8328 (alternate)
Director	G.P. Li: 949-824-4194 (day), 949-824-2047 (alternate)
Staff	Mo Kebaili: 949-824-8239 (day), 949-494-5892 (alternate)
Super User	Carlos Ruiz (818) 527-6349 (Anytime, voicemail or text only)

#### Hazardous chemicals, gases, and conditions

Hazard name	Description of hazard
High voltage	Electrical shock, ignition source
CH <sub>4</sub> (Methane)	Flammable, Non-corrosive
H <sub>2</sub> (Hydrogen)	Flammable, Non-corrosive
N <sub>2</sub> (nitrogen) gas	Asphyxiant Non-flammable,
Ar (Argon)	Non-flammable, non-toxic



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## Alarms or indications of danger

Alarm type	Condition and response
Gas Detector (Sensidyne)	
H <sub>2</sub> and CH <sub>4</sub>	
O <sub>2</sub> flow Alarm	Problem with process state. Halt process and correct problem or notify the staff or the lab manager before continuing.
Pungent or foul smell	Gas leak. Shutdown the tool at once and evacuate the area. Contact the staff and the lab manager.

### Emergency shutdown plan #1

In the event of an emergency, when there is very little time, *press the large red emergency shut-off button at the entrance of the room 1*, this will shutdown the gas system, and will stop the gas flow. Leave the facility at once, and then contact the lab manager or the staff.

### Emergency shutdown plan #2

In the event of an emergency, when there are a few minutes available, *turn off the gas switches on the gas panel, the control power and the main power*. This will stop gas flow into the system. If there is no fire, and no smell of gases, enter the room and close off all gas cylinders by turning them fully clockwise. Check the oxygen tank, feel the door for possible fire, and if safe, close the oxygen tank by turning fully clockwise. Leave the facility at once, then, contact the staff and the lab manager.

# Usage Policies for 2 inch Nano Furnace

## Standard policies for usage

The nano furnace can accept up to 2" substrate to grow carbon nanotubes. Mass flow controllers digitally control H<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>, and Ar gas flows. The programmable temperature range is up to 1000°C.

### Contact information

The INRF staff or the lab manager can be reached at (949) 824-8239 or (949) 824-9831.

### Authorized users

Only INRF registered users who have completed the training and passed the certification can use this equipment. Users can only use the portion of the system for which they have been trained.

### Training

Users must have received direct training from the staff in order to use this equipment. Users are expected to understand the nature of the system, as well as the proper control and use of the gases. Training varies slightly, depending on the process to be performed. Contact the staff for details and to arrange for a training session.

### Usage log sheets

Users are required to log all activities in the log sheets provided. All users must log in when they used the furnace (date and time), which gases they used, and when they completed their process in the user log sheets. If users notice anything unusual, they should record it in the user log sheets, and add details in the main comments area on the log sheet. Any maintenance to the tool will be logged in the maintenance log sheet (maintenance staff only).

### Safety equipment

As safety equipment for use on this equipment, cleanroom gloves and tweezers should be used when handling pieces in the tube. Care should be taken to avoid burns when working near the furnace tube. The users need to use the gas leak detector to make sure that no gas is leaking from the furnace tube end cap.

### Standard equipment and materials

The laboratory provides the following gases: N<sub>2</sub>, H<sub>2</sub>, CH<sub>4</sub>, and Ar. Other gases must be cleared with the lab manager.

### User maintenance \*

To keep the furnace contaminant free, keep the end cap on the tube when it is not in use to keep a positive pressure within the furnace tube under N<sub>2</sub> flow.

**Waste disposal**

Dispose of alcohol soaked wipes in a waste container marked for flammable solid waste.

**Scheduling**

Reservation can be done online, and the system can be used on a first come, first served usage if no reservation was made.

**Other issues**

Users should remain physically present in the cleanroom facility during the entire use of the nano furnace.

At no time should a user adjust a pressure regulator on a gas line. Gas control should be “on” or “off” only, using only the appropriate valves. For most gases, this is usually the valve at the cylinder head.

**Non-standard use**

Users may not modify any hardware on this equipment. For use of non-standard processes, gases or materials, contact the staff or the lab manager.

# Usage Notes for 2 inch Nano Furnace

## Guide for using the Nano Furnace

### Gas Cylinders

All gas cylinders should be turned on or off at the cylinder valves. At no time should a user adjust a pressure regulator. Clockwise for all valves, means CLOSED. The standard off configuration for the system is to close the cylinders valves, but leave all other valves alone.

### System Setup

The nano furnace can accept up to 2" substrate to grow carbon nanotubes. Mass flow controllers digitally control H<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>, and Ar gas flows. The programmable temperature range is up to 1000°C.

150 sccm of N<sub>2</sub> flows in the quartz tube, when the nano furnace is in the idle mode. This N<sub>2</sub> flow maintains a positive pressure in the quartz tube to keep it clean from particulates contamination.

There are four mass flow controllers dedicated for H<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>, and Ar used by the nano furnace. Each mass flow controller can be digitally set to maintain a preset gas flow.

### Safety Check

The nano furnace is monitored by a combustible gas leak detector. The combustible gas detector is installed above the furnace.

The users should verify that the exhaust scavenger has a negative flow.

The users should check for any potential leak of combustible gases with the handheld leak detector, around the nano furnace.

In case of a potential combustible gas leak, the users should abort their process, they should stop flowing combustible gases inside the nano furnace, by setting the hydrogen and methane mass flow controllers to zero. The users should immediately contact the INRF staff or the lab manager.

**A. STANDBY**

1. The quartz tube is at 25°C ambient temperature, and has N<sub>2</sub> purging it at 150 sccm flow rate.
2. The exhaust overhead should be on with a negative flow. Verify by looking at the indicator.
3. The gas cylinders should be turned off at the cylinders' valves.
4. The Sensidyne combustible gas detector should be online. Verify that the calibration date is less than thirty days.

**B. SAMPLE LOADING**

1. Carefully remove the end cap from the quartz tube and slide your sample into the center of tube with N<sub>2</sub> flowing.
2. Reinstall the end cap onto the quartz tube.

**C. SYSTEM START UP**

1. Open the argon cylinder valve. Do not adjust the regulator, and it should be delivering 12 psi.
2. Switch the cable from the N<sub>2</sub> mass flow controller to the Ar mass flow controller. Set the Ar flow controller to 1500 sccm.
3. Turn off the N<sub>2</sub> gas.
4. Turn on the furnace temperature controller to run the predefined temperature program. (Do not change the program without informing the INRF staff.)
5. Keep flowing Ar until the temperature reaches 900°C in the quartz tube. (The temperature ramping will take about 30 minutes.)
6. Make sure that the temperature is stable at 900°C before opening the combustible gases valves.
7. Open the H<sub>2</sub> and CH<sub>4</sub> valves located on the top of the cylinders. Do not adjust the regulators. Record the cylinder pressures in the logbook.
8. Turn on the H<sub>2</sub> and set the mass flow controller to 200 sccm. Use the portable leak detector to verify that good seals are made throughout the quartz tube.
9. After verifying that there are no combustible gas leaks, turn off the Ar valve. Keep the H<sub>2</sub> flowing at 200 sccm for 5 minutes.
10. Turn on the CH<sub>4</sub> and set its mass flow controller to 1000 sccm.
11. Keep the gases flowing for 10 to 15 minutes. Do not exceed 15 minutes.
12. At the end of the activated growth the temperature of the quartz tube will start to drop. Turn off the CH<sub>4</sub>.
13. Turn on the Ar, and its flow rate should be set at 1500 sccm.
14. Turn off the H<sub>2</sub>.
15. Record the CH<sub>4</sub> pressure in the logbook and close the cylinder valve.
16. Record the H<sub>2</sub> pressure in the logbook and close cylinder valve.

17. When temperature of the quartz tube drops below 200°C, turn off the Ar gas and turn on the N<sub>2</sub> at a flow of 150 sccm.
18. Record the Ar pressure in the logbook and close the cylinder valve.
19. Let the system cool down to room temperature. Take out the sample. It generally takes more than 3 hours for the system to cool down to room temperature.
20. Clean the joint between the end cap and the quartz tube and gently rejoin them.
21. Put the system in the standby mode.