# Microwave Reactor Standard Operating Procedure (SOP)

Start of the day

1. Switch on the microwave power generator supply and set to 0 W, the exhaust valve controller, the MFC controller (press <ESC> twice, then <1> to go to the main display), the pyrometer display, and the water chillers (x2)

## Switching samples

1. Close the exhaust valve and gas line tap
2. Make sure lab jack is supporting reactor baseplate
3. Slowly open the air inlet valve until pressure begins to increase – listen for light hiss
4. At atmospheric pressure, gently lower the lab jack to drop the baseplate out
5. Change wire, disk and substrate as required and ensure they are centred
6. Raise lab jack, making sure not to shake baseplate. Align baseplate with chamber so it goes in freely – **do not force the baseplate into the chamber**
7. Close the air inlet valve to finger-tight
8. Turn exhaust valve control dial to SS and make sure pressure set point is set to 0
9. To get to base pressure: once pressure is low, open exhaust valve by small amounts until 10-1 Torr is reached, then open valve fully
10. Ensure required interlocks are “on” (blue) and interlock alarm is tripped (red)
    * **Water interlock must always be “on”**
    * For standard H-term/growth, pressure and H2 flow interlocks should be “on”
    * Reflected power interlock must **not be** turned “on” until plasma is stable

## Running reactor

Start up

1. Open taps for required gases and gas line tap
2. Turn on air blower behind rack and ensure pyrometer is set to correct emissivity
3. Set the set-point pressure (p) dial to 15 Torr and set the exhaust valve to “Auto”
4. Turn on the H2 flow by pressing <ON><ALL> then <ON><1> on the MFC controller
5. Wait for p to stabilise at about 15 Torr
6. Check the striking power (0.70 kW) on the microwave supply
7. Check air, water and gas flow, and reset interlock alarm (turns green); then reset the fault on microwave power supply display

***(Make sure you know steps 19-22 as they must be performed in rapid succession)***

1. Strike by pressing “Start” on microwave power supply. Check if plasma has struck, and check it sits nicely above substrate (not on quartz window)
   * If no plasma is visible/high reflected power (>0.35 kW), tune to strike plasma: at around 0.32 kW, plasma *usually* strikes and reflected power drops
   * If plasma won’t strike, drop pressure until it does - do not go below 10 Torr.
   * **Do not run with high reflected power (> 0.35 kW) for more than 1 minute**
2. Turn up pressure ***quickly*** **after** striking and check plasma position again
3. Set conditions required for growth. Try to change P and p together by setting p, then dialling P slowly. Take care when changing power (P) as the dial varies increment with speed of dial turning. Aim for P ≈ 10p. If using CH4, turn on at about 50 Torr
4. Minimise reflected power using (left and middle) knobs on top of the waveguide
5. Turn “on” (blue) interlock for reflected power
6. -----------Watch pretty colours-------------

Shut down

1. Switch reflected power interlock “off” (orange) before changing any conditions to avoid accidental trip
2. If used, switch off non-hydrogen gases after growth time is complete and leave for at least 2 minutes to pump chamber clear of carbon
3. Slowly turn down microwave power dial and pressure set-point dial simultaneously, stopping p at 30 Torr, until plasma goes out
4. Press “Stop” on microwave power supply, set pressure set-point to 0 Torr, open exhaust valve and turn off H2 flow
5. Turn off air blower when cool and ensure the MW power is set to 0 W
6. Close gas taps and gas line tap
7. Return to step 2 to remove sample/switch samples between runs

## End of the day

1. Set the microwave power generator supply to Standby. Turn off the exhaust valve controller, the MFC controller (press <ESC> to return to the main menu, then <0> to go to standby), the pyrometer display, and the water chillers
2. Ensure the chamber is under vacuum before leaving it for extended durations

Information on interlocks:

Conditions for interlock to trip and trigger alarm (turning off MW power):

* + Water must go from “on” to “off”
  + Pressure must go above 300 Torr
  + Reflected power must go above 20 W
  + H2­ flow must go below 100 sccm

If intending to run the reactor outside of these conditions, please consult with Paul May or James Smith to get approval first.

If you encounter any problem while using the reactor, turn off MW power (“Stop” on microwave power supply display), turn off all gas flow and contact either:

Paul May – paul.may@bristol.ac.uk

James Smith – james.smith@bristol.ac.uk

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If something unexpected happens and you’re in any doubt as to what to do, **IMMEDIATELY** **TURN OFF MW POWER**, *then* seek assistance!

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