

This guide obtains information how to operate the MAGNETRON. Most of known issues and solutions are mentioned here. In case you need more detailed instructions, contact the instrument guarantor.

MAGNETRON Guide

Getting started

1. Start the program **Bestec Server396** and wait until the “Profile initialization finished” log appear.
2. Start the program **Bestec Client 396**.
3. Go to DESKTOP menu and select **396-Process**.
4. Start water **COOLING** circuit - click on Cooling/open valve **W-201** – right click and select “W-201 OPEN & CWP1-SWITCH ON”.
5. Check the motors **M-MT2** and **M-SR2** are initialized correctly. If not (RED state), choose the motor and click on “Find Ref”.

Known issue: M-MT2 may need several attempts to find reference.

Sample loading

6. Set the **motors positions**: M-MT2 to “Transfer LL-SP” and M-SR2 to “Transfer” position.
Known issue: If the motors are not in known position (RED state) return to step 5.
7. **VENT** the load lock (LL) chamber - right click on the LL scheme and select “Vent”.
8. **INSERT** the holder with the sample into the LL chamber and align it properly in horizontal front to back position.
Note: Bad horizontal alignment can prevent to insert the substrate holder into the process chamber holder.
9. Close the door to the LL chamber and fix it firmly.
10. **PUMP** the LL chamber to the pressure $< 1\text{E-}5$ mBar.
11. Open the valve **V-200** - right click on the V-200.
12. **LOAD** the sample to the manipulator stage in the deposition chamber.
Note: Switch on the light inside the process chamber might help.
13. Retract the transfer rod back to the original position.
14. Close the valve **V-200**.

Deposition setup

15. Set the sample deposition **DISTANCE** using M-MT2 - go to: Motor M-MT2 “SP Pos” (e.g. set 0 mm for the slowest but the most homogeneous deposition over 4” wafer or thickness “sensor” position (30 mm) for quicker deposition of small samples placed in the middle of deposited area with the same deposition rate as it is shown by THS-21 thickness sensor – see below).
16. Select the **material** for deposition – go to **396-Source configuration** menu and connect the source with desired material in Switch Box – right click on relay **REL-20x** scheme – “On”.

Known issue: source with desired material is not present in the “Source Configuration” box.

Solution 1: Call the instrument guarantor to solve it.

Solution 2: Experienced users may change the cable from one of connected sources to desired source under the process chamber. Note the number of reconnected cable (DC-OUTx or RF-OUTx) and change the source number

on the drop-down menu next to the number of reconnected cable in source configuration menu. Then connect the source as it is written in this point above.

17. Go back to **396-Process** menu. At the process chamber scheme close **VP-202** and **VP-203** valves, switch off **G21** gauge, open **VP-204** and **VG-201** valves – right click on them.
18. Manually open the valve **VS-20x** at the selected magnetron source under the process chamber.
19. Set **MFC-21** to desired Ar flow (e.g. 15 sccm) – write the number in sccm to the box and press Enter.
20. Set the pressure in the chamber to 9E-3 mBar – right click on **VP-201**, Control, SP [mBar], enter 9E-3 and click on “Set Press”. If everything is OK, the “Status” of all generators is green-checked.

Known issue: The Generator status is red-checked. Please wait until the correct pressure is set. You may also check the magnetron rack if the DCS-2x and RFCO-21 sources are switched on. If the problem persists, check all previous steps in this guide.

DC sputtering

21. Open the relevant magnetron source shutter – right click on relevant magnetron source scheme.
22. Go to the source relevant **GENERATOR DCS-2X** menu and set “Setpoint” to 20 W and “Ramp” to 0 W/s. Then click on “Set SP”.
23. **START** the source – press “On” button at selected generator. If there is no problem, “On” and “Plasma” fields as well as the source scheme will change color to green.

Known issue 1: The Plasma is not started in few seconds.

Solution 1: Try to increase the pressure in step 20. to 3E-2 mBar- or/and open the relevant magnetron source shutter if not done yet (step 21) and repeat the start.

Solution 2: Check if the correct cable is connected to the target. See the *Solution 2* in step 16.

Known issue 2: The Voltage is too low or 0 V, some current flows. The source is probably short-circuited. The process chamber needs to be opened to fix this issue. Please inform the guarantor about this issue.

24. Set the desired **power** of the source - set “Setpoint” to 20-180 W and “Ramp” to 2-5 W/s.

Know issue: If the target was not used for a long time or some reactive sputtering was done before, it is good to go to higher power to clean the target for 10-20 minutes before your deposition (**DON'T DO** that with expensive targets such as **Pt, Pd, Au!**).

Note: Going over 180 W is recommended for experienced users only! Please be sure that the target is cooled properly – indium foil under the target is usually needed.

25. Set the **deposition pressure** to ~1E-3 mBar (the lower pressures are recommended for higher deposition rates).

Known issue: Too low pressure might cause the discharge unstable or switch it off during deposition. To solve it, try to increase the pressure to ³1E-3 mBar (e.g. 1.3E-3 mBar for Al, 1E-3 mBar for most of other targets).

26. Open the relevant magnetron source shutter (if not done in step 21 already) – right click on relevant magnetron source scheme. If there is no need to measure the deposition rate jump to step 32.

27. In the **THICKNESS THS-21** menu select the deposited material - go to “Settings...” and select the material from drop down menu and press OK.

Note: The “Global Tooling” should remain at 100 %. The real tooling differs according to the deposited material in range from 60 % to 90 % and the distance of your sample from the source. Your own research on tooling factor is therefore needed! You may try to set “Global tooling” to 73 % for 0 mm (maximal) sample distance.

28. Manually **INSERT** the thickness Sensor **THS-21** into the chamber.

29. Select the desired **angle** of the source using Vernier shift under the process chamber. The angle can be deducted from the Excel file (396_Sputter_distances_and_angles_2015_07_29.ods) placed on Desktop (e.g. for 4" wafer and 4 mm thick target is good to use position -25.4 mm for homogeneous deposition which means 0.698 for Thickness Sensor distance and 0.631 for the wafer at 0 mm sample distance – see step 15).
30. Check the deposition rate ($\text{\AA}/\text{s}$) in the **THICKNESS THS-21** menu.

Known issue: The deposition rate measured at thickness sensor distance differs from the real deposition rate on the sample in case when the sample distance is different to 30 mm. The higher number (lower distance) is the higher is the real deposition rate. For homogeneous deposition over 4" wafers use of 0 mm distance is strongly recommended.

Solution: Never believe to the thickness sensor even the sample distance is at thickness sensor distance (30 mm)! Always make your own research on the real deposition rate for each material separately and use it in next depositions. You may try to set "Global tooling" to 73 % for 0 mm (maximal) sample distance.
31. Manually **RETRACT** the thickness sensor THS-21 from the chamber.
32. Set the magnetron source angle for the sample – see step 29 (e.g. 0.631 for 4" wafer).
33. Set the sample **ROTATION** (e.g. 5 rpm/min) – right click on the SUBSTRATE scheme.
34. **OPEN** the substrate shutter – right click on the SUBSTRATE scheme.
35. Let the deposition run for desired time period.
36. **CLOSE** the substrate shutter – right click on the SUBSTRATE scheme.
37. Go to the source relevant **GENERATOR DSC-2X** menu and set "Setpoint" to 20 W and Ramp to 2 W/s. Then click on "Set SP" and wait until the value of 20 W is reached.
38. **SWITCH OFF** the source – press "Off" button at selected generator and disconnect the sources in 396-Source configuration menu (described in step 16).
39. Repeat sputtering procedure for another material.

Switching back to normal state

40. Stop sample rotation – right click on SUBSTRATE, then select "SUBSTRATE rotation STOP".
41. Once all deposition processes are finished, set Ar flow to zero (**MFC-21**), wait 5 s, close **VG-201**, **VP-204**, open **VP-201**, switch on cold cathode gauge **G21** and open valves **VP-203** and **VP-202**.
42. Manually close the valve **VS-20x** at the selected magnetron source under the process chamber.
43. Wait for the pressure in process chamber $<1\text{E-6}$ mBar.

Sample unloading

44. Check the motors **M-MT2** and **M-SR2** are initialized correctly. If not (RED state), choose the motor and click on "Find Ref".

Known issue: M-MT2 may need several attempts to find reference.
45. Set the **motors positions**: M-MT2 to "Transfer_SP-LL" and M-SR2 to "Transfer" position.

Known issue: If the motors are not in known position (RED state) repeat the procedure described in step 5.
46. **OPEN** the gate **V-200** - right click on the V-200.
47. **UNLOAD** the sample to LL using the transfer rod.

Note: Switch on the light inside the process chamber might help.
Known issue: The rod is not well aligned to the sample holder.
Solution: Try to adjust the height and angle of the main stage in the process chamber. Please inform the guarantor.

48. **CLOSE** the gate **V-200** - right click on the V-200.
49. **VENT** the load lock (LL) chamber - right click on the LL scheme.
50. Remove the sample holder and fix the LL door firmly.
51. **PUMP** the load lock (LL) chamber - right click on the LL scheme.

RF sputtering

52. Go to the **GENERATOR RFCO-21** menu and set "Setpoint" to 20 W and Ramp to 0 W/s. Then click on "Set SP".
53. Set "Tune mode" to automatic regime – click on "Auto".
54. **START** the source – press "On" button. If there is no problem, "On" and "Plasma" fields as well as the source scheme will change color to green after several seconds of autotuning.
Known issue: The Plasma is not started in few seconds.
Solution: Try to increase the pressure in step 20 to 5E-2 mBar or/and open the relevant magnetron source shutter (step 21) and repeat the start. If the source doesn't start, try to set higher RF power - maximally 100 W.
55. Follow the steps 24-35.
56. Go to the **GENERATOR RFCO-21** menu and set "Setpoint" to 20 W and "Ramp" to 2 W/s. Then click on "Set SP" and wait until the value of 20 W is reached.
57. **SWITCH OFF** the source – press "Off" button at generator and disconnect the sources in "396-Source" configuration menu (described in step 16).
58. Repeat sputtering procedure for another material.

Sample heating

59. Switch on the generators **GENERATOR PS-21** and **GENERATOR PS-22** – go to generators menu and click "On".
60. Go to **HEATER ETD-21** menu and set the automatic or manual mode.
Note 1: In **automatic** mode, set the temperature of sample stage and ramp.
Note 2: In **manual** mode, set the percentage of generator power. See the plot below.
Known issue: The values in the plot were measured on a 4" metal plate. The real values for the samples on other substrates may differ from the plot. Make your own research for different materials if needed.
61. Check the **HEATER ETD-21 plot** to know the actual value of temperature at the sample holder.
62. Ramp down the temperature and switch off the generators **GENERATOR PS-21** and **GENERATOR PS-22** – go to generators menu and click "Off".

