CORAL Name: RIE-SAMCO-F-230iP

Location: Bay U6
Purpose: Etching
Contacts: Eric Lim, Bob Bicchieri, Donal Jamieson

Contents

Introduction 1
Safety 2
Hazards 2
User Qualifications and Responsibilities 2
Operating Procedures 3
Appendices 6
Material and recipe restrictions: 6
Loading of samples/carrier/cover ring: 6
Tips and Tricks: 8
Common Errors/Failures: 8
System software not on screen 8
Can't edit recipe time or other parameters 8
"APC2 offset low" error 8
System aborts during process 9
Pressure Conversion Chart 10

Introduction

The purpose of the RIE-F-SAMCO-230iP system is to etch semiconductor grade thin films using mainly fluorine-containing gases. The RIE-230iP utilizes high-density, inductively coupled plasma that is created using two RF power supplies. Additionally, the system utilizes a load lock chamber for faster sample loading, reduced etch chamber pump-down times and also to prevent accidental exposure to hazardous gases and etch byproducts. Baseline recipes are set up to etch Silicon, Silicon Dioxide, Silicon Nitride, Silicon Carbide, Silicon Oxynitride, as well as graphene and other 2D materials. We can also work with users to develop etches for other materials. There are some restrictions to what materials are allowed in the etch tool and what type of recipes can be run (see appendices).

The system software runs through a web interface to the main computer. At the bottom of the browser window, there are 6 buttons that are always present:



Figure 1 screen navigation buttons

These buttons are how we navigate between the different screens for the tool. To run wafers, the important screens are **Jobs** (1), **System** (2) and **Recipes** (3).

The system has a secondary screen and number of buttons below the monitor:



Power On:	Re-energizes system after shutdown
Power Off:	Turns off the power to the system – only qualified staff should press this and only after the system has been placed in a safe state.
EMO:	Emergency Machine Off - Press if the tool is behaving dangerously, or making loud noises.
BZ STOP:	Press this on the secondary screen to silence the machine



Safety

Hazards

- Hazards present on system are high voltage, RF radiation, and pressurized gases. Ar, N2, CF4, CHF3, and SF6 can displace oxygen and cause rapid suffocation, while CH4 and H2 are highly flammable, and O2 is a strong oxidizer and can cause or intensify a fire. Under normal operation the user is protected from these hazards by the tool panels and interlocks, and the Toxic Gas Monitoring System (TGMS). Do not attempt to open or remove any panels as you risk exposing yourself (and others) to these hazards.
- Mechanical pinch/crush points exist with the loadlock lid and robot arm. Exercise care when loading/unloading samples and carriers from the loadlock.

User Qualifications and Responsibilities

During training you will learn to run wafers and edit batches. To be considered qualified you need to be trained by the staff in charge, be up to date with your safety trainings and have a PTC approved process. There are restrictions to what materials are allowed in the etch tool and what type of recipes can be run (see appendices). Circumventing these restrictions or running processes/materials that have not been approved by the PTC can lead to disqualification from the tool.

Users are expected to leave the system with the 8” carrier in the loadlock and to pump down the loadlock before

disengaging from CORAL.

If you encounter any problems while operating the machine, report them immediately in CORAL so that the staff can address them in a timely fashion.

Operating Procedures

Reserve and engage the RIE-F-Samco-230iP on CORAL. CORAL disables the lid sensor on the loadlock, so you need to engage in order to run any process on the tool. Verify that the system is not being used and the 8" quartz carrier is in the loadlock.

Set correct User Level:

To edit run time or other parameters, you must be logged in at "BATCH" permission level. Select "BATCH" from the dropdown menu labeled "**User Level**" in the upper right of the screen and enter the password: mit

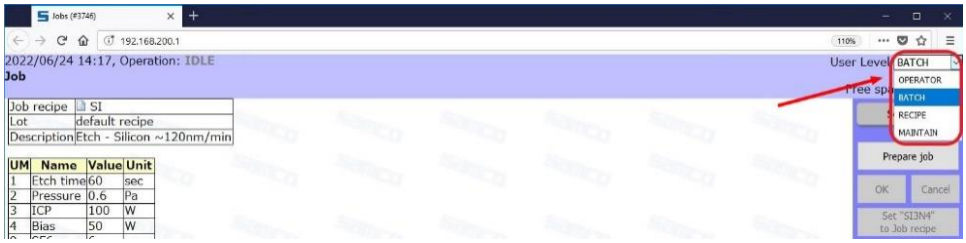
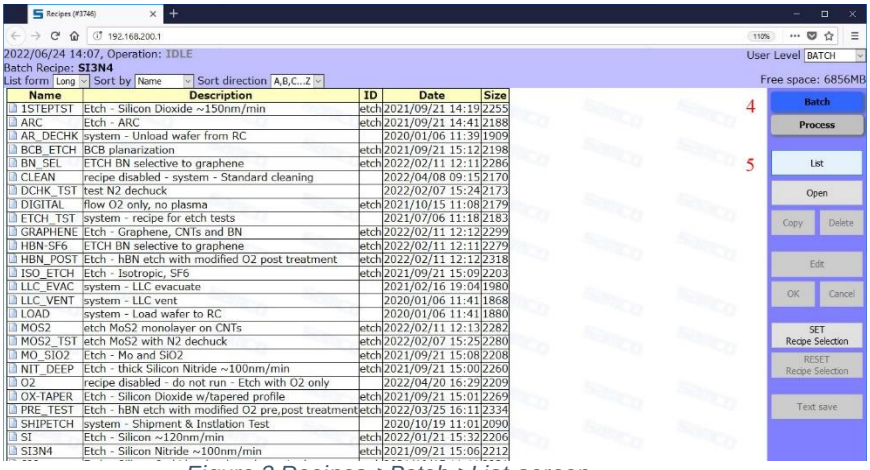


Figure 2 User level dropdown menu

Pre-condition chamber, then vent to load sample:

1. In the system software, go to the **Recipes** screen (3), click the "**Batch**" button (4) then click the "**List**" button (5) then select the Batch (sequence) you want to run. Valid Batches are indicated with "etch" in the ID field.



Name	Description	ID	Date	Size
1STEPTST	Etch - Silicon Dioxide ~150nm/min	etch	2021/09/21 14:19	2255
ARC	Etch - ARC	etch	2021/09/21 14:41	2188
AR_DECHK	system - Unload wafer from RC		2020/01/06 11:39	1909
BCB_ETCH	BCB planarization	etch	2021/09/21 15:12	2198
BN_SEL	ETCH BN selective to graphene	etch	2022/02/11 12:11	2286
CLEAN	recipe disabled - system - Standard cleaning		2022/04/08 09:15	2170
DCHK_TST	test N2 dechuck		2022/02/07 15:24	2173
DIGITAL	flow O2 only, no plasma	etch	2021/10/15 11:08	2179
ETCH_TST	system - recipe for etch tests		2021/07/06 11:18	2183
GRAPHENE	Etch - Graphene, CNTs and BN	etch	2022/02/11 12:12	2299
HBN-SF6	ETCH BN selective to graphene	etch	2022/02/11 12:11	2279
HBN_POST	Etch - hBN etch with modified O2 post treatment	etch	2022/02/11 12:12	2318
ISO_ETCH	Etch - Isotropic, SF6	etch	2021/09/21 15:09	2203
LLC_EVAC	system - LLC evacuate		2021/02/16 19:04	1980
LLC_VENT	system - LLC vent		2020/01/06 11:41	1868
LOAD	system - Load wafer to RC		2020/01/06 11:41	1880
MOS2	etch MoS2 monolayer on CNTs	etch	2022/02/11 12:13	2282
MOS2_TST	etch MoS2 with N2 dechuck	etch	2022/02/07 15:25	2280
MO_SIO2	Etch - Mo and SiO2	etch	2021/09/21 15:08	2208
NIT_DEEP	Etch - thick Silicon Nitride ~100nm/min	etch	2021/09/21 15:00	2260
O2	recipe disabled - do not run - Etch with O2 only		2022/04/20 16:29	2209
OX-TAPER	Etch - Silicon Dioxide w/tapered profile	etch	2021/09/21 15:01	2269
PRE_TEST	Etch - hBN etch with modified O2 pre,post treatment	etch	2022/03/25 16:11	2334
SHIPETCH	system - Shipment & Instlation Test		2020/10/19 11:01	2090
SI	Etch - Silicon ~120nm/min	etch	2022/01/21 15:32	2206
SI3N4	Etch - Silicon Nitride ~100nm/min	etch	2021/09/21 15:06	2212

Figure 3 Recipes->Batch->List screen

The Batch details should appear on the screen:

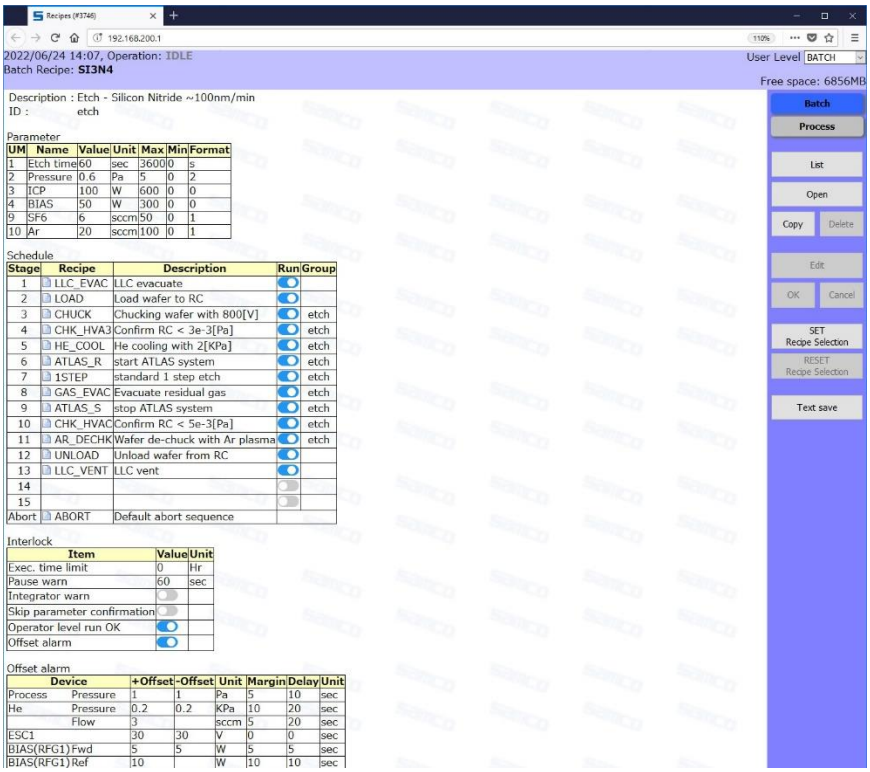


Figure 4 Batch details

2. Go to the **Jobs** screen (1) and click on "the "**Prepare Job**" button (6).

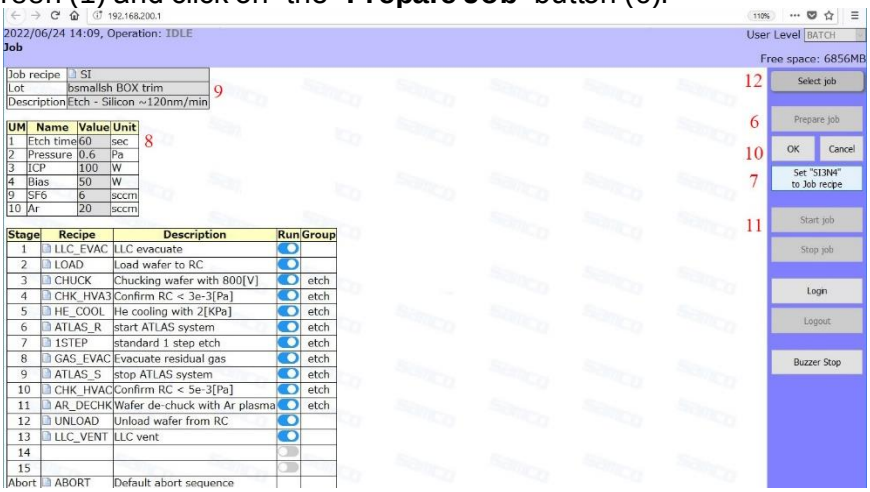


Figure 5 Jobs screen in prepare job mode

3. Click the button labeled "**Set 'xxx' to Job recipe**" (7) where 'xxx' is the Batch you selected in Step 2. This will load the selected Batch with default process parameters.
4. Click on the **Etch time** value field (8) to open a popup window. Enter a time for the etch process. Depending on the Batch, you may be able to change other process parameters as well.
5. Click on the **Lot** field (9) to open a popup window. Enter your Coral ID and a description of your run or any other comments you want to save.
6. Click "**OK**" (10) and the system will beep twice.
7. Click "**Start Job**" (11) then click "OK" in the popup window. The system will beep once and start the Batch. Processing details are available on the "**System**" screen (2).

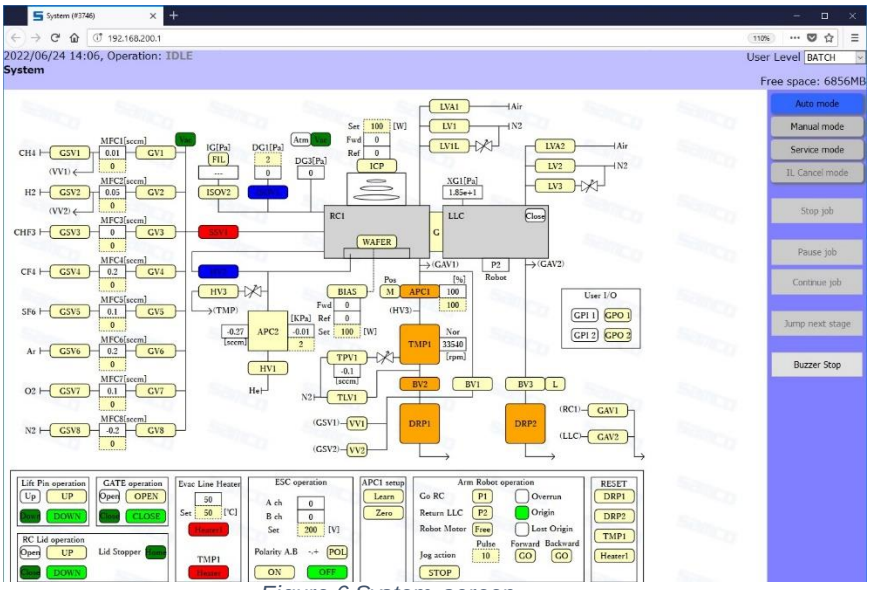


Figure 6 System screen

When all the stages in the Batch are complete, the system will sound 2 fast then 5 slow beeps. At this point, the loadlock will be vented and the system will be ready for you to load and run your samples.

Running your samples:

8. Open the loadlock, place your samples on the carrier. If you are running whole wafers, remove the carrier, place your wafer on the robot arm, then place the appropriate cover ring on top (metal side down). Close the loadlock lid.
9. Click on the "**Prepare Job**" button (6) on the **Jobs** screen (1).
10. Click once on the **Etch ti**me field (8) and enter the etch time in the pop-up window. Update the **Lot** field (9) with new comments, if necessary.
11. Click "**OK**" (10) and the system will beep twice.
12. Click "**Start Job**" (11) then click "OK" in the pop-up window. The system will beep once and start the Batch. When all the stages in the Batch are complete, the system will sound 2 fast then 5 slow beeps. You can then open the loadlock and remove your sample.
13. Repeat from Step 9 to load and run your next sample.

Finishing your run:

14. Once your last sample has finished and is removed, make sure that the carrier is loaded on the robot arm with the metal side down, then close the loadlock lid. Go to the Jobs screen (1), click on "Select Job" (12) and click on "LLC pump" (13).

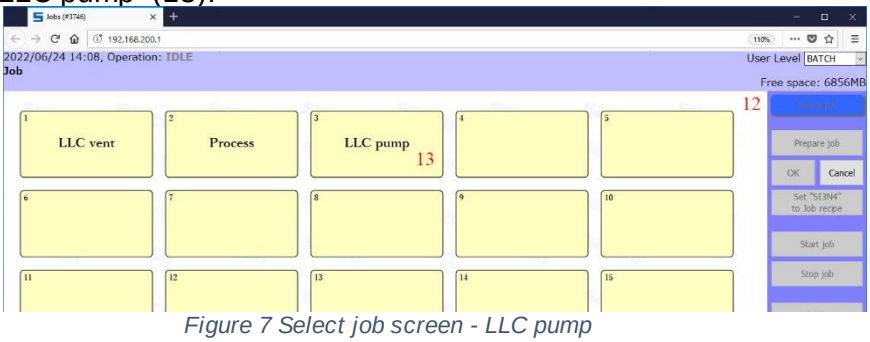


Figure 7 Select job screen - LLC pump

The system will return to the Jobs screen. Click “OK” and the system will beep twice.

15. Click “Start Job” then click “OK” in the pop-up window. The system will beep once and start the loadlock pumpdown sequence. Once the loadlock pumpdown has completed, the system will sound 2 fast then 5 slow beeps.
16. Once the loadlock has pumped down and the system is idle, disengage the RIE-F-Samco-230iP system on CORAL. If you disengage before the pumpdown is complete, the system will think the loadlock lid has opened and will abort.

Appendices

Material and recipe restrictions:

Currently we do not allow metal masks in the RIE-F-Samco-230iP
Processing with pure O2 is limited to short pre and post etch treatments for our 2d materials etches, please do not run extended O2 processing, it attacks the chamber conditioning and can cause flaking in the chamber

Loading of samples/carrier/cover ring:

Correct loading:

- Metal side of carrier or cover ring is facing down, samples placed on carrier.



Figure 8 correct loading of carrier

- If running 4” or 6” wafer, wafer goes on arm first, then cover ring is placed on top of wafer.

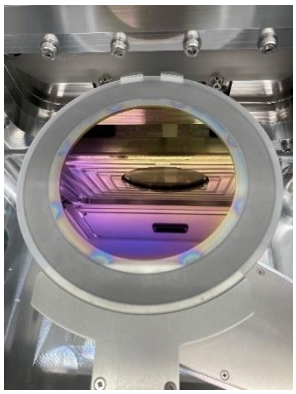


Figure 9 correct loading of wafer and cover ring

Incorrect loading:

- Cover ring underneath wafer - wafer will be lifted off arm, but cover ring will stay on arm and get stuck on lift pins.

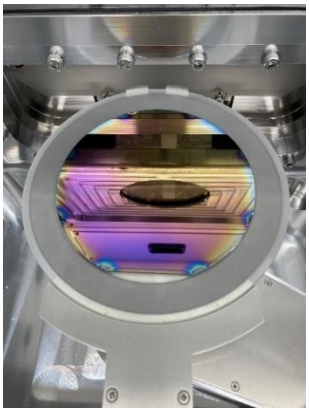


Figure 10 Incorrect loading - cover ring under wafer

- Cover ring or carrier is loaded with metal side up – cover ring or carrier won't be held down by electrostatic chuck.



Figure 11 Incorrect loading - Carrier metal side up

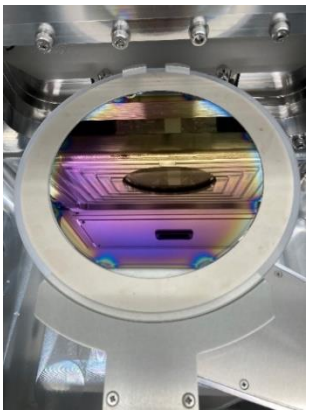


Figure 12 Incorrect loading - Cover ring metal side up, wafer on top of cover ring

- 4" or 6" wafer loaded with no cover ring, or cover ring loaded with no wafer - surface of electrostatic chuck won't be fully protected from plasma.

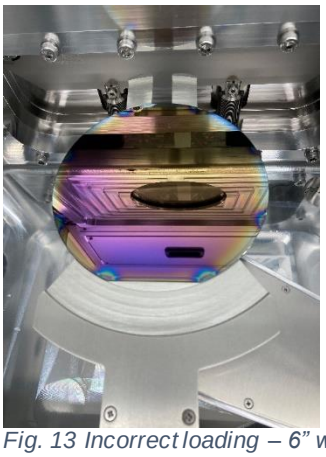


Fig. 13 Incorrect loading – 6" wafer with no cover ring

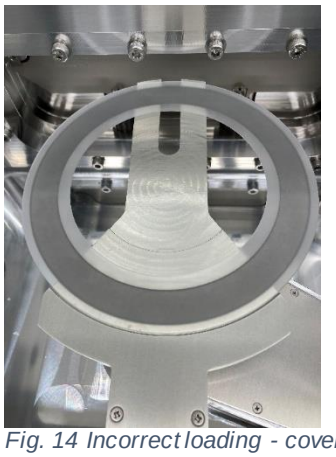


Fig. 14 Incorrect loading - cover ring with no wafer

Tips and Tricks:

- Larger samples may need guard pieces to prevent the sample from moving during pumpdown.
- If you are running whole wafers, remove the carrier, load your wafer onto the arm, then place the appropriate cover ring over your wafer with the metal side down.
- Only disengage on Coral when the system is not running a batch and is idle. If you disengage before the batch is finished, the system will think the loadlock lid has opened and will abort.

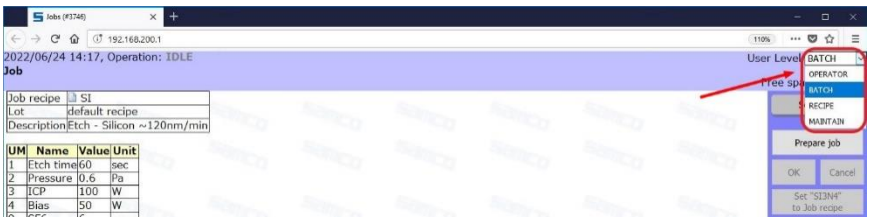
Common Errors/Failures:

System software not on screen

The system software runs through a web interface to the main computer. If the system software is not showing on the screen, open a Firefox browser window to 192.168.200.1.

Can't edit recipe time or other parameters

You should be able to edit the etch time for all batches, and for some batches you may be able to change other process parameters as well.
To be able to edit run time or other parameters, you must be logged in at "BATCH" permission level. Select "BATCH" from the dropdown menu labeled "User Level" in the upper right of the screen and enter the password: mit.



"APC2 offset low" error

This means the system is flowing more He then expected to maintain the backside He cooling pressure. This is normally due to residue or debris on the backside of the carrier.
To recover:

- Go to Jobs (1)->"Select Job"(12) and click on "Unload Wafer" (14).

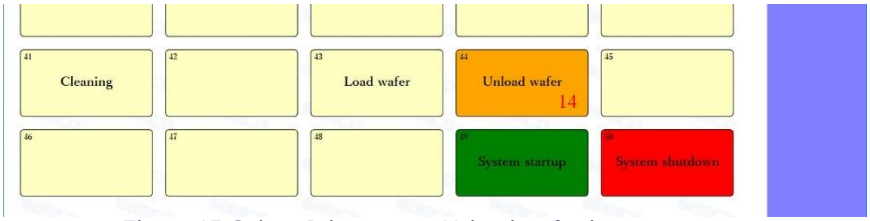


Figure 15 Select Job screen - Unload wafer button

- Click on "OK" (10) then "Start Job" (11) , then "OK" in the popup window.

The system will then pump out any residual gas, dechuck and transfer the wafer to the loadlock then vent the loadlock.

At this point you can wipe the backside of the carrier or wafer with isopropyl alcohol or acetone, then try to run again. You can retry wiping the backside twice or try using a different wafer. If the system still won't run, this means there is probably debris on the electrostatic chuck and the chamber will need to be wet cleaned by staff. Collect your samples, then put the system in Shutdown on Coral and disengage.

System aborts during process

If any of the process parameters are outside a pre-defined window for too long, the system will abort. The process will stop, and the sample will stay in the chamber.
To recover your sample:

- Go to Jobs (1)->"Select Job"(12) and click on "Unload Wafer" (14) .

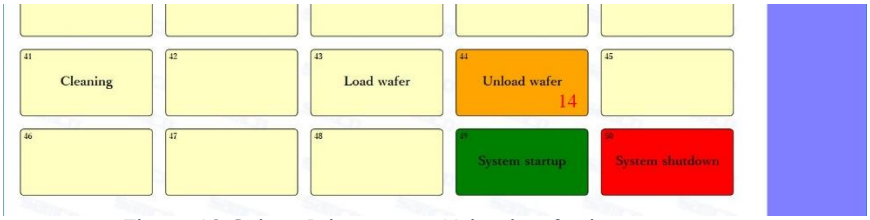


Figure 16 Select Job screen - Unload wafer button

- Click on "OK" (10) then "Start Job" (11) , then "OK" in the popup window.

The system will then pump out any residual gas, dechuck and transfer the wafer to the loadlock then vent the loadlock.

Pressure Conversion Chart

Pascals	mTorr	
0.005	0.0375	
0.25	1.875	
0.5	3.750	
1	7.50	
2	15.00	
3	22.50	
4	30.00	
5	37.50	
6	45.00	
7	52.50	
8	60.00	
9	67.51	
10	75.01	
15	112.51	
20	150.01	
25	187.52	
50	375.03	
100	750.06	
2700	20251.67	
100000	750061.68	