VAC COAT

AMT
ANDREAS MATTIL
Technischer Vertrieb

DTT

Triple Source Thermal Evaporation Coater

User Manual

Vaccoat Ltd. is the owner and manufacturer of DTT Thermal evaporator.

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Disclaimer

The components and packages described in this document are mutually compatible and guaranteed to meet or exceed the published performance specifications. No performance guarantees, however, can be given in circumstances where these component packages are used in conjunction with equipment supplied by companies other than Vaccoat Ltd.

This Operating Manual is divided up into the following major sections, each section dealing with specific topics, as follows:

- **Section 1**: **Content**
- **List of Figures**
- **List of Tables**
- **Section 2**: **Health and Safety**

It is important for all firm's product, which describe very important issues in the field of safety.

- **Section 3**: **Introduction**

Introduces this manual.

- **Section 4**: **Setup and Installation**

Instructions on how this instrument should be installed and the connections which should be made between the equipment items.

- **Section 5**: **Operation**

Instructions on how to start-up and run the instrument.

- **Section 6: Maintenance**
- **Section 7: Index**

1- Contents:

List of Figures:

List of Tables:

2- Health &Safety

The Vaccoat Company has provided maximum safety for its production systems and operators. It is required to read the complete user instruction before starting to work with the device.

All service and repairs should only be performed by a qualified specialist. Vaccoat Company will not be liable for any loss or damage caused by repairs and services performed by an unauthorized or unqualified person.

Vaccoat Co. will not be responsible against loss or damage caused by incorrect use of the equipment.

2.1- Safety Policy

This section contains important information relating to all health and safety aspects of the equipment. As such it should be read, and understood, by all personnel using the instrument whether as an operator or in a service capacity. Vaccoat Co. is committed to providing a safe working environment for its employees and those that use its equipment and conducts its business responsibly, and in a manner designed to protect the health and safety of its customers and employees. It also seeks to minimize any adverse effects that its activities may have on the environment. The equipment has been designed as free-standing bench mounted instruments. Vaccoat Co. cannot be held responsible for any damage, injury or consequential loss arising from the use of its equipment for any other purposes, or any unauthorized modifications made to the equipment. All service work carried out on the equipment should only be undertaken by suitably qualified personnel. Vaccoat Co. is not liable for any damage, injury or consequential loss resulting from servicing by unqualified personnel. Vaccoat Co. will also not

be liable for damage, injury or consequential loss resulting from incorrect operation of the instrument or modification of the instrument.

2.2- Servicing

2.2.1- Disclaimer

All service work on the equipment should be carried out by qualified personnel. Vaccoat Co. cannot be liable for damage, injury or consequential loss resulting from servicing from unqualified personnel. Vaccoat Co. will also not be liable for damage, injury or consequential loss resulting from incorrect operation of the instrument or modification of the instrument.

2.2.2- Operators and Service Engineers

A normal operator of the equipment will not be trained in or qualified for service work on the equipment and may cause a hazard to him/herself or others if such work is attempted. Operators should therefore restrict themselves to the normal operation of the equipment and not by removing covers from the electronic equipment or dismantling of the instruments.

Service Engineers who are suitably trained to assess and isolate electrical, mechanical and vacuum hazards should be the only personnel who access the equipment.

2.3- Hazard Signals and Signs

2.3.1- Hazard Signal Words

The standard five hazard signal words are defined as follows:

- DANGER- imminently hazardous situation or unsafe practice that, if not avoided, will result in death or severe injury.
- WARNING - potentially hazardous situation or unsafe practice that, if not avoided, could result in death or severe injury.
- CAUTION - potentially hazardous situation or unsafe practice that, if not avoided, may result in minor or moderate injury or damage to equipment.

2.3.2- Hazard Labels Used on Equipment

Several hazard symbols may be found on the equipment, they are shown in Table.1 with their meaning:

Table 1: Hazard Labels and Their Definitions

Sign Shape	Sign Name	Sign Definition
	Electric Shock Risk	Imminently hazardous situation or unsafe practice that, if not avoided, will result in death or severe injury.
	Warning	Potentially hazardous situation or unsafe practice that, if not avoided, could result in death or severe injury.

	Caution	Potentially hazardous situation or unsafe practice that, if not avoided, may result in minor or moderate injury or damage to equipment.

2.4- Earth connection

The device must be connected to a plug with proper earth connection; this would prevent electrocution of user in case of a short circuit in the system. However, in the absence of proper earth connection, the thickness gauges will not work properly.

3. Introduction

The Triple Source Thermal Evaporation Coater device; DTT; is a deposition system with thermal evaporation method in high vacuum, with glass cylindrical chamber and the turbo- molecular pump. This device by having a suitable size and its preferences is capable to reach the desired vacuum level in 10~15 minutes and depositing large group of materials, with the three thermal sources (boat- basket).

The DTT with usage of three copper electrodes is able to fit in different size of boat and basket and they are changeable easily. Therefore structuring the multilayer with three different materials without having to break the vacuum and possibility of alloying is provided. The touch screen control panel and user friendly software makes the user to reach the desired result with the maximum time and energy saving.

Figure 3-1: DTT Desktop Thermal Evaporator

3-1 Mechanisms of thermal evaporation deposition method

Thermal evaporation is a deposition method in a high vacuum condition with applying the electrical current to vaporize the source material and deposition on the substrate based on the pressure differentiation between the source and the sample holder. This method is one the most common deposition method to create super thin layers. Chamber's pressure and the boat's temperature are the parameters that need to be controlled in this process. In this method the source material will be placed in the boat or filament made of resistant metals (Ta, Mo, or W). The electric current by passing through the boat will make it hot and the source material will be vaporized and depositing a thin layer on the substrate.

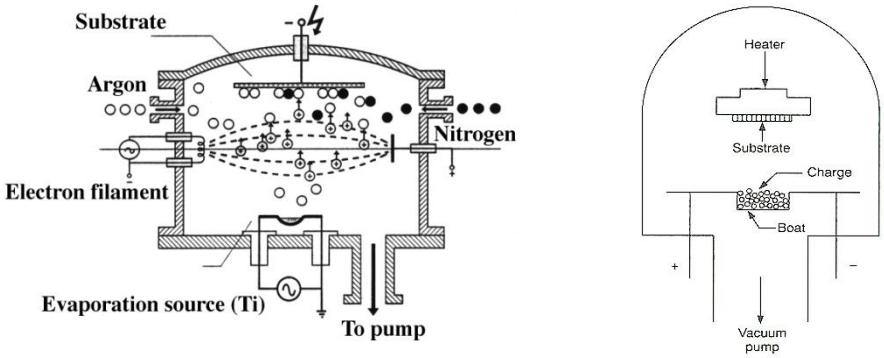

Figure 3-2: Schematic of thermal evaporation deposition process

3-2 Specifications

Table 2: DTT Desktop Triple Source Thermal Evaporator Coater Specification

Dimension	**650 Width x 500 Depth x 560 Height mm**
Weight	60 Kg
Glass Chamber Dimension	Pyrex Cylinder Shape, Diameter 300mm, Height 250mm, Thickness 7mm
Display Screen	7" Diagonal (16:9) 800x480 High Color-Graphic TFT- LCD
User Interface	Color & Touch Screen
Data Transfer	USB Port – For Transferring the data and graph to PC
Sample Holder Dimension	Square shape 40x40 mm
Chamber's Base	Stainless Steel with Turbo Pump, Thickness Gauge, Shutter, Pressure Gauge & Sample Holder Inlet port
Chamber's Door	Made of Aluminum
Boat/basket Size	50~90 mm length
Number of boat/basket	3 Pieces
Thickness Sensors	
Number of Sensors	1 Piece
Specification	Crystal thickness gauge with sensors, oscillator and the water circulated crystal holder
Resolution	1 Angstrom
Accuracy	1 nanometer
Vacuum Equipment	
Turbo Molecular Pump	Capacity 90 L/s , (Leybold)
Backing Pump	Two stage rotary pump 4m^3/h
Pressure Gauge	Leybold (Ionivac model); Full Range
Final Vacuum	<5x10^-6 Torr
Process	
Thermal Evaporation	Thermal Evaporation Coating based on Time mode or Thickness mode
Service and other Information	
High Current Power Supply	DC: 100 A, 25 V
Number of High Current Power Supply	2 pieces
Electric Feedthrough	4 pin
Electric High Current Feedthrough	100 A
Vent Valve	1x¼", one for Ventilation
Mass Flow Controller(MFC)	0-100 sccm
Electronic Shutter	1 piece
Electrical Inlet	Inlet: 220v, 20A, 50Hz *

*** CAUTION: Single phase AC power with appropriate earth connection is required.**

3-2-1 Advantages

1- Easy operation and fast preparation of system for deposition.

2- Controlling the layer thickness with high repeatability during the deposition.

3- Easy insertion and removal of samples.

4- The possibility of using different materials for the thermal evaporation purpose.

5- The ability of enabling the two power supply at the same time (optional).

6- Precise adjustment ability of pressure.

7- Reaching the right vacuum level to perform the deposition.

8- Ability to view graphs of pressure and thickness.

3-2-2 Features

- Turbo-molecular pump (Made in Germany)
- Rotary backing pump
- Full-range vacuum gauge (Made in Germany)
- Sample holder
- Boat Selection
- Crystal thickness sensors
- High current power supply
- Electronic shutter

DTT contain three main parts: High current power supply, metal boxes and the glass vacuum chamber on the top.

The electrical parts, electronic modules and turbo-molecular pump are inside the metal box. The diaphragm backing pump is outside the machine.

3-2-3 The equipment inside the metal box

Inside the metal box, there is a tray (Figure 3-3), including electrical and electronic parts of the device. The tray includes:

1- 24 V power Supply
2- Pressure Module
3- Relay & Motor Drive Module
4- MFC Module
5- Thickness Gauge Module
6- MFC (Mass Flow Controller)

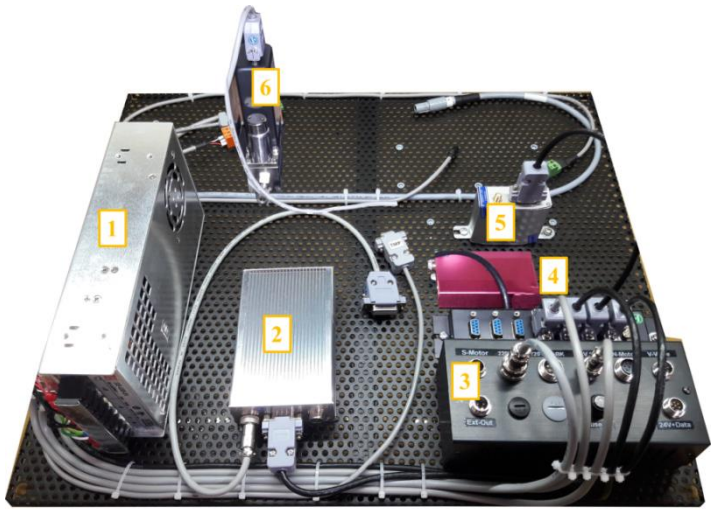

Figure 3-3: The tray in the metal box

3-2-4 The internal components of the glass chamber

Figure 3-4 shows the internal components of the glass chamber. The base plate made of Stainless Steel, and components such as pressure gauge, the turbo- molecular pump inlet are embedded inside the chamber.

1- Turbo inlet connection
2- 4 pin electrical feed through
3- Gas inlet
4- Pressure gauge connection
5- Copper electrode
6- Thickness gauge sensor
7- Rotational sample holder
8- Shutter
9- Air filter for the ventilation purpose

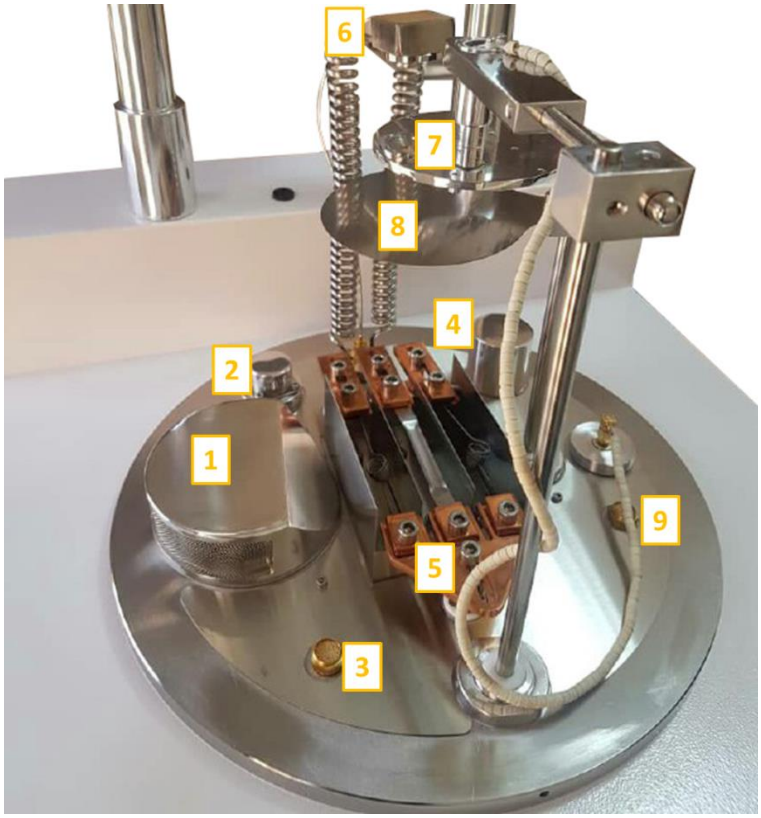

Figure 3-4: Inside the vacuum chamber

To prevent the leakage, avoid any bumps or scrapes, especially in areas where the glass chamber is connected to base and Aluminum door. Hitting the edges of the glass will cause the leaks in that area.

i. Copper Electrode

This device is equipped to three separated copper electrodes to hold the boat for evaporation purpose. The length of each one is adjustable from 50 to 90 mm.

Figure 3-5: Copper Electrodes

These electrodes should not have connection to each other or the steel internal surface.

ii. Thermal sources (Boat/ Basket)

Selection of kind of the thermal sources is a very important item to reach the desired deposition. Less thickness of the selected Boat or Basket leads to less required electrical current to evaporation and thus less unwanted radiation heat.

NOTE:

It’s recommended that use the Boats with thickness of less than 0.1 mm and width of less than 8 mm.

If the deposition time is less than 15 minutes and the power supply current is less than 40 Amp, there is no need to cool the electric feedthroughs and so thickness meter. But for more time or currents, it’s recommended to cool feedthroughs and thickness meter (Figure 3-6).

Figure 3-6: Feedthrough and thickness meter cooling system (Plastic blue hoses)

For the first time using the cooling system, turn off the system and make sure that there is no any water leakage inside the metal box (Figure 3-6).

iii. Shutter

This device is equipped to an electronic shutter and its positioning can be controlled through the touch screen control panel. The distance between the shutter and the substrate and the thermal source is adjustable. For this purpose, the operator should open the shutter's connection to shaft and tight it back after the height adjustment.

Figure 3-7: Electronic Shutter

iv. Sample Holder

Figure 3-8 shows the sample holder. User is able to adjust the position of the sample holder in three directions (X, Y and Z). Shape and the dimension of sample holder could be customized based on the user requirements.

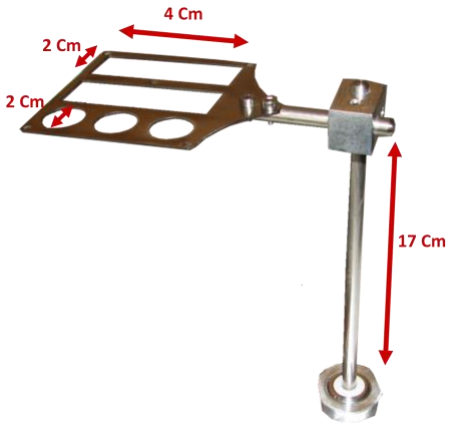

Figure 3-8: Sample holder

In order to use of sample rotation during the deposition process, set the samples on the rotational surface and fix them by the clasps. Fix the surface on the right place (Figure 3-9) and connect the motor power cable. For setting the desired speed see the item No. 9 in part 5-2.

NOTE:

In order to increase the motor lifetime, it's recommended that turn on sample rotation motor after opening the shutter and after closing the shutter or finishing the deposition turn off it.

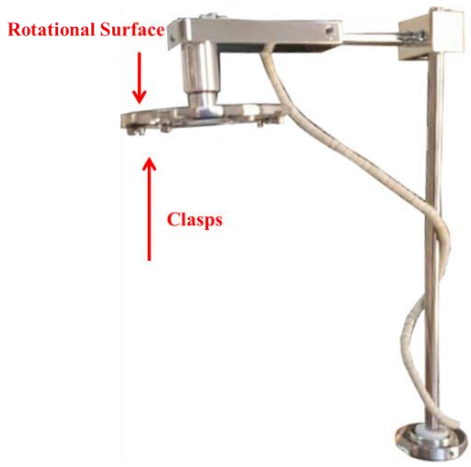

Figure 3-9: Motorized sample holder

v. Turbo-molecular pump inlet

Due to the high speed of rotating vane pumps of turbo, (70 thousand RPM) entry of anything even very fine particles, will cause a serious damage to it, so in order to protect the pump, four filters is used by the following description:

1. Metal nets (30 microns), to prevent the possible entry of impurities into the pump.
2. Aluminum mesh screen to protect the inner nets.
3. Exterior nets

Figure 3-10: Turbo molecular pump inlet

vi. Pressure gauge inlet

The pressure gauge is manufactured by the famous German company Laybold (IONIVAC model). The pirani filament of this gauge is so thin and sensitive.

Therefore the pressure gauge is protected from both sides; one by a half-cylinder which its inlet, is facing the inner layer of container glass and not to the thermal evaporation source. This positioning will stop the layer to sit on the opening inlet. And the other filtering is by a metal mesh, to prevent the entry of dust into it.

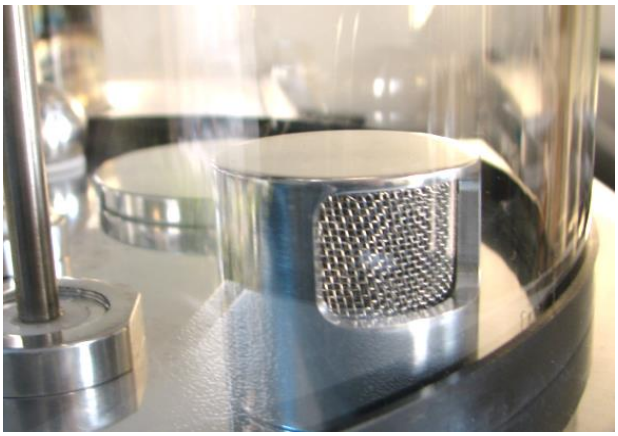

Figure 3-11: Pressure gauge inlet

3-2-5 High current power supply

Following procedure indicates the current power supply usage for the thermal evaporation method:

1. Connect Common, high current and 24 V cables to the right place on the metal box.(see the Figure 3-12 and Figure 4-2)

NOTE: The electrical common cable is thicker than the high current cables and so signed by "-"symbol on the cable.

2. By using the turbo-molecular pump, the chamber's pressure must reach its lowest point. In high pressure the tungsten will oxidized.
3. Stimulate the HC key, which stands for High Current from the system's monitor.
4. Rotate ON / OFF switch clockwise on the right of the power supply.
5. Turn the Voltage knob clockwise up to 24 volts.
6. Turn the flow knob slowly in clockwise direction, until the flow and temperature increases and the basket turn to red, and material that have poured into it melted and then evaporated.

NOTE:

After completion of the deposition, lower the current flow and wait for venting inside the chamber up to 15 minutes. The boat or basket is hot, and in the presence of oxygen will be oxidized.

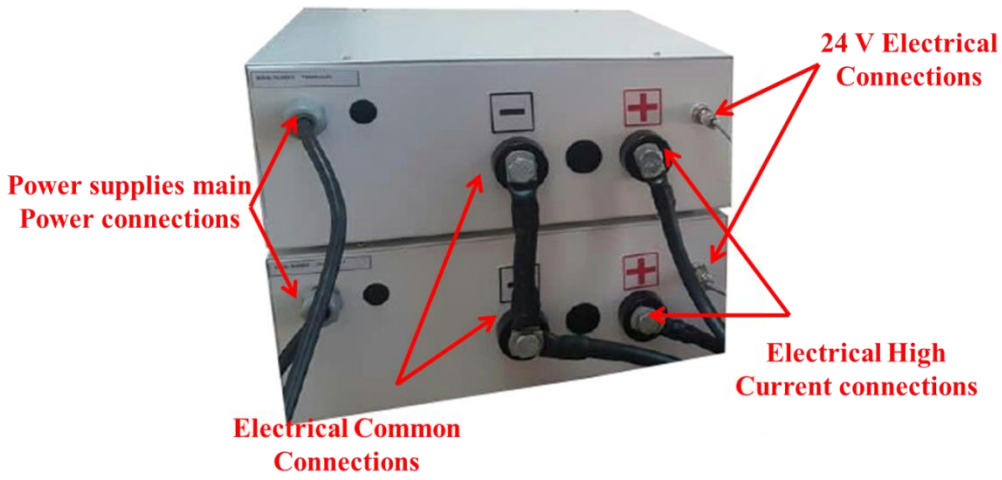

Figure 3-12: High Current Power Supplies (Back view)

4- Set up and Installation

This device must have a single phase AC earth connection.

The installation of this device must be done by expert and professional personnel and in accordance with these instructions. Failure to do so may result in damage of the machine.

It is necessary for any user, who is going to work with this device, to attend the training course which will be held by Vaccoat company's experts and receive a license to operate.

The appropriate ambient temperature of the device should be in the range of (5 to 35°C) and relative humidity must be less than 75%.

The proper ventilation is essential for the device, and the device should not be exposed to direct sunlight and should be placed in a suitable environment and free of dust.

4-1 Required equipment for the device installation

- Input Power: 220 V, Frequency: 50~60 Hz 20 A with a suitable earth connection.
- A strong table with a length of 130 cm and a width of 80 cm and a height of a desk and tolerance of 60 kg weight.

4-2 Initial checkup after device collection

With confirmation of Vaccoat Co. unpack the device on the table in convenient place, away from direct sunlight and splashing water.

Do a visual inspection, for any signs of stroke and damage caused by transportation.

- The accessory box and its content should match with DTT list.
- All parts of the devices should not include the loose and opened pieces especially chamber glass and L-shaped O-rings.
- The device must be delivered in vacuum condition. For venting the system, must open the blue valve on the side of the device. During the venting of system, the sound of air entering the chamber will be heard, confirming the system had been vacuumed.

NOTE:

The metal box which is prepared for carrying the device must be maintained in duration of warranty and after-sales service. So it can be used in case of sending the device to the Vaccoat co.

4-3 The connections

All the connectors of the device must be in accordance with this user's guide.

1- Electrical connections.
2- Vacuum pump connection
3- Thickness gauge cooling system.

Figure 4-1 shows the place of electric connections at the side of the device.

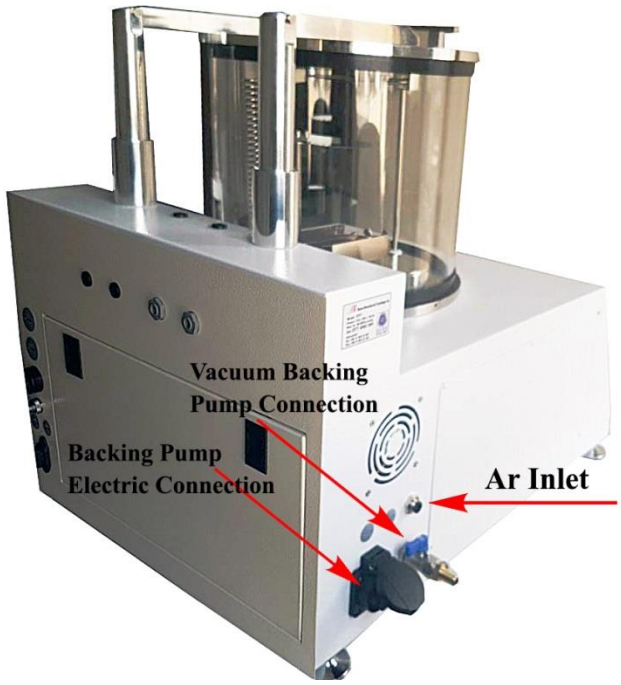

Figure 4-1: Side view of the DTT

4-3-1 Electric Connection

1- The main cable

Make sure the connections are firmly in place. The plug which device is connected must be properly earthed. This prevents the user from electrical shock, if any short circuit happens in the system. However, in the absence of suitable earth connection, thickness gauge will not work correctly.

2- The cable of the backing pump connects to the left side of the deivce (Figure 4-1).

The system's design makes each cable unable to connect to the location other than its own.

3- 24 voltage cables of power supply.(2 pin)
4- Shared connection of evaporation sources.
5- Evaporation source connections.

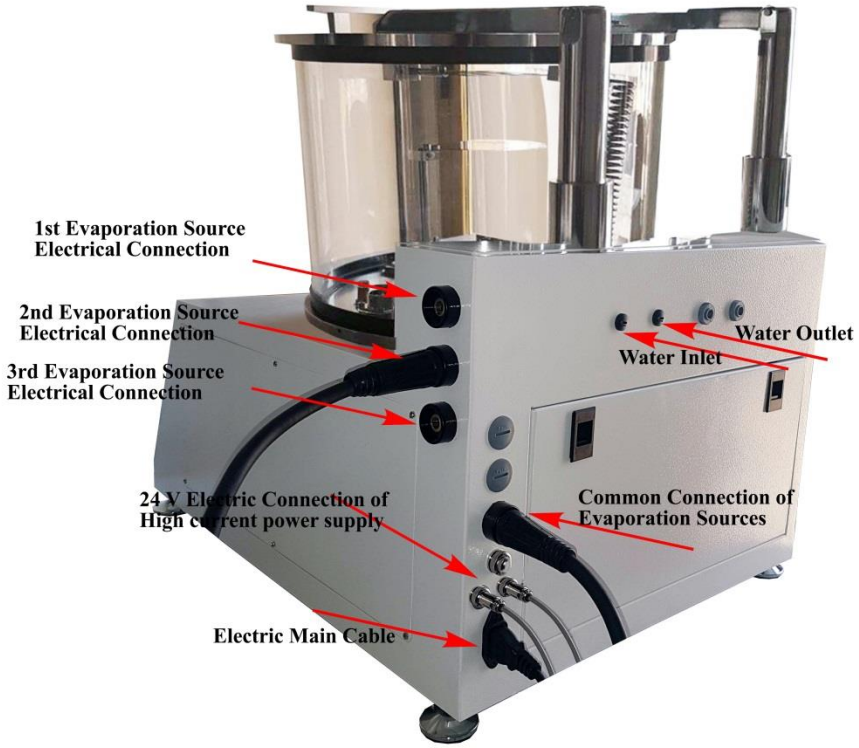

Figure 4-2: Back Side view of DTT

4-3-2 Vacuum pump connection

The backing vacuum pump connects to the device, by the hose with length of 1.5 m (Figure 4-1).

4-3-3 The Connection of cooling system thickness gauge

To keep the quartz crystal cool during the deposition by a proper flow of water (about 0.5 liters per minute) passes through the thickness gauge and even quartz crystal.

Best method for areas where the water hardness is high, is water circulation bath by the temperature less than 20°C or cooling the system by a small chiller which keep the water temperature about 5-20°C.

If the recommended methods are not available, it is possible to use the city water flow and a 50 microns filter. (Can be freely collected from the Vaccoat Company) See Figure 4-3.

Before start the water circulation, the leakage inspection must be done, especially for the hoses which reach the thickness gauge. This is because these parts are adjacent to boards and electronic components and pouring water might cause the short circuit or burn some of them.

Figure 4-3: Water filter for installing in the cooling system

The system is equipped with a water filter at the inlet water section. (Figure 4-4)

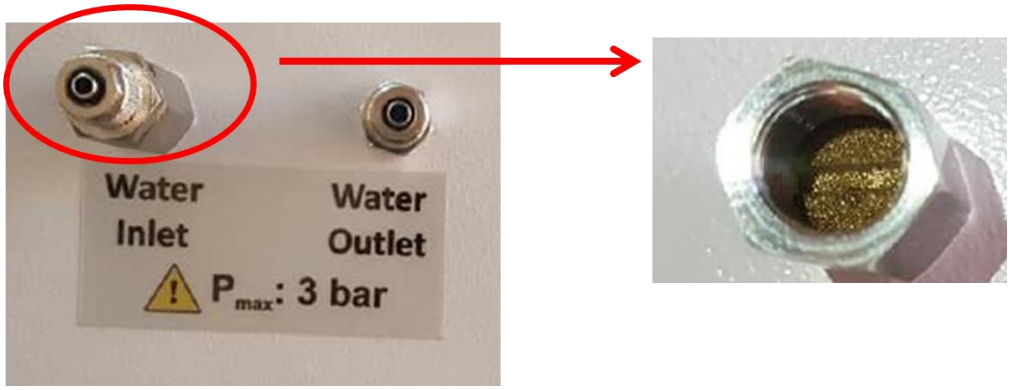

Figure 4-4: Installed water filter on the system

5- Operation

There are a number of adjustable parameters that the user can monitor and adjust through the touch screen control panel. List of adjustable parameters is shown in Table 5.

Table 3: Adjustable Parameter in Touch Screen

Parameter	Allowable Range
Tooling Factor	0.2~9.99 (Default Value is 1)
Source Material	Material's Density (Default material is Copper)

Note: Once the setting configuration is done, it will be saved as the default setting and the devices will use the same setting after turning on.

5-1 Device preparation before the setup

1- Fill up the rotary pump with the appropriate oil if the backing pump is a rotary pump.

Do not turn on the rotary pump without proper oil. It will cause a serious damage to the pump.

2- Switch on the backing pump (Figure 5-1).

3- By using the No.6 Allen wrench open the blue valve cap, installed on the side of the device and put the blue valve in open situation.

4- Replace the ISOKF16 connection or hose clamp with the cap of blue valve (Figure 4-1).

5- Put the cleaned sample on the sample holder and place it in front of the evaporation source.

6- Place the source material on the boat

Figure 5-1: Main switch of the backing pump

NOTE:

- It is recommended to use the boat or basket with the thickness in range of 0.05~0.1 mm. It makes the boat to reach the desired temperature with the lower current.
- It is recommended to cover the interior parts to avoid the deposition of them (sample holder shaft, electric connection and etc.) with aluminum foil.
- Review the material library in the Vaccoat website and make sure that you have chosen the right material and boat.

7- Turn on the system. In order to turn on the system use the power board (Figure 5-2). Connect the main cable of the system and power supplies to the power board in order to protect the device against the electrical voltage fluctuations and turn on/off the system.

Figure 5-2: Power board

5-2 Deposition Manual

8- Push the start button on screen.

Figure 5-3: Start Page

All the vacuum and deposition parameters are visible on the home Page (Figure 5-4).

The home page contains two sections, commander items and display items.

The commander items are as follows:

- Vacuum pump activation
- Turbo-molecular pump page
- Target type and Thickness gauge setting page
- MFC's setting
- Motorized Part page or boat selection. Note that, once this page is open the other part of screen will not operate.
- HC power supply activation (Pressure<5 mTorr)
- Time mode selection for deposition
- Thickness mode selection for deposition
- Zero Thickness meter activation
- Vent valve opening
- Page selection

Display Items:

- Pressure display
- Temperature and time display
- Thickness and pressure charts
- Thickness gauge setting

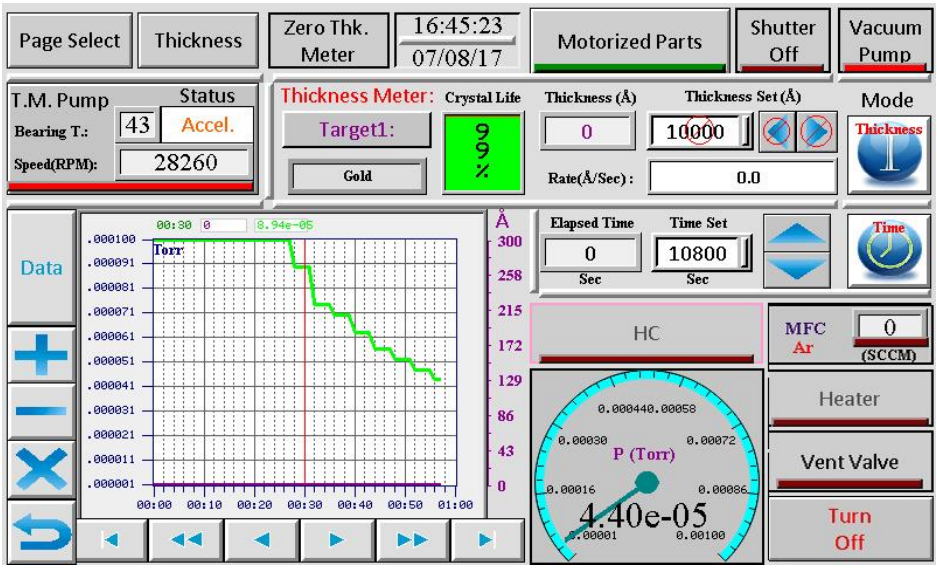

Figure 5-4: Main Page

9- Using the boat selection feature, place the substrate to the desired Source position (Figure 5-5). Use sample rotation to obtain a thin film with high uniformity.

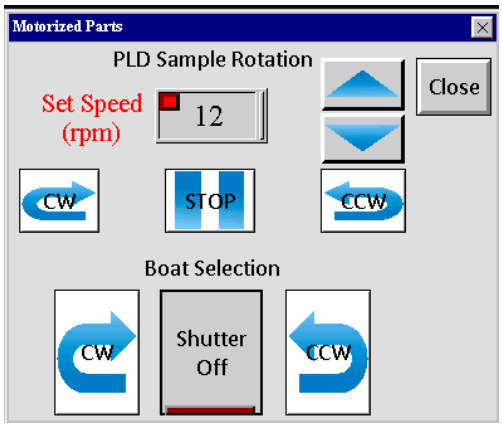

Figure 5-5: Motorized page

NOTE:

Place a steel cube under the basket or boat to avoid the deposition of the base plat and make sure that is not in contact with the boat. Otherwise it will cause the electric leakage.

10- Close the door.

Once closing the door, be careful not to hit the glass.

11- Adjust the setting for target and the thickness sensors.

The DTT, uses one crystal thickness sensors, measuring the thickness of layers deposited on the substrate. This allows the user to measure the thickness of each layer during the multilayer deposition and the thickness of the deposited layer can be displayed separately. Quartz crystal of this thickness sensor are crystals with a frequency of 6 MHz, and when the surface of Crystal is covered by sputter atoms, initial frequency (Starting frequency) decreases. Circuit frequency counters, calculates the frequency variations and converts it into the thickness.

Thickness sensors can be used by both time mode and thickness mode. In time mode, the deposition process based on the desired duration is set to perform. In this mode, the thickness gauge is active and measures the thickness until reach the scheduled time and then the power supply will turn off.

In the thickness mode, the desired thickness is selected in the settings and when the thickness of the layer deposited reaches the desired thickness, deposition process will stops automatically.

The user must press the Zero Thickness meter button to zero the previous thickness, before starting the new deposition process.

NOTE:

If you are upgrading the software for first time, before to start the deposition press the Zero Thickness meter, otherwise it will not show the thickness.

On the screen the crystal life option shows the remaining of its life. And before the end of its life the user should provide the new one. If the user intends to use a new material as a target, it is necessary to set the correct target in the thickness setting menu.

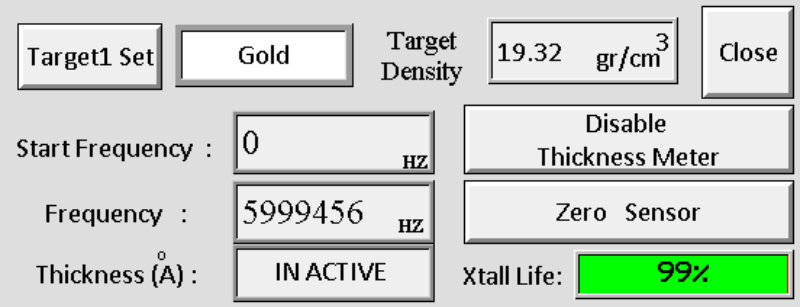

Figure 5-6: Thickness gauge page

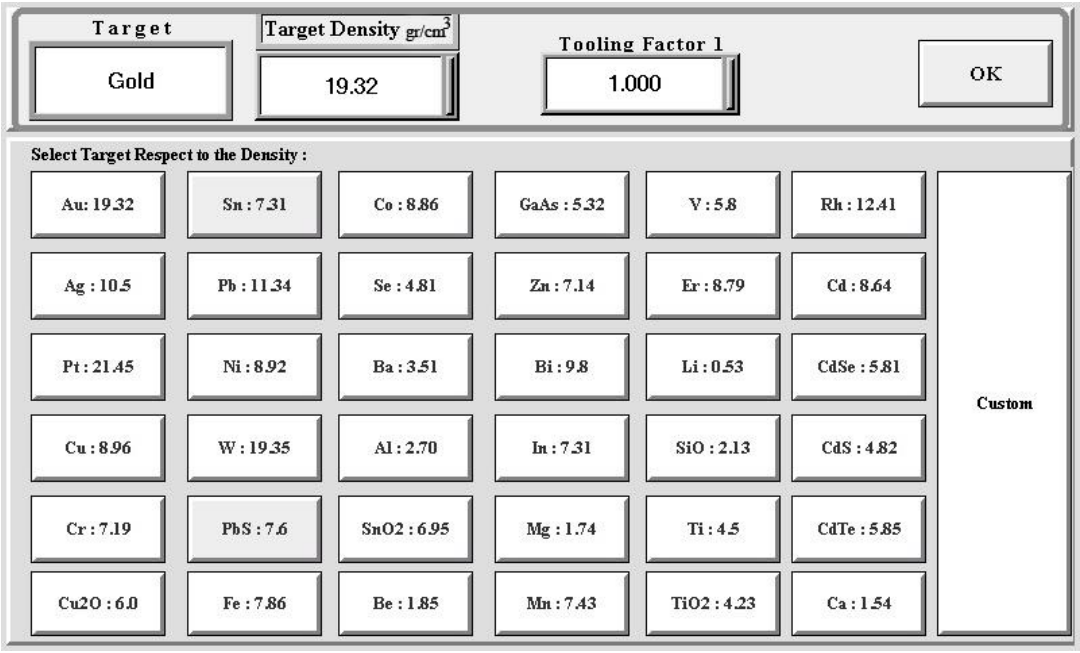

Figure 5-7: Target set page

If the new target is not on the list, then users must use the Custom Key new material and enter the density in terms of gr / cm^3, and then press the OK.

In the target selection window there is an option called Tooling Factor. This parameter is set based on the distance from the sample holder and so angle relative to the target. The geometric factors have a direct impact on the thickness read by the device.

Since the position of the substrate relative to the location of the sensor thickness gauge is different, so the thickness sensors should be calibrated by standard methods such as Ellipsometer. For example if the tooling factor selected 1 and after the deposition it show 10 nm thickness, but measuring by Ellipsometer show 35 nm it means the correct tooling factor is 3.5.

12- Press the vacuum pump key to turn on the backing pump. Once it is on the chamber will go under vacuum condition and it is not possible to open the door. The pressure gauge will show the pressure drop after 30 seconds (Figure 5-8). The unit of pressure by default selected, Torr, but if touch the Torr in the screen it will be changed to mbar.

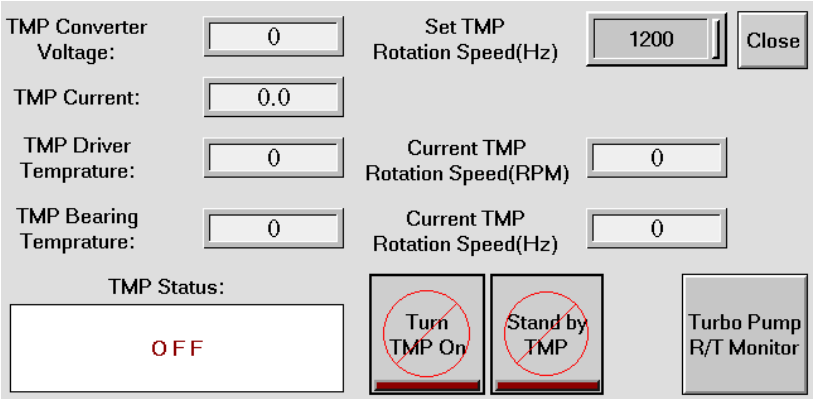

Figure 5-8: Turbo Molecular pump page

13- After a few minutes, once the pressure is $5x10^{-1}$ torr, press the turbo pump (TMP) key to enter its setting page. Enter the desired speed of pump in terms of frequency (1 Hz is equal to 60 rpm) and then turn on the pump to start to work (Figure 5-8).

In the absence of leaks, after 10 minutes the system pressure will reach 2 $x10^{-5}$ and after 45 minutes it will reach $8x10^{-8}$.

In the turbo pump page the pump's status parameters are continuously monitored. If a parameter is outside of the permitted range of operation, it will turn to red. To view the allowable range of each parameter, refer to Appendix 1.

When the TMP is on its vanes are rotating by high speed thus don't move the system.

If the input pump's speed and the monitored speed have more than 10 Hz difference, it means the pump's converter is in trouble and the user must contact the Vaccoat Company.

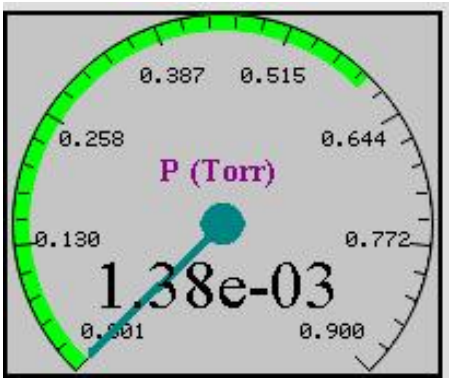

Figure 5-9: Pressure Display in the main page

14- Open the MFC page (Figure 5-10) to enter the desired reactive gas. (If it's required)

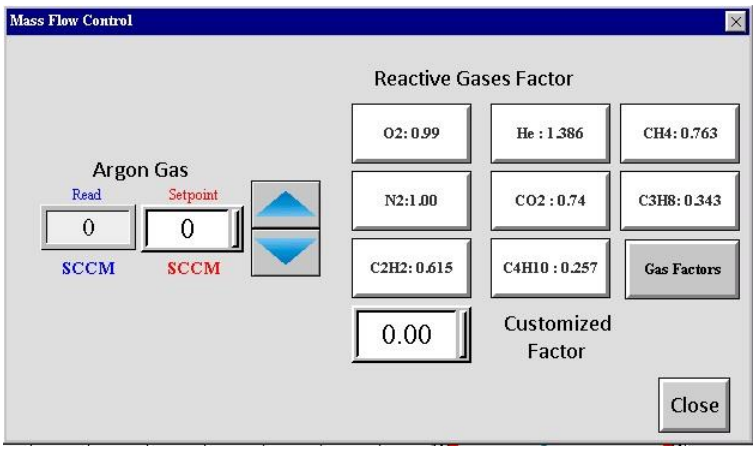

Figure 5-10: MFC (Mass Flow Control) Page

15- Choose the deposition mode based on time or thickness.

In this section, the user can adjust DTT setting for the mode of deposition according to his/her needs, based on the thickness of the active layer or the time. (Figure 5-9)

If the thickness is not important for the user by setting the time, the thickness will be disabled automatically and the sputtering will be done on time and when the set time is reached, the device will stop sputtering.

If the thickness of the layer is important for the user, he/she can enter the desired thickness in terms of angstroms, and the device will do the sputtering based on the thickness.

In this case, the time will be disabled and when the layer is deposited with the desired thickness, the device will stop the deposition automatically by turning off the power supply.

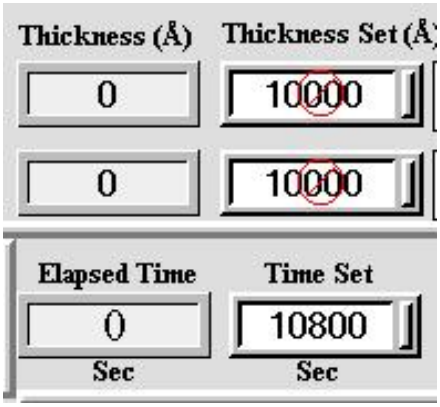

Figure 5-11: Deposition mode setting section in main page

16- Allow the system to reach the pressure of $5x10^{-5}$.

If you start the heating the boat in higher level of pressure the boat will oxidized.

17- Activate the HC key, which stands for High Current from on the touch screen control panel.

18- Rotate ON / OFF switch clockwise on the right of the power supply (Figure 3-13).

19- Turn the Voltage knob clockwise up to 24 volts.

20- Turn the current knob slowly in clockwise direction, until the current and temperature increases and the basket turns to red, and material that have poured into it will be melted and then evaporated.

The copper feed through are isolated in respect of base plate with the Teflon washers. Due to layer deposition on them it will cause the binding with chamber's floor. Therefore cover these parts with slides or steel cubes that surrounded the basket.

21- Turn the shutter around to start the deposition.

By starting the deposition red /violet graph on the main screen will be displayed.

Information on thickness, pressure and flow during the sputtering process, are visible as following.

The Pressure – Thickness graph

Figure 5-12: Thickness and pressure curves display

In the main window, the graph of thickness and pressure appears during deposition. With the keys on the left in this sector can zoom in/out the graph. The keys are located at the bottom of the sector can scroll left/right.

Logger Page

In the logger page can stream the graphs of deposition parameter such as thickness, time and rate. By pressing the SAVE LOGGED DATA key or PRINTSCREEN can save the data. In this sector can change the scales of graphs by SCALE key. (Figure 5-13)

The red vertical line in the window with is moveable in horizontal axis. If the user touches the red line and move it, the data in two small rectangles in the top of chart, will be displayed.

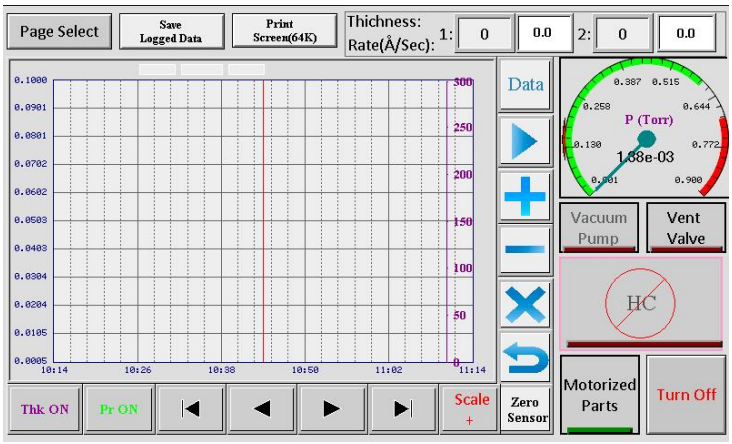

Figure 5-13: The logger page

In this sector the yellow line indicates the thickness and the green line indicates the pressure.

Key	Operation
	Converting the graph to data and vice versa
	Start to draw the graph
	Zoon in
	Zoom out
	Deleting the graph
	Undo key

Operational Page

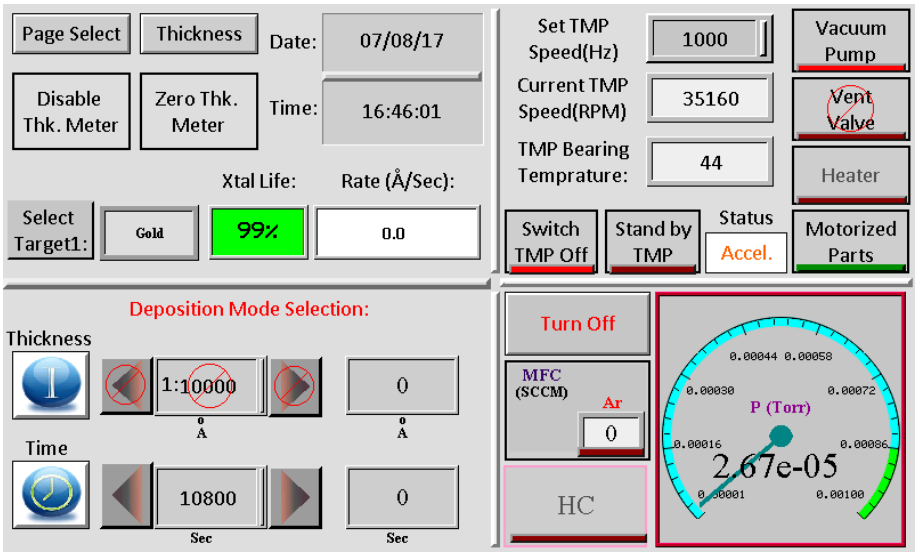

Figure 5-14: Operational page

In this window deposition parameters are displayed in a new form, and the users who have no interest in graphs can use this sector.

5-3 Picking up the Sample

At the end of the deposition, and cutting off the water, and closing the main valve of the gas cylinder, to turn off the system as user should follow the below instruction:

NOTE:

After completion of the deposition, lower the current and wait for venting inside the chamber up to 15 minutes. The boat or basket is hot, and in the presence of oxygen will be oxidized.

1- Disconnect the water circulation system.
2- Turn off the turbo pump by pressing the Turn TMP off bottom. Before reaching 50Hz speed, it is not possible to do the venting.
3- Activate the vent valve for the ventilation.
4- Vent the system and then slowly open the chamber's door and pick the sample up.
5- Recommended to keep the system in vacuum position thus after closing the door turn on the vacuum pump and then open the ball valve and after a 3-5 minutes

close the ball valve and turn off the vacuum pump. Turn off the system by Turn Off key on the screen.

6- Disconnect the Power supply cable from the plug.

5-4 Device Setting

The main setting of the device should be done in the following page.

Figure 5-15: Panel Page

Table 6 shows the parameter settings can be done in this sector.

Table 4: Setting Parameters

Key	Description
History	Shows the last 300 deposition history
Safety Remove USB	To remove the USB in safe mode.
Update OS & APP	For updating the OS & APP
Copy OS_APP	To Copy the old version of software.
Time & Date	Shows the Time & Date
Increase Brightness	To increase the brightness of display
Decrease Brightness	To decrease the brightness of display
Save Brightness	To save the brightness setting.
Maintenance	To check the connectivity of all parts of device.

Status	**Shows the status of device.**
Main	**To save the setting and going on main page.**
Beep Sound	**Active and deactivate the beep sound**

History Page

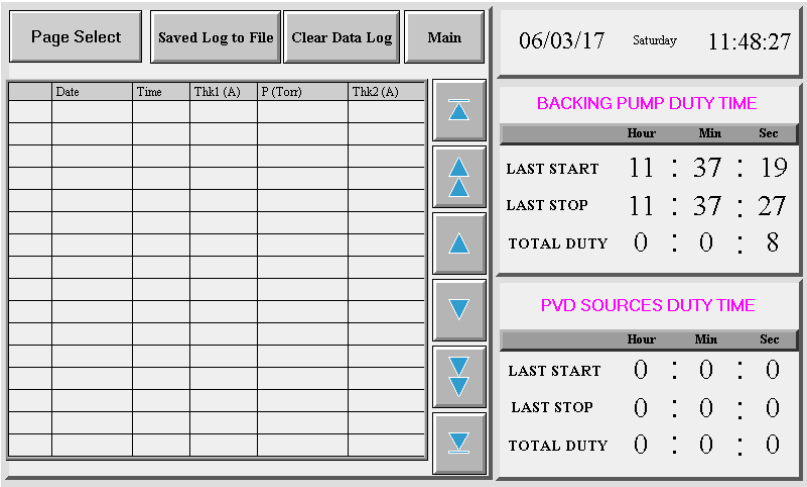

Figure 5-16: History Page

This window will allow the user to see date, time, and pressure the thickness of the last 300 layer which is deposited with the latter view. The details of pumps and rotary sputtering process will be shown in the window. All this information can be saved by SAVE LOGE to FILE button to flash connected to the USB.

Maintenance page

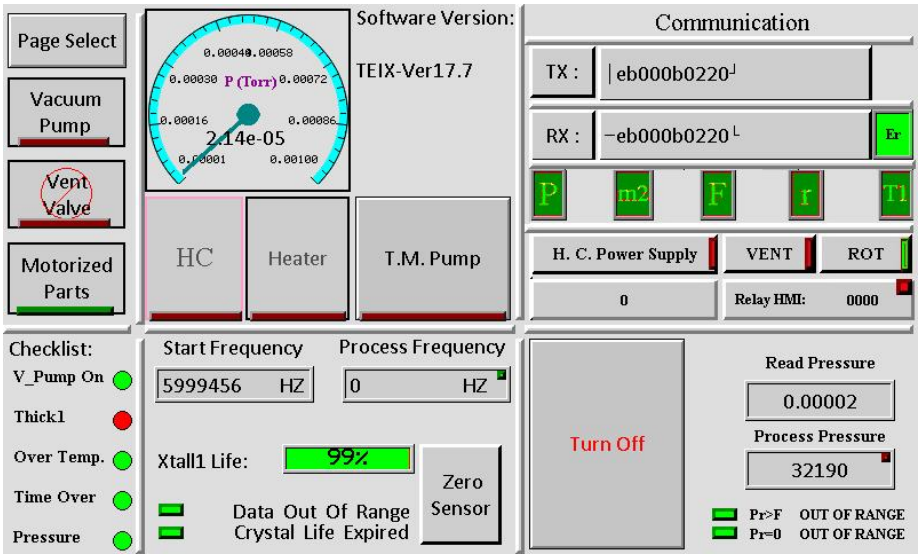

Figure 5-17: Maintenance Page

This system is designed for the quick troubleshooting and user normally do not need this sector.

This sector contains 6 parts:

Part I: Including the option of the sputtering system. If not it is not active, the light located under the each item turns to red and if it is enabled and having no defect is green.

In the second part, there is the list of important parameters in the sputtering process. Red lights Parameter shows that these parameters will not create the necessary conditions for the sputtering process. For example, if the pressure light is red, means the pressure is not low enough to start the deposition process.

The third part shows the main parameters and control buttons of device. Beside of each parameter, a red light is placed. It means none of these parts are activated. But, for example if the HC section is activated by the user, then the HC signal is green. If, it did not happen (in spite of being active HC), its lights still remain red, indicating a defect in this part of the system.

Part IV, is showing the parameters of crystal thickness gauge. Green lights, means it is functioning properly displays thickness gauge and crystal life, so if any of these lights become red, there is a defect in one or two of the items.

Part V, shows the electronic communication between various parts of the device. Green for each parameter indicates a proper functioning and red indicates that the function is impaired.

The various part of devices in the field are displayed with the initials, therefore, T1, represents the thickness gauges, the letter P, represents the pressure, the letter m, indicating the motor, the letter r, represents the relay module inside metal boxes and F represents the mass flow controller (MFC).

So if the device does not work properly, the user can refer to this section of the application and can find out which part is been impaired.

Part VI includes two parameters of pressure and temperature. The Read Pressure (mTorr) represents the pressure on the Pressure and the Process Pressure is an electronic data. The lower part or NTC is showing the data of the temperature sensors of cathodes. If it is red, it means there is a fault in one of the sections. (Table 7)

Table 5: NTC Section Parameters

Cut of range	The wire is disconnected
Short out of range	Short circuit has happened
Overheat	There is overheating in the area.

Caution:

All the information in maintenance section is solely to inform the user. And in case of a problem, the user should not attempt to repair or replace parts arbitrary and it is highly recommended to contact the Vaccoat Co. immediately.

Software Upgrading

To upgrade the software, user should follow the instructions:

- After receiving the new version of software from Vaccoat Co., the user must transfer it to the memory stick and connect it to the USB port.
- In the panel page press the Update OS & AP. If the device is running, it may not recognize the memory stick. Therefore press the Restart Panel AP.

- Choose the new file with the suffix of prp and press OK. Then the device will replace the new version with the old one. It is recommended to save the old version before upgrading.
- Make Zero Thickness only for first time after uploading the new software.

Restart Panel AP: Turns on the device and opens the main page.

6- Maintenance

Make sure the electricity power key is Turned off, during any part of maintenance activity.

Table 6: The maintenance activities time and description.

Activity	Time
Cleaning the Chamber	After the deposition, once the inner layer of chamber is covered by the layers.
Cleaning the particles inside the chamber	When the parts are deposited by layers and it has scaling appears.
Changing the target	It depends on the target usage
Inspection of wires and plugs	Every time before starting the deposition.

6-1 Evaporation Source Installation and Replacement

Turn off the system and loosen the wing bolt at the sides of the basket and remove it. And then replace it with the new one. To replace the new boat or basket and to adjust the length need to loosen the wing bolt and displace the copper connection. Do not tight the wing bolt too much; it will cause damage to the copper thread.

NOTE:

Consumable items can be ordered to Vaccoat Co. or authorized companies by Vaccoat Co. Please contact our office for consultancy and technical advice.

6-2 Crystal Replacement

1- Loose the screw, that holding the door.

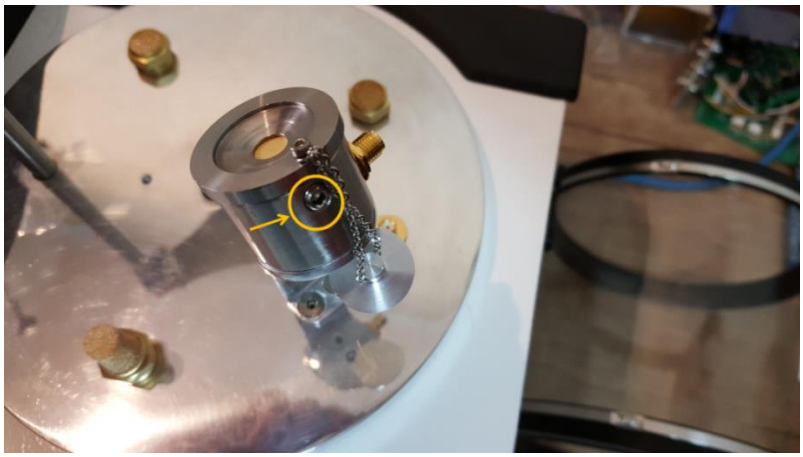

Figure 6-1: Door holder screw

2- Remove the crystal placed on small grooves on the holder.

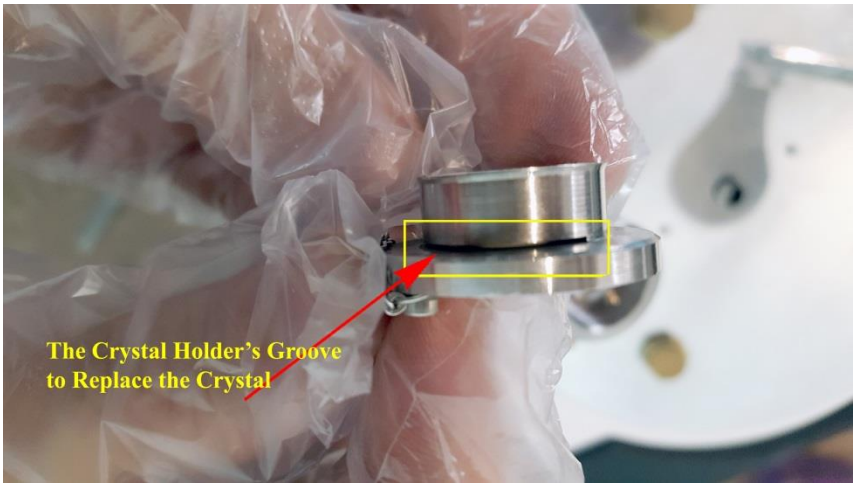

Figure 6-2: Small groove to replace the new crystal

3- Insert the new crystal with caution in the right direction to the groove shown in the Figure 6-3.

Figure 6-3: Insertion of new crystal to the groove

4- To avoid falling crystal, keep the crystal holder in such a way that the groove is side up.
5- Put the crystal holder in place in a way that the groove is side up.
6- Tighten the screws holding the door.

6-3 Cleaning the Device

It is recommended to cover the vacuum chamber's internal parts by a disposable aluminum foil to avoid coating them during the sputtering process.

To avoid base of vacuum chamber coating, there is a still plate with thickness of 0.5 mm on the base plate that is tighten by four screws. Just open the screws and wash the plate to clean the vacuum chamber's base.

Chamber

To wash the glass chamber should be very careful, because the edges of the glass are very vulnerable and easy to chip off, and this causes the device not to reach the desired vacuum level. So the user should note the following:

- Use gloves in all washing steps.
- It is recommended, to use the dilute acid for washing the chamber in the place with fan ventilation and wearing a mask. To avoid breaking the glass, use the plastic bumpers and put it under the chamber.
- The washing liquid can be dilute sulfuric acid or hydrochloric acid.
- Use acid-stained cloth and clean the glass.
- Rinse the glass as well as no traces of acid left on it.
- Dry the outside and inside of the glass by a lint-free.

- To ensure the clearance of acid on the glass, clean it with a cloth soaked in acetone.

- ❖ Avoid any skin or eye contact while using acid.
- ❖ Avoid device's body contact with acetone. It will damage the painting of the body.

O-rings

- First open the clips of O-rings, and then carefully remove them. It should be noted that it should not be stretch away because of its material (Viton) with low elasticity, and it will not return to its initial state.
- Inside and outside of O-rings can be washed by conventional dishwashing liquid and then rinse out.
- After washing the O-rings, they must be rubbed with the vacuum grease.
- Vacuum grease should be applied only to the extent that the O-rings are shiny and should not use a lot of grease on the O-rings it leads to disruption of the vacuum process.
- Put the O-rings in its place and close the clips.

Internal Items in Chamber

Remove the aluminum foil and clean the parts with a soft brush (toothbrush). So the layers of material deposited on the part are separated as scaling.

6-4 Transportation and Handling

The system consists of three separated parts power supply and bias; chamber and rotary pump. Cables between the power supply and chamber is designed in a way that they are not able to be placed shuffle. The cables between the chamber and the turbo pump controller are very sensitive. And if they are too stretched can cause the damage, in order to move the system contact the Vaccoat's office guidance.

6-5 Troubleshooting the DTT

This device does not need everyday service. But in case of any problem in accordance with Table 9, can troubleshoot and then fix it.

Table 7: Troubleshooting table of DTT

Item	Reason	Troubleshoot
Failure to achieve the desired pressure	1. The door is not completely closed, a foreign body between the chamber and the O-rings or base. 2. There are leaks in the connections. 3. The rotary pump gas ballast valve is open 4. The presence of moisture in the chamber	1. By visual inspection to remove a foreign body between the O-rings and base or the door. 2. Check the connection between the vacuum pump and the chamber 3. Close the gas ballast valve of the rotary pumps 4. Do not put any wet object inside the vacuum chamber
Turbo pump is getting off by itself.	Monitored temperatures in turbo pumps are exceeded. (Appendix 1), which is due to leak.	Fix the leaks and after cooling the system, turn on the pump again.
The chamber's pressure display on the screen does not work	The lack of connection between the pressure gauge module and monitor.	Check the page of maintenance and troubleshooting to see if the lights of the P are red, it means the flat cable connection with pressure module is interrupted.
Crystal Life shows the number 0%	See the section 6-5-1.	See the section 6-5-1.
Despite the applied voltage & current the displays shows Zero.	1. There might be a disconnection in evaporation source. 2. The short circuit has happened in system.	1. Check the boat connections. 2. By ohmmeter check the connections.
The power supply is not turning on.	1.The pressure is not low enough- less that $5x10^{-3}$ 2. The cable at the back of the device is loose.	1. Wait for the pressure to get lower. 2. Put back in the electric cable.
By increasing the current, the boat will not turn to red.	The short circuit has happened in system.	By ohmmeter check the connections
"Battery backed RAM data" appears on the monitor	Battery backed is discharged	Turn on the system for 2 or 3 hours without turn on the vacuum pump (set again all parameters which was saved such as "tooling factor")

If the above item and solutions is been fulfilled, please contact the Vaccoat Co for more guidance.

6-5-1 Thickness sensor troubleshooting

One of the defects commonly happen to thickness gauge is a sudden Zero Crystal Life. Usually the life of crystals slowly decreases and after a few dozen or a few hundred times deposition (depending on thickness) its life is over, so if the life of the crystal, for example, is 50% and suddenly turns to zero, it doesn't means the end of life of the crystal. But it tells, there is a fault in thickness gauge. For troubleshooting should act as follows:

First, with a visual inspection, make sure that there is no particle on the crystal. After ensuring the absence of such a problem, turn the golden socket which connects the thickness gauge wire to the crystal counter-clockwise to be removed. Then connect the test crystal (Figure 6-4) to the wire and wait for 10 seconds, if the crystal life turns to Green and showed the 98% or 99% that means there is a problems with connection of crystal three springs which pushing it upwards (Fig. 6-5).

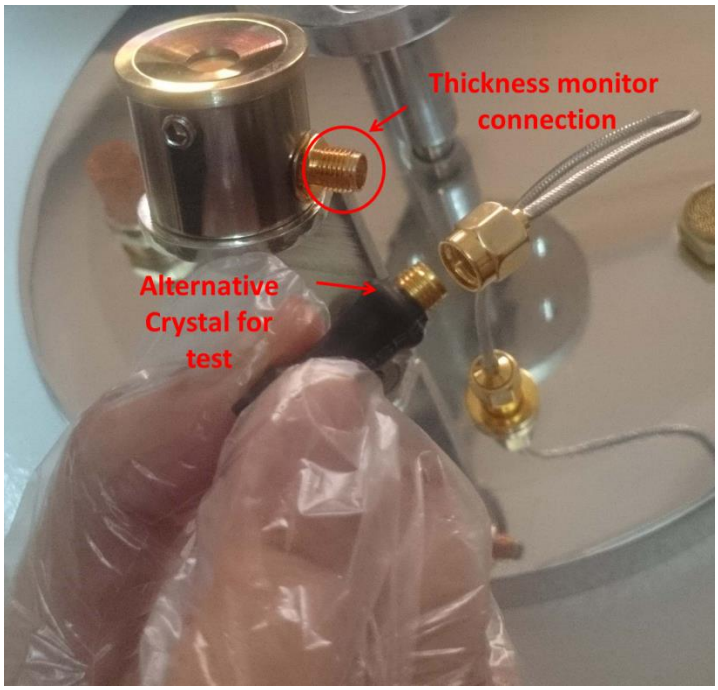

Figure 6-4: Connecting the alternative crystal to test the thickness meter

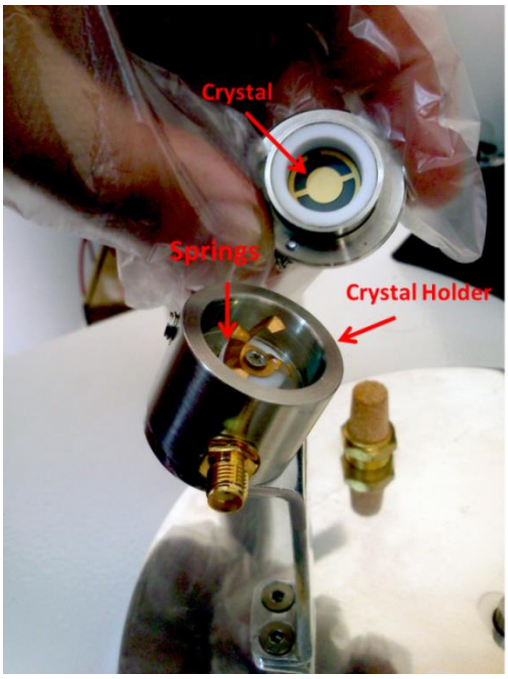

Figure 6-5: Different parts of thickness gauge

Put back the crystal's wire in place, with an Allen wrench in loose the thickness gauge door a little bit and turn it about 30 degrees and push down. Then wait for 10~15 second and if the problem still there, open the crystal door slightly and be careful not to drop the crystal. (It will be useless after that.)

Then Pull the three springs behind the crystal symmetrically and equally upward to have a better connection with crystal. Then put back the crystal in the right direction in its place and push it a little bit downward until the crystal life turns to green and tighten back the screw with Allen wrench.

6-5-2 Leakage and Leakage Detection

One of the problems that any vacuum system sooner or later will face is the leakage of the system and not to achieve the desired pressure. Therefore need to avoid doing the things that cause leaks in the system and detect the leakage location and fix it.

Leak detection work is time-consuming and likely the leak is at the last place that you're looking for. In this regard you must be patient and careful. Normally for leak detection there are helium vacuum leak detectors; which are very expensive. But there are more affordable ways which we will mention later on.

Basically leaks are divided into two categories: Real and Virtual leaks. The real leaks are happened because of openings arise in a vacuum chamber. If the vacuum pump turned off the pressure is gradually increased and will be identical to the atmospheric pressure.

The Virtual leaks that is not because of holes between the vacuum chamber and the atmosphere, but it has reasons such as trapped air in the vacuum chamber that the gradual release of it is not allowing the vacuum to reduce the pressure. (Normally it is because of the bad design of the system's compartments.) Or the virtual leaks happen because of the wet compartment in the chamber, which is not allowing the vacuum pump decrease the pressure.

Therefore to detect the leak, it is needed to find it out as a real leak or virtual.

Actual leaks are divided into two main groups:

Large leaks: finding such leaks are easier than others and in some cases even the sound of the leak is audible. Normally not properly closed door of chamber or of containers creates the leaks and the pressure gauge does not show any drop in pressure. Sometimes by putting a small hose adjacent to the ear and twisting the other end near the places, can detect the leak.

Small leaks: it is a little difficult to find these leaks. To find the leaks need to use the medical alcohol in the syringe and spray to that area. If there is a leakage the alcohol will be drawn to the chamber and converted from a liquid to a gas. And thus suddenly chamber pressure will increase.

Recommendations in connection with the leak

1- Avoid unnecessary manipulation in the system.

2- The system won't leak by its own, so if the pressure does not getting low, need to check the latest changes, which has been done. And from that point should start to detect the leak.

3- One of the most sensitive parts of the machine is the glass chamber, especially the edges. Therefore the opening of its door is very important.

The door and the baseplate is been polished, and because the pressure of the atmosphere are compressed to each other, so by lifting the door, the chamber may remain connected to it and after a few second get disconnected and hit the base. Therefore it may cause the crack to it.

To open the chamber's door hold the glass chamber with the palms of your hands and with your thumbs push the cover upwards. The closing also need to be done slowly, not to hit the edge of chamber.

4- Any scratches on the baseplate may cause the leakage. However, due to its material of the aluminum, need to be careful not hitting the door or base with sharp objects. The sacks with nails

sensible will cause leakage but the sacks which are not possible to feel with nails are usually not important.

In the presence of such sacks with very soft sandpaper (800 or 1000) sand the scratches to disappear, then clean location with a clean cloth and some alcohol.

7- Appendix 1

Turbo Molecular pump parameter list:

No.	Designation	Min.	Max.	Default	Unit	r/w	Format	Description
1	Actual frequency	0	65535	0	Hz	R	U16	Actual rotor frequency
2	Actual motor tempreture	-10	150	0	˚C	R	S16	
3	Actual converter tempratture	-10	100	0	˚C	R	S16	
4	Motor temperature warning threshold	0	150	80	˚C	r/w	S16	Exceeding the motor temperature warning threshold results in a warning
5	Setpoint frequency	P19	P18	1000	Hz	r/w	U16	Setpoint of the rotor frequency
6	Bearing temperature warning threshold	-10	150	60	˚C	r/w	S16	Exceeding the bearing temperature warning threshold results in a warning
7	Motor temperature lower warning threshold	-10	150	5	˚C	r/w	S16	Falling below the motor temperature lower warning threshold results in a warning
8	Motor temperature lower error threshold	-10	150	0	˚C	r/w	S16	Falling below the motor temperature lower error threshold results in an error message
9	Bearing temperature warning threshold	-10	150	65	˚C	r/w	S16	Exceeding the bearing temperature error threshold results in an error message
10	Motor temperature error threshold	-10	150	100	˚C	r/w	S16	Exceeding the motor temperature error threshold results in an error message