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CFM 1050 Reactive Closed Field Magnetron Sputtering System

Chamber

The chamber is a single walled, vertical axis, stainless steel cylinder, which is water cooled (or heated) via trace cooling channels. The chamber sits on a stainless steel base plate. Access is by means of a hinged large front opening door. The pumping port is situated in the side of the chamber to assist uniformity of deposition. Multiple ports for location of the rectangular magnetron sources, are situated along the length of the cylinder. The vertical geometry minimizes problems with particulates.

Specific dimensions as follows:

CFM 1050

Chamber diameter (internal)	1640mm
Chamber height (internal)	1620mm
Chamber diameter (external)	1690mm
Chamber height (external)	1670mm.
Drum diameter	700mm
Linear magnetron length	1255mm
Magnetron width (target size)	133mm
Magnetron positions:	6
Available coating area ($\pm 1\%$):	11,130 cm ²

The system is provided with front and back doors. Each door has three magnetron positions – six magnetron positions in total.

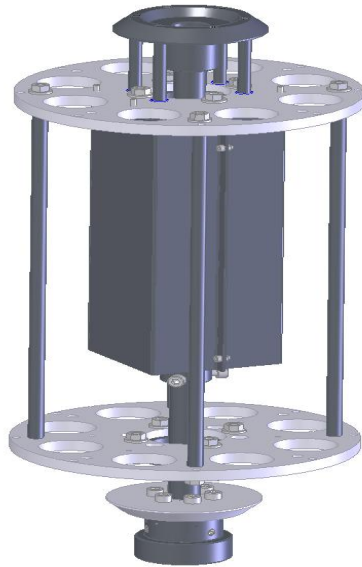
Further ports in the chamber walls are included as follows: 2 off view ports, 2" diameter (these can also be used for the infrared temperature monitor which can be supplied as an optional extra). 1 off 70 FC flanged port, to accommodate a mass spectrometer (not supplied); 5 off NW 25 flanged ports; 4 off NW 10 flanged ports. The NW 25 & NW10 ports are provided for vacuum gauges, gas inlets, venting etc. and provide ample spares for further accessories.

For all system options one set of removable shields are included to simplify chamber cleaning, the spare set can be used while the other set is being cleaned, minimizing system downtime.

Drum Substrate carrier

The CFM systems are equipped with a precision single axis drum with fixturing to accommodate a range of substrate sizes. The drum is mounted by means of a magnetic fluid rotary feed-through. The substrates are rotated by means of a geared motor giving speeds of typically 50rpm. This ensures $\leq \pm 1\%$ thickness uniformity over the central drum surface.

One universal precision drum with shutter is supplied – as shown below:



Universal drum configuration

Segment sizes are interchangeable to accommodate various substrate sizes. Specific segment widths to be agreed with the customer. Cylindrical drum geometries are available for coating of flexible sheet.

A cylindrical drum for sheet loading in a CFM 1050 is shown as follows:



Above also shows CFM1050 door incorporating three of the six magnetrons.

Magnetron sputter sources.

Three magnetron positions are available on each of the two doors of the vacuum chamber. Two magnetrons are supplied as standard. The magnetrons are directly cooled to enable efficient coating deposition and are designed to produce intense ion bombardment of the substrates during deposition.

The magnetrons are arranged in the patented closed field magnetron configuration (CFM). This system uses unbalanced magnetrons in an arrangement whereby neighboring magnetrons are of opposite magnetic polarity. The deposition zone in which the substrates are located is surrounded by linking magnetic field lines. This traps the plasma region, prevents losses of ionizing electrons and results in significant plasma enhancement.

The arrangement and strength of the magnetrons is optimized for this system.

The systems enable coating deposition to be carried out using a high density of low energy bombarding ions at room temperature. This results in deposition of very dense, non columnar coating structures with low internal stresses. The use of a low bias voltage during deposition also allows deposition of coatings with dense structures at room temperature temperatures .

The ion bombardment power drawn by the substrates during ion cleaning is very much higher than that drawn during deposition which significantly increases the efficiency of ion cleaning resulting in coatings with very high levels of adhesion.

The use and design of the CFM system is covered by the following patents: UK patent No 2258343, European patent No 0521045, US Patent No 5554519, Japanese Patent No 3397786.

Vacuum Pumping System.

For the standard CFM1050 system the chamber is pumped by the following pumps:

Backing pumps: Edwards E2M75 rotary pump and EH2400 roots blower combination.

Main chamber pumping: 4X Edwards 2000l/s turbo pumps.

Water vapour pumping: Telemark dual circuit water chiller pump and meissner coil

Note different pump suppliers can be used on customer request.

All valves are electro-pneumatic and the pumping sequence is automatically controlled by the computer.

Vacuum Gauges

Pressure is monitored by a Penning/Pirani combination with an Edwards active gauge controller with digital display.

Power Supplies

Magnetron power supplies.

The two magnetrons are powered by two off Advanced Energy Pinnacle 10kW pulsed DC power supplies. These units have excellent arc suppression and can operate on constant current, voltage or power. Power supplies can be run to allow simultaneous deposition from each magnetron.

Gas Control

Two gas inlets are provided as standard, one for argon mass flow control and the other associated with the reactive gas control system. All gas lines are stainless steel and incorporate Nupro electro-pneumatic closure valves. Gas lines are configured for two linear magnetrons although this can be extended to four magnetron positions optionally.

Reactive gas flow is maintained at the appropriate rate by a gas controller monitoring magnetron. The number of reactive gas lines can be extended also as an option. This system is used to control the exact composition and stoichiometry of reactively deposited coatings.

A continuously tunable gate valve can be incorporated for real time active pressure control. This is feedback controlled from a baratron gauge.

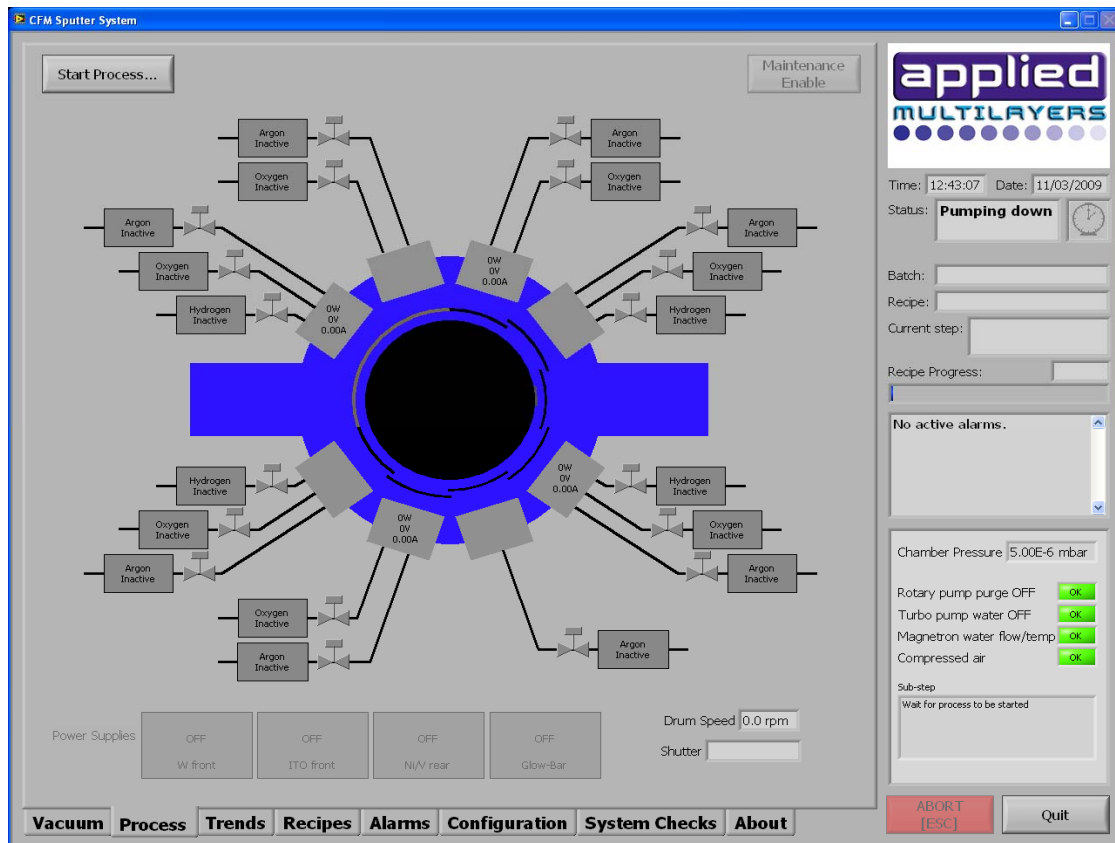
Process Control

The CFM 1050 system is supplied complete with computer control.

The system control is fully automatic through a system computer. This includes a suite of menus for the various coating types, automatic recording of deposition parameters, status displayed on mimic diagrams, orderly and safe shut down procedures. Existing menus can be easily modified and new menus written with no specialized programming skills. The system can be monitored from the factory by Ethernet link.

The computer fully controls the vacuum system and allows easy writing of coating sequences using the recipe writer section of the program. These coating recipes consist of a series of coating steps, each include all coating parameters (e.g. power supply settings).

Typical process screen for the six magnetron CFM 1050 is shown as follows.



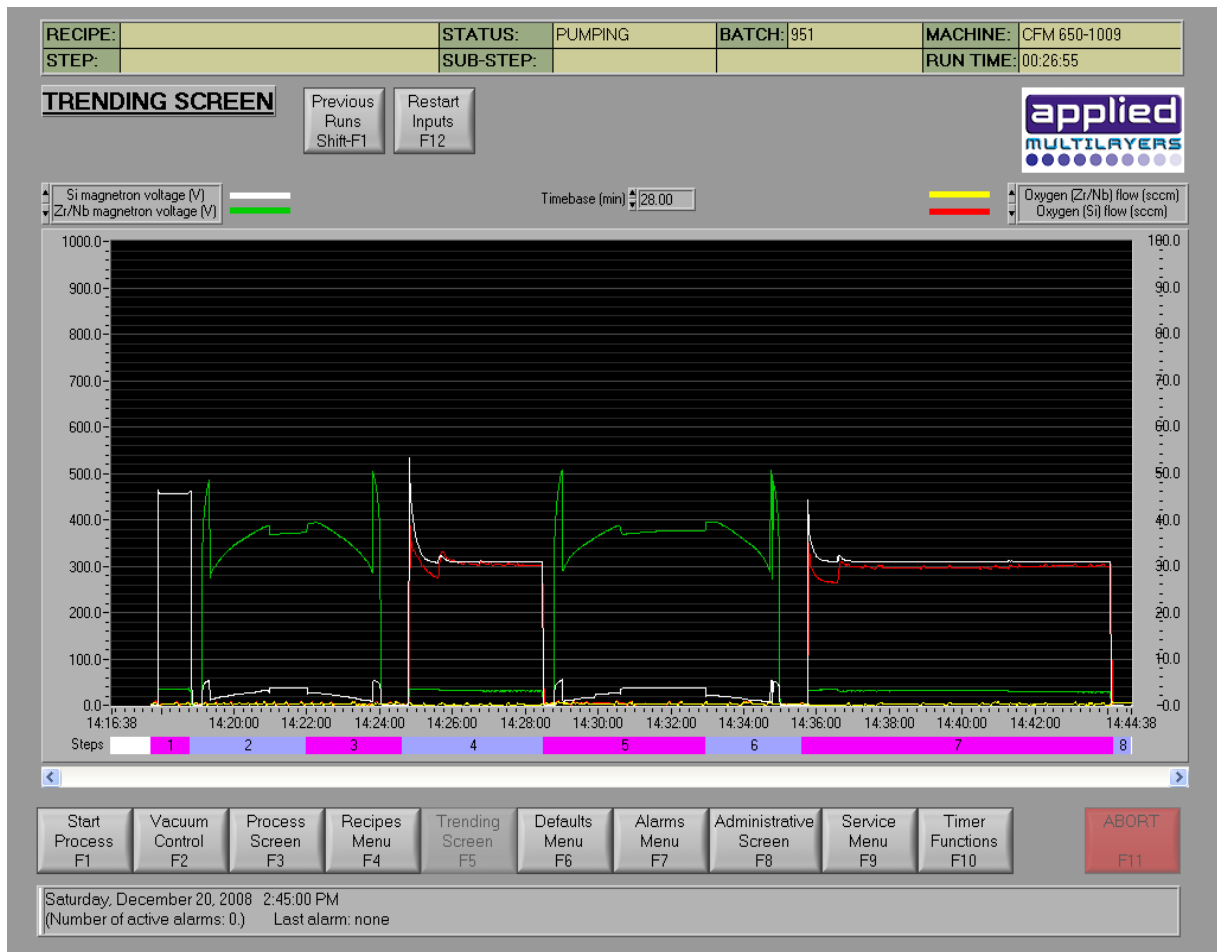
Process Control screen – 8 magnetron system

The following data is logged and may be displayed;

- Magnetrons - current, voltage
- Bias - current, voltage
- Pressure – Chamber and backing pressure
- Time
- Rate of rise before run
- Gas

A trending screen is displayed during the process, the data that is displayed is chosen by the operator and can be changed during the process if required. Once the run has finished, the data is logged in a spreadsheet format file. The process recipe is then attached to the end.

During the process, parameters are checked to see if they are within tolerance of the set parameters and the process will abort if outside of these tolerances.



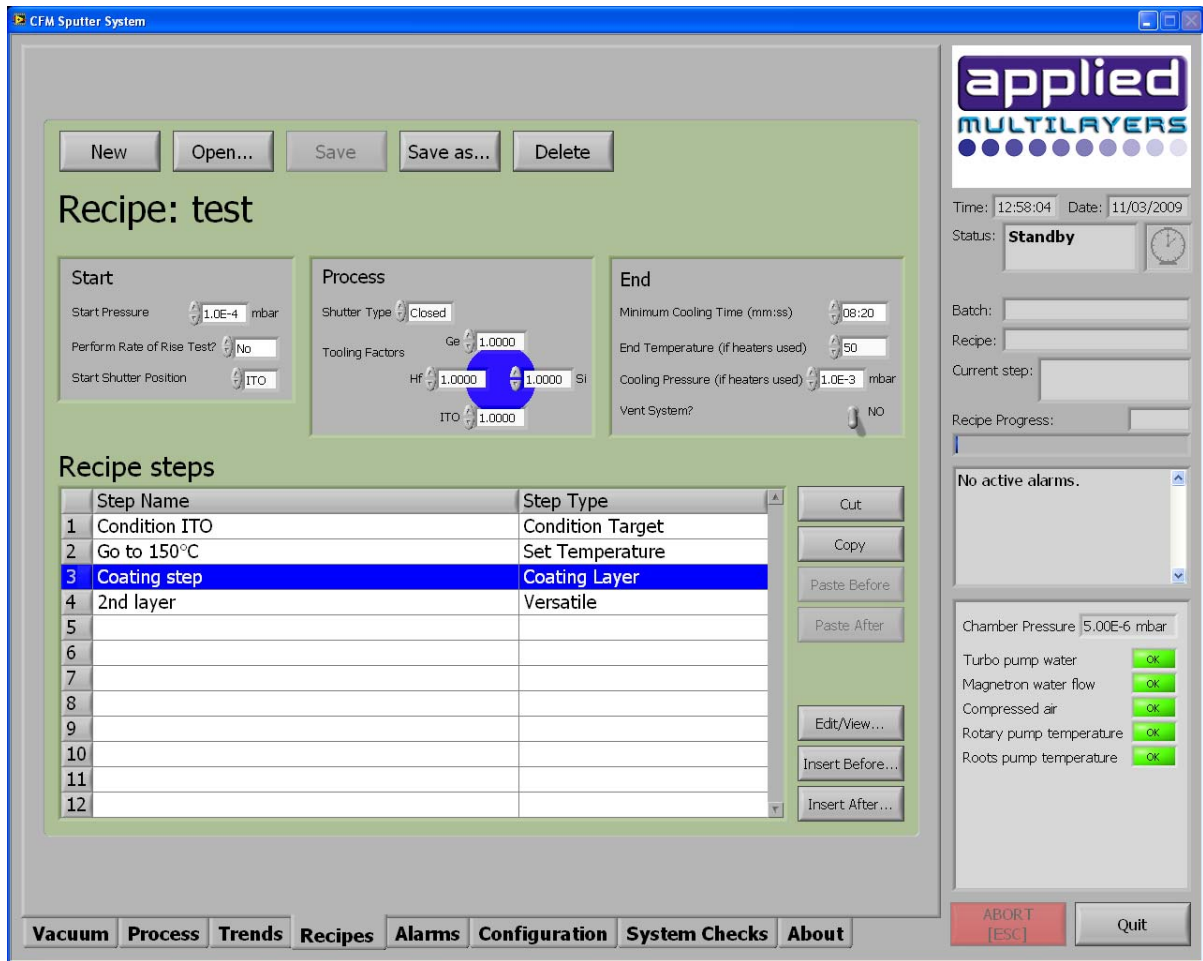
Trending screen

Password protection is included on certain screens.

Timer functions allow the timed start-up or shutdown of the pumping system.

A manual coating can be performed via a manual control screen where all coating parameters can be user set. All parameters are data logged in the same way as an automated coating process.

Recipe editing for single and multilayer layer deposition is available. This includes substrate cleaning, target conditioning stages, magnetron stabilisation, deposition and shutdown.



CFM Sputter System

Time: 12:58:04 Date: 11/03/2009
Status: **Standby**

Batch:
Recipe:
Current step:
Recipe Progress:

Recipe: test

Start
Start Pressure: 1.0E-4 mbar
Perform Rate of Rise Test? No
Start Shutter Position: ITO

Process
Shutter Type: Closed
Tooling Factors: Ge: 1.0000, Hf: 1.0000, ITO: 1.0000, Si: 1.0000

End
Minimum Cooling Time (mm:ss): 08:20
End Temperature (if heaters used): 50
Cooling Pressure (if heaters used): 1.0E-3 mbar
Vent System? NO

Recipe steps

Step Name	Step Type
1 Condition ITO	Condition Target
2 Go to 150°C	Set Temperature
3 Coating step	Coating Layer
4 2nd layer	Versatile
5	
6	
7	
8	
9	
10	
11	
12	

Buttons: Cut, Copy, Paste Before, Paste After, Edit/View..., Insert Before..., Insert After...

Chamber Pressure: 5.00E-6 mbar

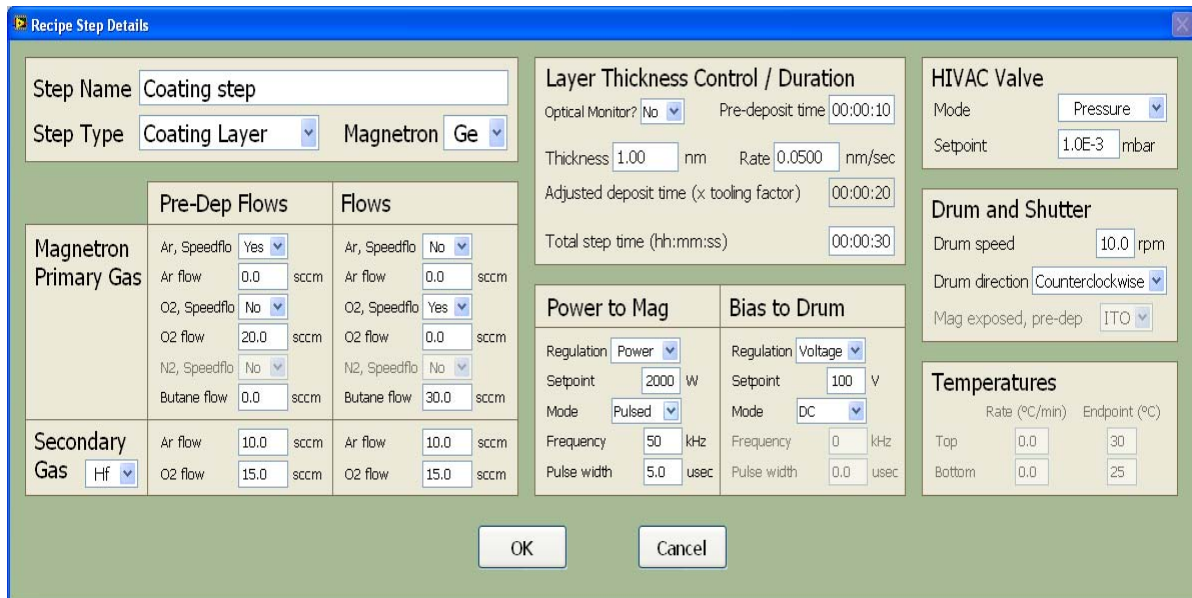
Turbo pump water: OK
Magnetron water flow: OK
Compressed air: OK
Rotary pump temperature: OK
Roots pump temperature: OK

ABORT [ESC] Quit

Vacuum Process Trends Recipes Alarms Configuration System Checks About

Recipe editing screen

Specific magnetron running conditions can be readily set using the following edit tab available within the recipe editor.



Recipe Step Details

Step Name: Coating step
Step Type: Coating Layer Magnetron: Ge

Layer Thickness Control / Duration
Optical Monitor? No Pre-deposit time: 00:00:10
Thickness: 1.00 nm Rate: 0.0500 nm/sec
Adjusted deposit time (x tooling factor): 00:00:20
Total step time (hh:mm:ss): 00:00:30

HIVAC Valve
Mode: Pressure
Setpoint: 1.0E-3 mbar

Drum and Shutter
Drum speed: 10.0 rpm
Drum direction: Counterclockwise
Mag exposed, pre-dep: ITO

Temperatures
Rate (°C/min) Endpoint (°C)
Top: 0.0 30
Bottom: 0.0 25

Pre-Dep Flows

Gas	Speedflo	Flow (sccm)
Magnetron Primary Gas	Ar, Speedflo: Yes	Ar flow: 0.0
	O2, Speedflo: No	O2 flow: 20.0
	N2, Speedflo: No	N2 flow: 0.0
	Butane flow: 0.0	Butane flow: 0.0
Secondary Gas: Hf	Ar flow: 10.0	O2 flow: 15.0

Flows

Gas	Speedflo	Flow (sccm)
Magnetron Primary Gas	Ar, Speedflo: No	Ar flow: 0.0
	O2, Speedflo: Yes	O2 flow: 0.0
	N2, Speedflo: No	N2 flow: 30.0
	Butane flow: 30.0	Butane flow: 30.0
Secondary Gas: Hf	Ar flow: 10.0	O2 flow: 15.0

Power to Mag
Regulation: Power Setpoint: 2000 W Mode: Pulsed Frequency: 50 kHz Pulse width: 5.0 usec

Bias to Drum
Regulation: Voltage Setpoint: 100 V Mode: DC Frequency: 0 kHz Pulse width: 0.0 usec

OK Cancel

Magnetron set-up screen

Warranties

All bought out items will carry the original manufacturer's warranty. This includes pumps, Power Supplies, Controllers, etc. All other items are warranted by Applied Multilayers LLC. and any defect in materials or workmanship reported within one year of purchase will be repaired or replaced free of charge.

Spares

A comprehensive spares list is provided, including a complete set of 'O' rings; Rotary pump oil; Vacuum Grease; 2 spare sight glasses, 2 NW 25 blanking plates; 2 NW 10 blanking plates; Drive belt for sample rotation, optical fibre for optical emission monitor.

In addition we stock most major items and will supply replacement parts by transport on notification of breakdown. This will be a free service under the warranty for the first year, but will be charged after the end of the warranty period.

Installation Requirements

Electrical requirements are 415V, 3 phase supply, 45kW total

Water cooling water requirements are; flow 20 liters/minute, pressure 3 bar; temperature 18°C.

Compressed air at 100psi is required.

Supplies of Research Grade Argon and Oxygen gases are required.

A supply of dry nitrogen is highly advisable for venting the chamber.