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## CFM450 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:

### **CFM450**

Chamber diameter (internal)	450mm
Chamber height (internal)	640mm
Chamber diameter (external)	528mm
Chamber height (external)	685mm
Drum diameter	250mm
Linear magnetron length	410mm
Magnetron width (target size)	133mm
Magnetron positions:	2
Available coating area ( $\pm 1\%$ ):	1875 cm <sup>2</sup>

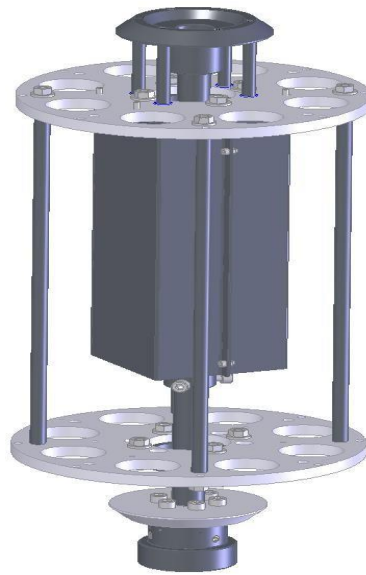
Further ports in the chamber walls are included as follows:- 2 off view ports, 2" diameter (these can also be used for the infra-red temperature monitor which can be supplied as an optional extra). 1 off 70 FC flanged port, to accommodate a mass spectrometer (not supplied); 5 off NW 25 flanged ports; 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 two sets 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  $< \pm 1\%$  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 segmented drum for lens loading is shown as follows for a CFM 450 system.



**Magnetron sputter sources.**

Two magnetron positions are available in the walls of the vacuum chamber. Two magnetron assemblies 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 CFM450 system the chamber is pumped by the following pumps:

Backing pumps: Edwards E2M40 rotary pump with EH250 roots blower combination.

Main chamber pumping options: Turbo Edwards 1600l/s. Alternatively One off Edwards 2,000 liter/sec Oil Diffusion Pump.

Water vapor pump: Telemark TVP 1000.

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 one off Advanced Energy Pinnacle 5x5 pulsed DC Power Units. 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 on request.

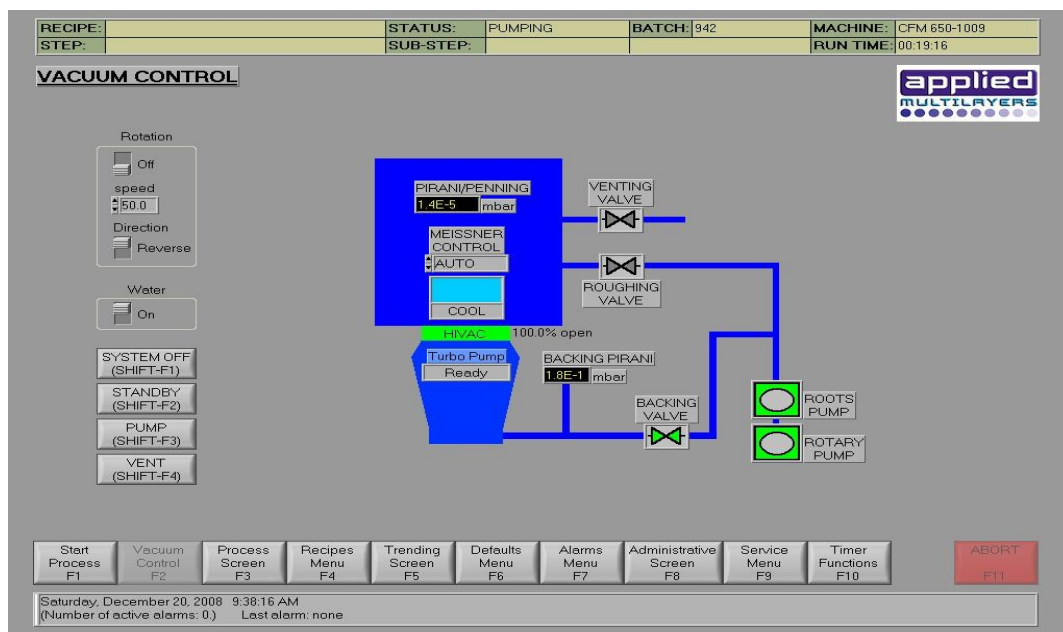
Reactive gas flow is maintained at the appropriate rate by a gas controller monitoring magnetron. The number of reactive gas lines can be extended on request. This system is used to control the exact composition and stoichiometry of reactively deposited coatings.

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

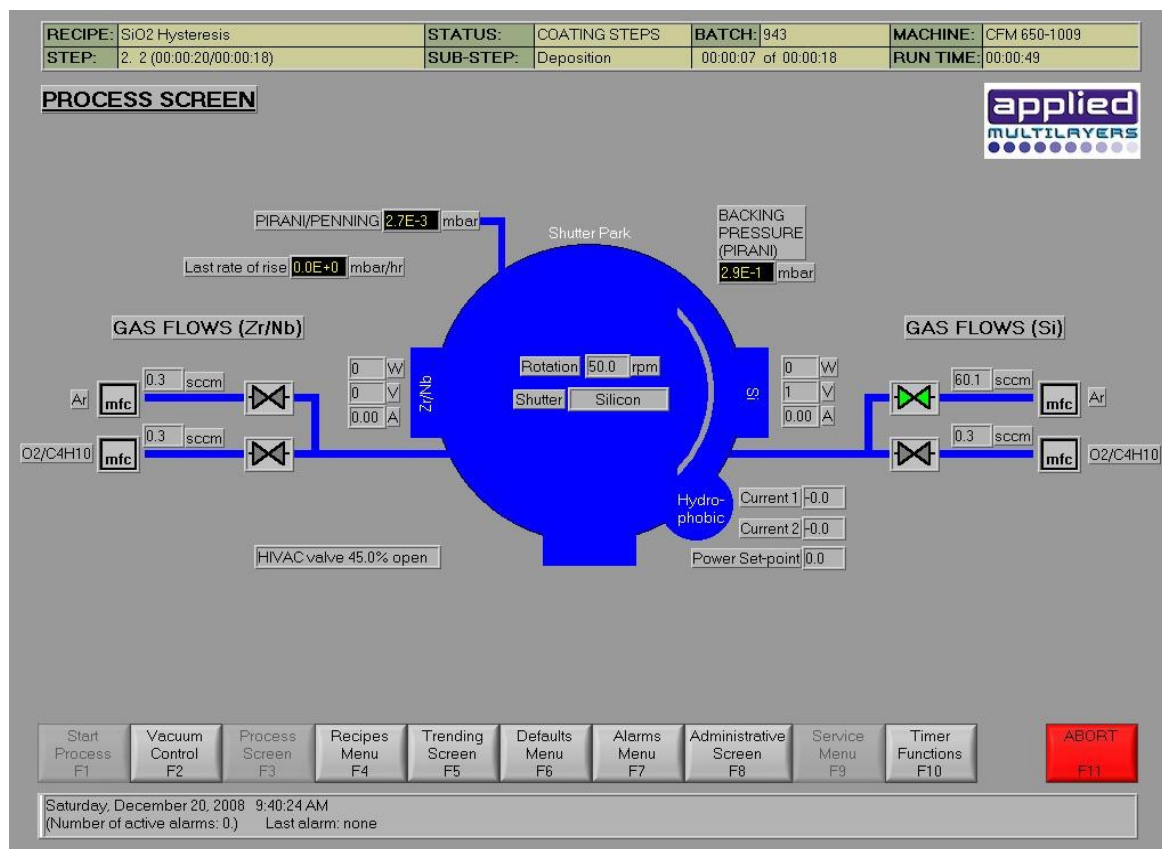
## Process Control

The CFM450 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 internet link. Example control screens as follows.



Vacuum Control Screen



Process Control Screen

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 (eg. power supply settings),

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.

An example trend screen is shown as follows:



Trend screen

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.

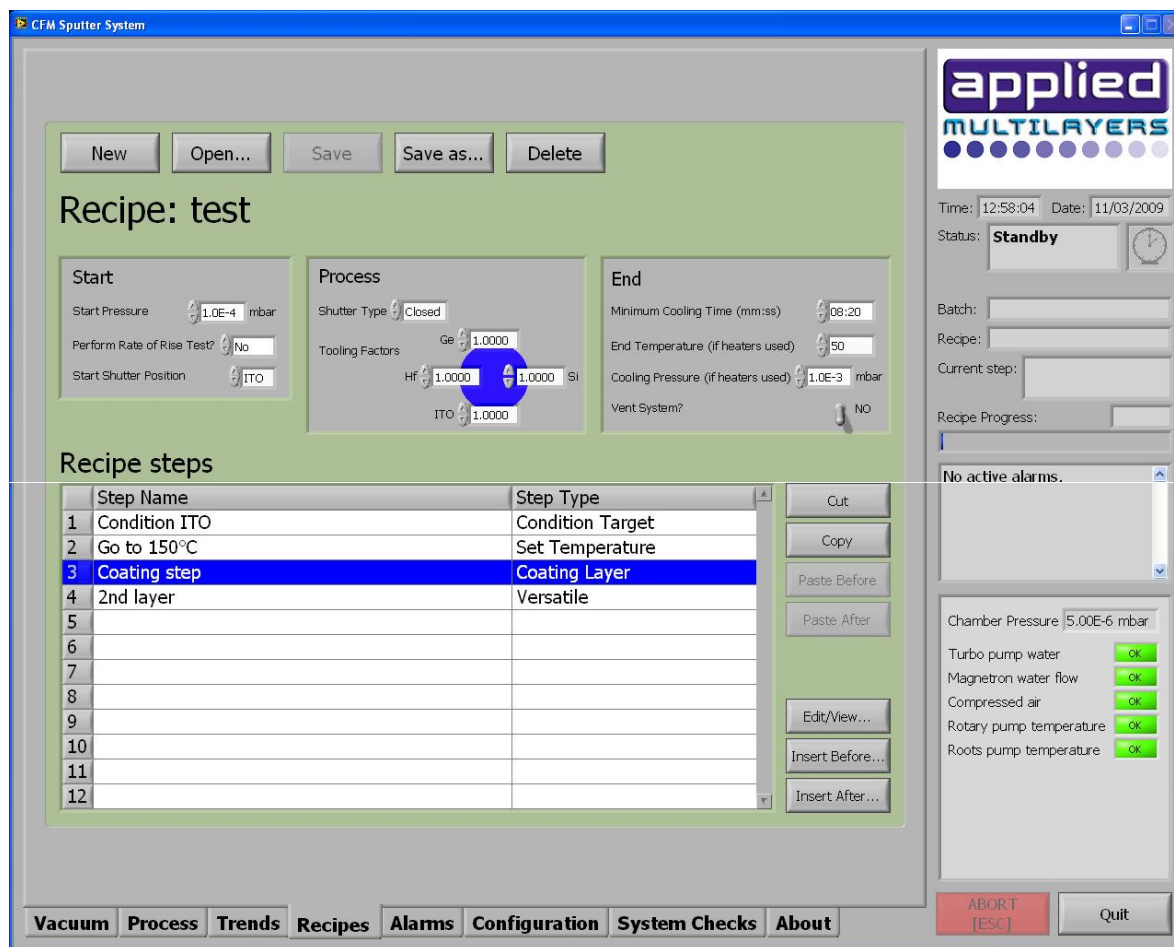
Password protection is included on certain screens.

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.

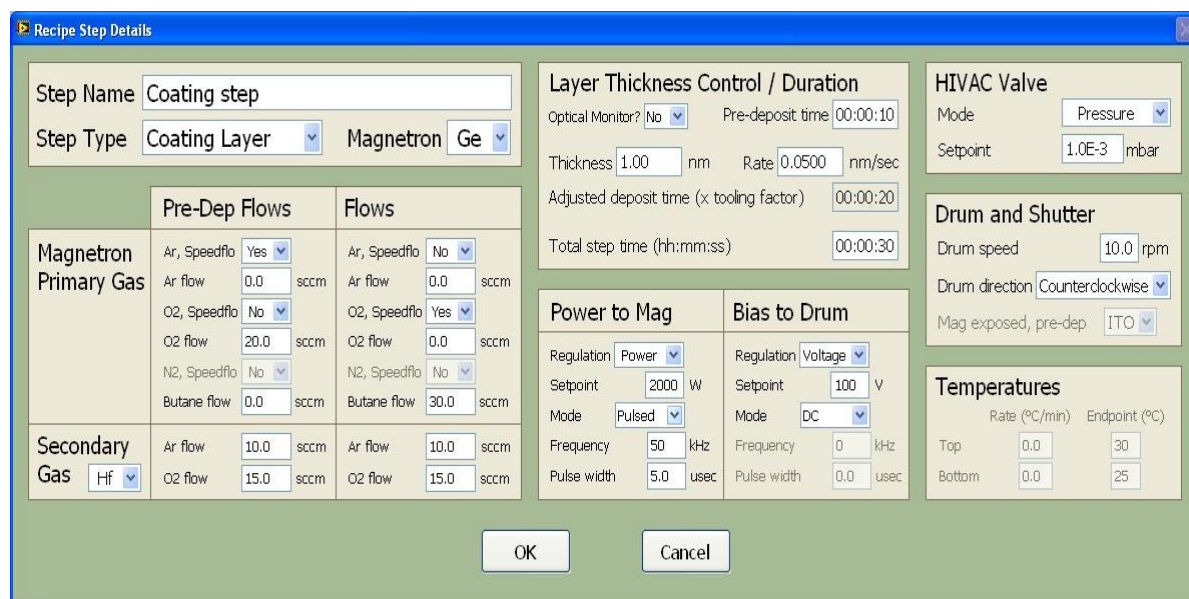
Recipe editing for single and multilayer layer deposition is available. This includes substrate cleaning, target conditioning stages, magnetron stabilization, deposition and shutdown.





Recipe editing screen

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



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 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; Diffusion pump oil; 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 fiber for optical emission monitor.

In addition we stock most major items and will supply replacement parts by air 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 about 18°C.

Compressed air at 100psi is required.

Supplies of research grade Argon and Oxygen gases are required.

A cylinder of dry nitrogen is advisable for venting the chamber.