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# CFM850 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 minimises problems with particulates.

Specific dimensions as follows:

#### CFM850/6

Chamber diameter (internal)	760mm
Chamber height (internal)	1381mm
Chamber diameter (external)	780mm
Chamber height (external)	1451mm.
Drum diameter	532mm
Linear magnetron length	1055mm
Magnetron width (target size)	133mm
Magnetron positions:	6
Available coating area (±1%):	11,130 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, minimising 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 cylindrical drum for sheet loading in a CFM850 is shown as follows:



#### Magnetron sputter sources.

Four magnetron positions are available in the walls 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 neighbouring 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 ionising electrons and results in significant plasma enhancement.

The arrangement and strength of the magnetrons is optimised 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 CFM850/ system the chamber is pumped by the following pumps:

Backing pumps: Edwards E2M175 rotary pump and EH1200 roots blower combination.

Main chamber pumping: 2 X Edwards 2000l/s turbo pumps

Water vapour pumping: Polycold 1100

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 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 incorprated for real time active pressure control. This is feedback controlled from a baratron gauge.

#### Process Control

The CFM650 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 specialised programming skills The system can be monitored from the factory by modem link.



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:

CFM 450/4 System Option

Specification number 02.73v09

PUMPING BATCH: 951 MACHINE: CFM 650-1009 RECIPE: STATUS: STEP: SUB-STEP: RUN TIME: 00:26:55 TRENDING SCREEN Previous Restart applied Runs Shift-F1 Inputs F12 MULTILRYERS Oxygen (Zr/Nb) flow (sccm)
 Oxygen (Si) flow (sccm) Si magnetron voltage (V) Timebase (min) 🛱 28.00 1000.0-180.0 90.0 900.0 800.0 80.0 700.0 70.0 <u>6</u>0.0 600.0-50.0 500.0-40.0 400.0-300.0-200.0-20.0 100.0-Ŧ0.0 -0.0 0.0 14:24:00 14:26:00 14:20:00 14:28:00 14:30:00 14:32:00 14:34:00 14:36:00 14:38:00 14:40:00 14:42:00 14:22:00 14:44:38 14:16:38 Steps 8 < > Vacuum Control Process Screen Recipes Menu Defaults Menu Alarms Menu Service Menu Timer Functions Start Trending Administrative Process Screen F1 F2 F3 F4 F6 F7 F8 F9 F10 Saturday, December 20, 2008 2:45:00 PM (Number of active alarms: 0.) Last alarm: none

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#### 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 stabilisation, deposition and shutdown.

putter System			
New Open	Save Save as	Delete	Time: 12:58:04 Date: 11/03
Start Pressure Perform Rate of Rise Test? (No Start Shutter Position Start Shutter Position	Process Shutter Type (Cosed Tooling Factors Ge (10000) Hf (10000) (10000)	L0000 SI Cooling Pressure (if heaters used) (1.000-3 mbar Vent System? NO	Status: Standby Batch: Recipe: Current step: Recipe Progress:
Step Name       1     Condition ITO       2     Go to 150°C       3     Coating step       4     2nd layer		Step Type     Image: Condition Target       Condition Target     Copy       Set Temperature     Copy       Coating Layer     Paste Before       Versatile     Date Afrece	No active alarms.
5 6 7 8 9 10 11		Edit/View Insert Before	Chamber Pressure (5.000-6 m Turbo pump water Magnetron water flow Compressed air Rotary pump temperature Roots pump temperature
12 suum Process Trends	Recipes Alarms Confi	r Insert After	ABORT Quit

Recipe editing screen

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

Recipe Step Details	5				×
Step Name	Coating step Coating Layer 🛛 🝸	Magnetron Ge 💌	Layer Thickness Co Optical Monitor? No V Thickness 1.00 nm	ntrol / Duration Pre-deposit time 00:00:10 Rate 0.0500 nm/sec	HIVAC Valve Mode Pressure V Setpoint 1.0E-3 mbar
	Pre-Dep Flows	Flows	Adjusted deposit time (x to	poling factor) 00:00:20	Drum and Shutter
Magnetron Primary Gas	Ar, Speedflo Yes Y Ar flow 0.0 sccm O2, Speedflo No Y O2 flow 20.0 sccm N2, Speedflo No Y Butane flow 0.0 sccm	Ar, Speedflo     No     Image: Speedflo       Ar flow     0.0     sccm       O2, Speedflo     Yes     Image: Speedflo       O2 flow     0.0     sccm       N2, Speedflo     No     Image: Speedflo       Butane flow     30.0     sccm	Total step time (hh:mm:ss Power to Mag Regulation Power Setpoint 2000 W Mode Pulsed V	Bias to Drum Regulation Voltage V Setpoint 100 V Made CC V	Drum speed 10.0 rpm Drum direction Counterclockwise V Mag exposed, pre-dep ITO V Temperatures Rate (°C/min) Endpoint (°C)
Secondary Gas Hf 💌	Ar flow 10.0 sccm O2 flow 15.0 sccm	Ar flow 10.0 sccm O2 flow 15.0 sccm	Frequency 50 KHz Pulse width 5.0 usec	Frequency 0 kHz Pulse width 0.0 usec	Top 0.0 30 Bottom 0.0 25

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 Ltd. and any defect in materials or workmanship reported within one year of purchase will be repaired or replaced free of charge.

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# 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 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 litres/minute, pressure 3 bar; temperature 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.