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Thin Film Deposition

Controllers and Monitors

PRECISELY THE
INSTRUMENTS
YOU NEED

INFICON
The Instrumental Difference®

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Precisely the Right Choices

However simple or complex your system—whether it involves thermal evaporation, sputtering, or ion beam processes—INFICON has precisely the right thin film deposition controller or monitor for you. All four quartz crystal-based instruments use the INFICON revolutionary patented measurement system, ModeLock, making them the most precise, most advanced instruments available.

THE PRECISE INSTRUMENT FOR YOUR PROCESS

- The IC/5 controller provides the ultimate control of deposition rate and thickness in systems with multiple sources, crucibles, materials, and processes.
- The XTC/2 controller provides economical yet powerful control of less complex processes.
- The XTC/C controller operates with your own system computer and custom software interface, saving you the cost of a front-panel display and keyboard.
- The XTM/2 offers superior measurement technology in a monitor-only instrument.

Whatever instrument you choose, you'll be backed by the worldwide technical support and expertise that only INFICON can offer.



MODELOCK–FOR UNSURPASSED PERFORMANCE

ModeLock, the unique measurement system used in all four instruments, provides crystal-frequency information with precision unobtainable from conventional "active oscillator" systems.1 This precision, combined with control algorithms tailored to your deposition process, provides unsurpassed performance for long crystal life, low rate depositions, and overall rate control.

One of ModeLock's most important benefits is the extension of the crystal's useful life. For some materials, such as indium, it nearly doubles crystal life.

ModeLock virtually eliminates "mode hopping," a failure to maintain crystal oscillation at the fundamental frequency. In the IC/5, ModeLock offers a single-measurement rate resolution of 0.005 Å–even while measuring at 10 times per second. This kind of precision means smoother rate control, especially important for processes with low deposition rates.

HOW MODELOCK WORKS

The ModeLock measurement system takes charge, continuously testing the monitor crystal for resonance at the fundamental frequency, thereby eliminating weaknesses inherent in the conventional measurement method.

The conventional measurement method incorporates the quartz monitoring crystal as an active element of the oscillator circuit. Consequently, the crystal controls the oscillator circuit. So, as the electrical characteristics of the crystal change during deposition, the oscillator circuit becomes less stable and may "hop" to another resonant frequency or fail completely, resulting in an inaccurate film thickness.

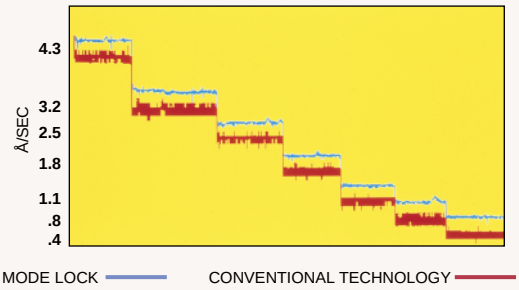
More powerful and precise—yet faster—than the conventional method, ModeLock continually tests and analyzes the phase-frequency relationship of the crystal. The crystal is not an active part of the oscillator circuit.

[1] ModeLock—Patented in United States, United Kingdom, Germany, and Japan (pending). For detailed technical information on ModeLock, contact INFICON for a copy of "The Technology of the Intelligent Oscillator for Quartz Crystal Measurement and its Advantages for Thin Film Processes."

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CONTROL RESPONSE OF ALUMINUM



The rate control provided by INFICON ModeLock technology is far superior to that of conventional technology, as demonstrated in the control of an aluminum deposition. The IC/5, as shown here, provides unsurpassed measurement precision and speed–0.005 Å measurement resolution updated 10 times per second.

RATEWATCHER—FOR LONG-TERM RATE CONTROL

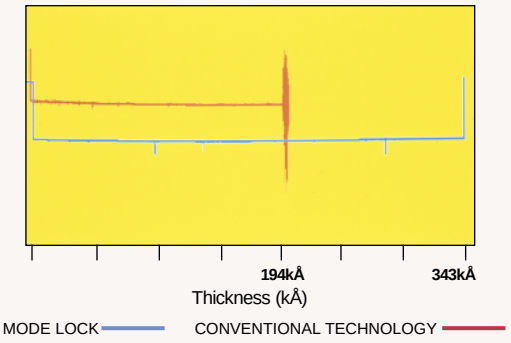
The three controllers (IC/5, XTC/2, and XTC/C) come with the INFICON RateWatcher feature, providing long-term rate control for in-line or loadlocked sputtering processes or for thermal evaporation from a resistive source.

The RateWatcher feature takes advantage of the process's short-term stability by sampling the rate periodically and adjusting source power at programmable intervals. This sampling scheme extends the life of the crystal while automatically correcting for long-term rate changes due to cathode wear or source depletion.

ModeLock measurement system determines and applies a precise frequency to the crystal, preventing the crystal from "hopping," or operating at a frequency other than the fundamental. This process takes place thousands of times per second to determine the resonant frequency to a precision of 0.0047/100 ms.

In other words, ModeLock, the fastest measurement system available, provides an intelligent link between the quartz crystal and the instrument, allowing the instrument to enhance the crystal's performance. ModeLock ensures precision, long crystal life, and freedom from mode hopping. The result is increased process security from beginning to end—improving yield, throughput, and quality.

CRYSTAL LIFE FOR COPPER DEPOSITION



INFICON ModeLock measurement technology provides significantly longer crystal life, illustrated here in the deposition of copper.

CRYSTALSIX® SENSOR—SECURITY TIMES SIX

All INFICON deposition controllers (IC/5, XTC/2, and XTC/C) can be equipped with the optional, patented CrystalSix sensor, which holds six crystals.[2] Whenever one crystal becomes unstable or fails, the deposition controller signals the CrystalSix sensor to sequence to another crystal automatically, maintaining control without interruption. In addition, the IC/5 offers a CrystalSix "position select" feature; allowing you to choose any of the six crystal positions on demand. By dedicating crystals to specific materials, you can increase long-term deposition rate and thickness accuracy.



[2]CrystalSix—Patented in the United States, United Kingdom, Germany and Japan.

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The IC/5™ Deposition Controller Ultimate Capability

The versatile IC/5 is ideally suited for control of deposition rate and thickness in systems with multiple sources, crucibles, materials, or processes. The IC/5 meets the needs of even the most complex, demanding, and unique applications. It excels in process control, logic capabilities, program and layer storage capacity, process data management, and especially rate and thickness control.



COMPREHENSIVE PROCESS CONTROL

With its extensive capabilities, the IC/5 can initiate pumpdown, control valves, activate substrate heaters, etc. This enhanced functionality may eliminate the need for ancillary instruments, reducing system complexity and cost.

The IC/5's logic and process control capabilities include 100 programmable logic statements; I/O and TTL relay boards provide up to 24 relay outputs, 28 TTL inputs, 14 TTL outputs, 20 counters, and 20 timers.

The logic statements can be used in conjunction with external inputs or outputs. Each statement can include up to five functions and can be linked using Boolean logic.

The IC/5 offers six assignable analog outputs for source control or chart recorder outputs for rate, thickness, or rate deviation.

POWERFUL PROCESS RECIPE AND DATA MANAGEMENT

The IC/5 deposition controller offers several features and options to allow you to manage process recipes and data efficiently:

- *Generous on-board storage*—up to 50 processes and 250 layers—allows for instant access to the process data and recipe files you use most. This accessibility is particularly valuable for complex processes involving many layers, for deposition systems that run many types of processes, and for R&D or process development applications.
- *Optional disk drive*—for unlimited storage of process data and recipes.
- *Optional off-line editing software*—for entering or editing parameters at a PC rather than at the IC/5 front panel. Programming with this software is more convenient and efficient, especially for processes with multiple layers and materials.
- *Data logging*—Pertinent process information (final thickness, average rate, run number, layer number, and so on) can automatically be logged in ASCII format to the remote communications port, printer port, or disk.

With the disk drive option, the IC/5 can save data in a spreadsheet format for easy process data storage and manipulation. Data logging allows for convenient post-run analysis and fast corrective action. It is indispensable for companies who need to comply with ISO9000 or QA requirements for process traceability.

AUTO Z—FOR PRECISE DEPOSITION OF MULTIPLE MATERIALS

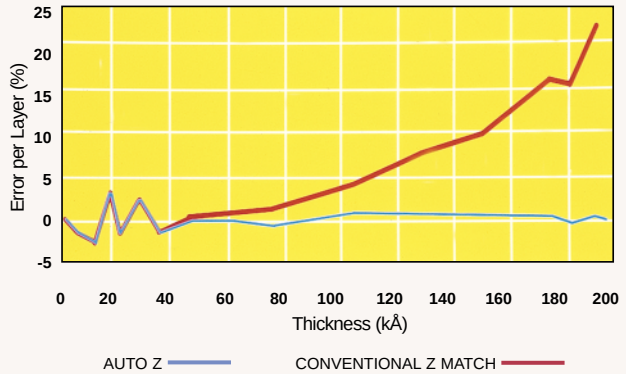
The IC/5's automatic Z-ratio determination, or Auto Z, increases the accuracy of thickness and rate control and eliminates the need for the user to estimate the acoustic impedance (Z) ratio.3

When multiple materials are deposited on a crystal, the Z ratio changes as the ratio of the materials on the crystal changes. Therefore, the value for Z needs to be

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dynamic. Auto Z continually updates the Z ratio during the process. This feature is especially important for maintaining thickness and rate accuracy during the deposition of layered or alloyed materials onto a single crystal.

AUTO Z ACCURACY FOR In/MgF_2 DEPOSITION



Auto Z dramatically improves the accuracy of measured thickness for multiple materials and layers.

[3]Auto Z—U.S. patent #5,112,642

AUTO TUNE—FOR FAST SETUP

The IC/5's AutoTune feature eliminates trial-and-error evaluation runs and reduces setup time by quickly and automatically determining the source's feedback control loop constants. AutoTune selects the best of several control algorithms—including a three-parameter PID (proportional, integral, derivative) algorithm—to provide smooth source control over a wide range of sources.

MULTIPLE SENSOR MEASUREMENT—FOR REPRODUCIBILITY

For certain optical coatings and other applications inwhich reproducibility and uniformity are especially important, the IC/5 controller can integrate the measurements of up to eight sensors, minimizing the effects of source distribution variations, and ensuring consistent deposition rate and final thickness from one run to the next.

As substrates rotate in a planetary fixture, the IC/5 collects data simultaneously from various sensor locations, ensuring information that's representative of the current source distribution. Compared with single-sensor controllers, this configuration significantly improves thickness reproducibility by controlling the deposition at a constant aggregate rate independent of fluctuations in source distribution. As source distribution patterns change, the IC/5 adjusts the power appropriately. While the rate at any one sensor may vary significantly, the aggregate rate is held constant. The total amount of material deposited on each substrate is controlled and accurate; overall thickness accuracy can be two or three times better than that of single-sensor controllers.

By accurately tracking changes in the source's characteristics as it depletes, multiple-sensor measurement allows you to:

- anticipate when to replenish the source;
- determine the optimum settings for the e-gun sweep, amplitude, and dither; and
- reformulate better process recipes.

Since all sensors are linked to a single IC/5 controller, rack-space requirements are minimal, and the updates are three to five times faster than with cumbersome multiple controller/computer configurations.

ACCURATE CODEPOSITION

The IC/5 controls the deposition of two materials simultaneously. It even contains a programmable ratio parameter to control alloy percentages over varying rates, as well as a cross-sensitivity (or cross-talk) parameter that automatically compensates for situations in which material from one source is deposited onto sensors used to control the other source.

The Auto Z feature also contributes to the IC/5's code-position capability by maintaining thickness accuracy even when different materials are mixed on a crystal.

EASY INTEGRATION INTO INSTALLATIONS

Adapter cables are available to easily retrofit the IC/5 into existing installations in place of older INFICON and other manufacturers' deposition controllers. Contact the INFICON technical support department for details.

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The Best of Technology and Economy



XTC/2 DEPOSITION CONTROLLER: POWERFUL AND EASY TO USE

For less complex process requirements, the XTC/2 controller delivers ModeLock measurement technology in an economical, space-saving package. This half-rack unit can control a three-layer process from a choice of nine stored films. It is capable of sequentially controlling two single, one dual, or two CrystalSix sensors and two source outputs.

The XTC/2 offers eight dedicated input functions and 12 relay output functions for system integration, as well as eight outputs for multiple-pocket crucibles.

The recorder output supports the additional functions of power and rate deviation, as well as the normal rate and thickness values.



XTC/C DEPOSITION CONTROLLER: BUILD YOUR OWN INTERFACE

If you prefer to build your own software interface for OEM, research, or other applications, the XTC/C controller gives you the essential technology you need, without the front panel display and keyboard. It offers all the performance and space advantages of the XTC/2 at an even lower price. You provide an additional advantage: custom software that works exactly the way you want.

XTM/2 DEPOSITION MONITOR: EXCEPTIONAL PERFORMANCE AND PRICE

The INFICON XTM/2 extends the unsurpassed measurement speed and precision of ModeLock technology to monitor-only applications—for the price of a conventional “active oscillator” device.



With a frequency resolution of 0.1 Hz in only 250 ms, the XTM/2, when set to 16-second averaging, accurately displays rate resolutions as small as 0.01 Å.

The compact, half-rack XTM/2 operates simply and conveniently with all operating and programming functions accessible from a single screen. This quartz crystal monitor offers a wide range of setup configurations, including etch or deposit mode, chart recorder functions, and multiple measurement averaging. The unit’s memory can store programmed parameters for up to nine films.

While its superior measurement capabilities make it suitable for any standard thin film vacuum deposition monitoring application, the XTM/2 can easily be configured for other applications, such as corrosion and contamination studies. The unit can run in either a deposit mode or an etch mode and offers a wide selection of measurement units, as shown in the chart.

UNITS DISPLAYED	
Rate	Å/s, ng/s or µg/s
Thickness	kÅ
Frequency	MHz
Mass	µgm, mgm

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Precisely the Right Sensors and Crystals

Sensors, feedthroughs, and quartz crystals from INFICON offer proven quality and durability. Our standard, compact, dual, and CrystalSix sensors are assembled mechanically rather than soldered together, so you can replace their parts conveniently in the field if necessary.

Our 6 MHz crystals work with all INFICON deposition instruments. Available with gold or silver electrodes, they are 100% factory tested to ensure quality.

Call INFICON, and we'll help you choose precisely the right sensor, feedthrough and crystal for your process.

	Maximum Bake-out Temperature*	Size (Maximum Envelope)	Water Line & Coaxial Length	Body & Holder
CrystalSix Sensor	130°C	3.5" dia. x 2.0" high (8.9 cm dia. x 5.1 cm high)	30" (76 cm)	304 SS (plate, holders, & material shield)**
Shutter Assembly	400°C	varies w/sensor type	N/A	300-series SS
Dual Sensor	130°C	1.54" x 3.23" x 1.95" high (3.9 cm x 8.2 cm x 4.95 cm high)	30" (76 cm)	304 SS
UHV Bakeable Sensor	450°C	1.35" x 1.38" x .94" high (3.4 cm x 3.5 cm x 2.4 cm high)	30" (76 cm), 20" (50.8 cm), or 12" (30.5 cm)	304 SS
Compact Sensor	130°C	1.11" x 1.06" x 1.06" high (2.8 cm x 2.7 cm x 2.7 cm high)	30" (76 cm)	304 SS
Sputtering Sensor	105°C	1.36" dia. x .64" high (3.45 cm dia. x 1.63 cm high)	30" (76 cm)	Au-plated BeCu
Standard Sensor	130°C	1.063" x 1.33" x .69" high (2.7 cm x 3.38 cm x 1.75 cm high)	30" (76 cm)	304 SS



*For bake only; waterflow is required for actual deposition monitoring.
**Aluminum body.

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CHOOSING THE UNIT PRECISELY RIGHT FOR YOU

		IC/5 CONTROLLER	XTC/2 & XTC/C CONTROLLERS	XTM/2 MONITOR
Measurement performance				
Resolution (Å/s/M)[1]		0.006	0.06	0.123
Max. crystal frequency shift		1.5 MHz	1.0 MHz	1.0 MHz
Crystal range & precision		6.0 to 4.5 MHz ± 0.0047 Hz (per 100-ms sample)	6.0 to 5.0 MHz ± 0.05 Hz (per 250-ms sample)	6.0 to 5.0 MHz ± 0.1 Hz (per 250-ms sample)
Thickness accuracy[2]		0.5%	0.5%	0.5%
Measurement frequency		10 Hz	4 Hz	4 Hz
Design features				
Multiple sensor measurement		yes (up to 8)	no	no
Auto Z		yes	no	no
AutoTune		yes	no	no
Codeposition		yes (2 source)	no	no
Process recipe & data management				
Film programs		not applicable	9	9
Material programs		24	not applicable	not applicable
Process layers		250	3	not applicable
Processes		50	1	not applicable
Disk drive available		yes	no	no
Data logging		yes	yes	yes
Hardware features				
Sensors[3]	Single	8	2	1
	Dual	4	1	0
	Crystal Six	8	2	0
Source Controls				
	Number of sources	up to 6[4]	2	
	Source control voltage	0 to ± 10 V, 0 to ± 5 V, or 0 to ± 2.5 V	0 to ± 10 V	not applicable
	Output resolution	15 bits over full range (10 V)	15 bits over full range (10 V)	
	Crucible positions	64	8	
Input/Output:	Inputs	14 standard, up to 28 optional; TTL/CMOS logic compatible or closure to ground	9 pre-defined; TTL/CMOS logic compatible or closure to ground	5 pre-defined TTL
	Outputs	8 standard, 16 or 24 optional programmable SPST relays rated @ 30 V(dc) or 30 V(ac) RMS or 42 V Peak @ 2.5 amps; 14 optional TTL outputs	12 SPST relays rated @ 30 V(dc) or 30 V(ac) RMS or 42 V Peak @ 2.5 amps	4 SPST relays rated @ 30 V(dc) or 30 V(ac) RMS or 42 V Peak @ 2.5 amps
	Recorder output	0 to ± 10 V[4]	0 to ± 10 V	0 to ± 10 V
	Logic statements	100 fully programmable; up to 5 actions, 5 events per statement	not applicable	not applicable
Communications:	Standard	RS232	RS232	RS232
	Optional	IEEE488	IEEE488	IEEE488
Display				
Thickness resolution[5]		1 Å	1 Å	0.1 Å, or 1 Å
Rate resolution[5]		0.1 for 0 to 99.9 Å/s; 1 for 100 to 999 Å/s	0.1 for 0 to 99.9 Å/s; 1 for 100 to 999 Å/s	0.01, 0.02, 0.06 for 0 to 9.99 Å/s (depending on averaging used); 0.1 for 10 to 99.9 Å/s; 1 for 100 to 999 Å/s
Operation				
Power requirements 50/60 Hz ± 3 Hz unless otherwise noted)		100 + 10% - 15% V(ac) 120 + 10% - 10% V(ac) 220 + 15% - 10% V(ac) 240 + 10% - 10% V(ac)	90 to 132 V(ac) or 180 to 264 V(ac)	90 to 132 V(ac) or 180 to 264 V(ac) (49 to 61 Hz, 25 VA)
Operating temperature		0° to 50° C (32° to 122° F)	0° to 50°C (32° to 122° F)	0° to 50° C (32° to 122° F)
Dimensions, excluding mounts (h x w x d)		5.25" x 17.63" x 18.5" (13.3 cm x 44.77 cm x 47 cm) full rack	3.5" x 8" x 12" (8.9 cm x 20.3 cm x 30.5 cm) half rack	3.5" x 8" x 12" (8.9 cm x 20.3 cm x 30.5 cm) half rack
Weight		29 lbs (13.2 kg)	6 lbs (2.7 kg)	6 lbs (2.7 kg)

[1]Material density= 1.0; Z ratio = 1.0; crystal frequency=6 MHz. Å/s/M = angstroms/second/measurement.

[2]Varies according to process; figures reflect typical accuracy.

[3]Maximum configuration of each type.

[4]The IC/5 has 6 DAC outputs that can be selected as source control voltages or recorder outputs.

[5]For the XTM/2 monitor, alternate measurement units appropriately scaled. Multiple measurement averaging enhances resolution.

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