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Physikalische Instrumente

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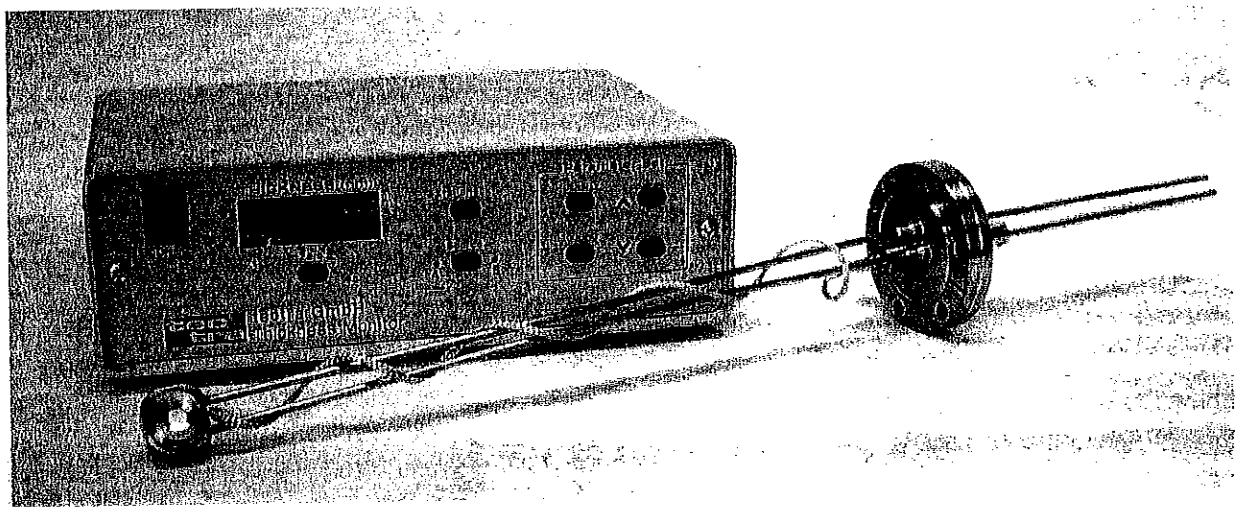
Operating Manual

MTM-10/10A

High Resolution Thickness Monitor
Quartz Microbalance



Revision 27. 11.2002

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1. Safety Instructions

- Read and follow all instructions in this manual.
- Do not carry out any unauthorized modifications to the thickness monitor or associated equipment.
- Do not remove the covers of the thickness monitor; there are no user serviceable components inside.
- When returning the unit for repair please fill in and include the Declaration of Contamination at the end of this manual.

2. Main Features

The MTM range of thickness monitors work on the principle of the quartz crystal microbalance where material is deposited onto the surface of an oscillating quartz crystal. The period of oscillation of the crystal increasing proportionally to the amount of material deposited and it is this increase that is used to calculate thickness.

All units in the MTM range have a thickness calculation and display update rate of ten times a second and can store four values for density and four values for tooling factor. The tooling factor is used to compensate for the geometric differences between the position of the specimen and the position of the crystal holder. The frequency shift of the crystal can also be displayed to give an indication of it's remaining life.

The MTM-10a thickness monitor provides an RS232 serial output for external data logging of the displayed thickness using a computer or similar device.

3. Installation

Carefully unpack the MTM-10 control unit and associated parts taking care not to damage the exposed surface of the crystal at the top of the crystal holder.

The basic thickness monitor outfit comprises:

- MTM thickness monitor / controller
- Oscillator unit
- Vacuum feedthrough with crystal holder and SMB cable (in-vacuum cable)
- BNC cable
- Power cord

This outfit may vary where it is supplied with special sensor heads.

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3.1. Mains Connection

BEFORE CONNECTING THE UNIT TO THE MAINS SUPPLY, ENSURE THAT THE VOLTAGE SPECIFIED ON THE SERIAL NUMBER LABEL IS COMPATABLE WITH THAT OF THE SUPPLY AVAILABLE.

The power cord supplied with the outfit will normally be fitted with a plug suitable for local requirements. In instances where a plug is not fitted then the cord supplied will follow the European colouring convention as follows:

- Line = Brown
- Neutral = Blue
- Ground = Green/Yellow

THE MAINS CONNECTION MUST BE MADE IN ACCORDANCE WITH LOCAL REGULATIONS.

3.2. Component Assembly

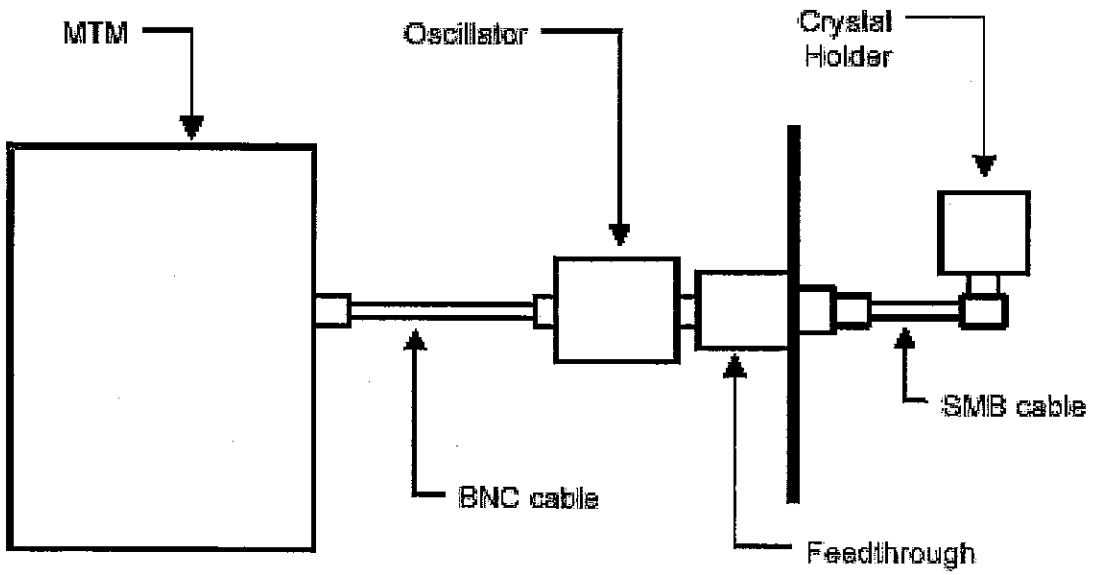
The vacuum feedthrough is mounted through a suitable hole in the vacuum system chamber with the body of the feedthrough on the non-vacuum side. Where the system has been supplied as an upgrade to a Cressington coater, then the feedthrough replaces the blanking plug in the chamber baseplate.

The crystal holder should be mounted as close to the specimen stage of the deposition system as is possible without interfering with any other equipment. This will ensure the most accurate measurement of coating thickness on the specimen. Where the system has been supplied as an upgrade to a Cressington coater, then provision has already been made for mounting the crystal holder.

Using the SMB cable, connect the crystal holder to the feedthrough.

Mount the oscillator onto the BNC socket of the feedthrough, in cases where a BNC elbow adaptor has been supplied then mount this between the oscillator and the feedthrough. Usingthe BNC cable, connect the oscillator to the input of the thickness monitor.

The diagram below shows the correct assembly of the components.



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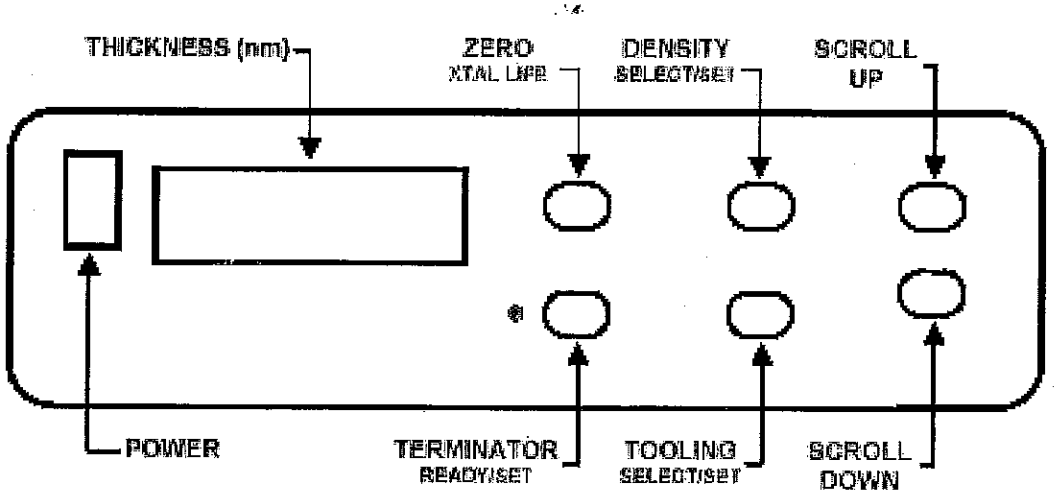
Turn on the thickness monitor. The display will show the software version number for approximately 1.5 seconds and then revert to showing thickness. If the display shows FAIL after showing the software version number then please refer to the trouble shooting section of this document.

4. Operation

The thickness monitor operates by displaying the thickness of coating since the last time that it was reset to zero, usually just before the coating process is started. A dedicated button is provided for zeroing purposes. Thickness is the default display mode and is shown in nm.

The front panel layout is shown below together with details of the dedicated functions of each of the buttons. Where a button has dual funtionality then the second function is shown in red.



4.1. Display

The display shows thickness measurements in the range –99.9nm to 999.9nm. If the measurement is outside this range then " or" will be displayed for positive values and "- or" for negative values.

4.2. Zero / Life Button

This is a dual function button used to reset the thickness display to zero or show the condition of the crystal.

A momentary press of this button will perform a zero of the display in readiness for the start of the coating process.

The display of crystal life is achieved by holding this button pressed. After one second the display will change to showing the frequency shift in kHz of the crystal from the nominal unused value of 6 MHz. The frequency is displayed for the duration that the button is pressed or for 2.5 seconds whichever is the longer. The thickness reading is not reset by this operation.

4.3. Density and Tooling Buttons

These buttons, in conjunction with the two scroll buttons, are used to set the stored density and tooling values.

A momentary press of either of these buttons will display the relevant value currently used for thickness calculations. At this point a different stored value can be selected by pressing either the up or down scroll buttons, continued selection beyond the four stored values will result in the selection repeating. The relevant value will remain on the display for 2.5 seconds after the last button press.

The adjustment of the selected value is achieved by holding the density or tooling factor button pressed, after one second the decimal point will start flashing to indicate that the value can now be changed using the scroll buttons. The relevant value will remain on the display for 2.5 seconds after the last button press and then revert back to showing thickness. If the density or tooling button is momentarily pressed whilst at the value adjustment stage then the mode will revert back to the selection stage.

The calculation of tooling values is a very complex problem due to the action of diffusion within the process chamber. Absolute calibration can only be achieved by measurement of the coating thickness by other methods; this value can then be used to modify the initial tooling value. Calculation of the initial tooling value can be found in Appendix A.

5. RS232 Output (MTM-10a only)

The RS232 output message consists of an eleven-character ASCII string terminated with carriage return line feed. The message is sent ten times a second and consists of two commaseparated variables, the first containing the sample number and the second the thickness value for that sample. The sample number is provided for use by the data logging equipment as the time base for the process being monitored.

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The output also provides handshaking via the clear to send input; there is no internal buffering. If the transmission is interrupted then messages may be lost, however when transmission resumes the sample number will be that for the latest thickness measurement. The format of the message is shown below:

N	N	N	N	N	,	T	T	T	,	T	CR	LF

Where:

NNNNN	=	Five-digit sample number, modulo 65536, since the display was last zeroed.
TTT.T	=	Five character four-digit thickness value, including decimal point, as shown on the display

The character format on the RS232 output is eight data bits, no parity and one stop bit.

The pin allocations for the connector are shown below:

Pin	Connection
1	Not used
2	Receive data (RXD)
3	Transmit data (TXD)
4	Data terminal ready (DTR)
5	Signal ground
6	Not used
7	Request to send (RTS)
8	Clear to send (CTS)
9	Not used

6. Quartz crystal changing

When the thickness monitor crystal is either over-loaded or loaded with stressed material it will cease to oscillate and the display will show "FAIL". At this stage it will need to be changed.

ENSURE ADEQUATE SAFETY PRECAUTIONS ARE TAKEN WHEN WORKING WITH POTENTIALLY HAZARDOUS MATERIALS.

- Switch off the thickness monitor system.
- Loosen the 2 small screws located on the side of the crystal holder cap. This will allow the cap to be separated from the holder base.
- Carefully remove the cap. Depending on the orientation of the crystal holder in the system the crystal will either remain on the spring or be removed with the cap.
- Replace the used crystal with a new one.
- Carefully replace the cap. Press the cap gently to compress the spring and then retighten the screws that retain the cap.
- Re-pump the system

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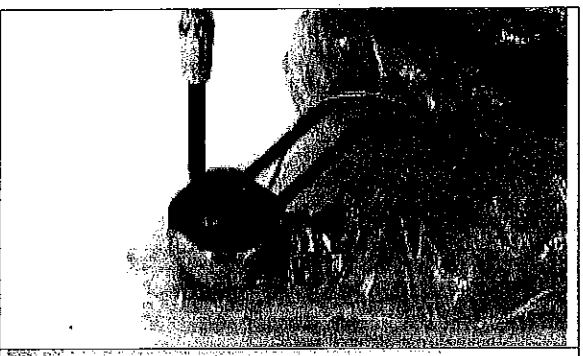
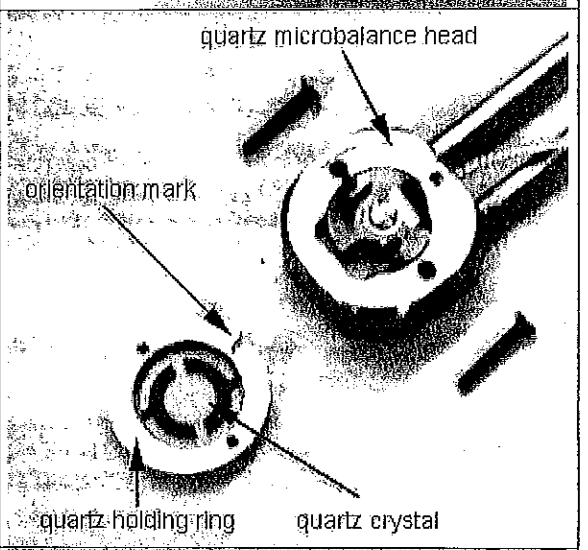
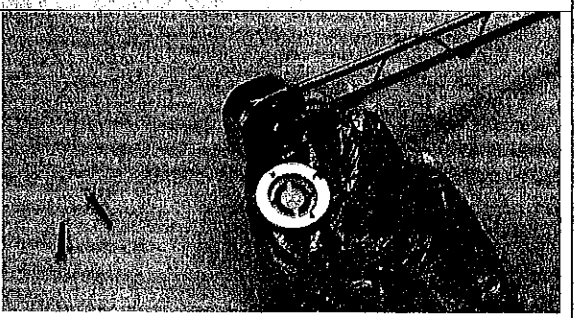
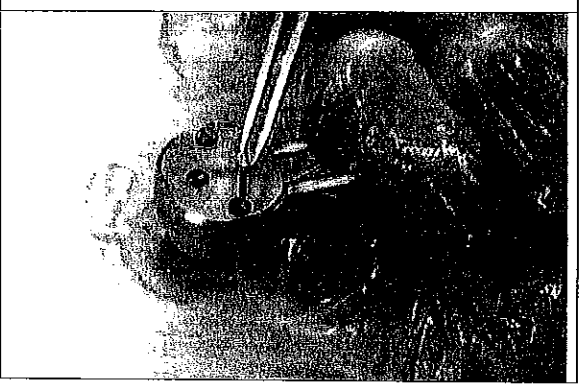
6.1 Crystal Changing at tectra Quartz Microbalance

To replace the crystal in the tectra Quartz Microbalance you will need an appropriate 6MHz crystal (tectra spare - Part No MTM-EK).

1. Undo the 3 outermost screws on the rear side of the quartz microbalance head. Hold the quartz holding ring in place with your thumb to prevent it dropping off as the screws disengage.	
2. Remove the quartz holding ring. Replace the quartz so that the patterned gold coating is visible from the contact side.	
3. To prevent the fragile quartz crystal falling out, we recommend that the assembly is carried out as shown in the picture. Place the quartz holding ring with crystal in your fingers and lower the quartz crystal head on top of it. Make sure the orientation mark looks towards the vacuum flange.	
4. Tighten the 3 screws on the rear side of the quartz microbalance head.	

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7. Trouble shooting

Symptom	Reason
MTM display shows "FAIL"	Crystal is overloaded with material and needs to be changed. Poor connection to crystal inside the holder. This is usually caused by insufficient tension of the spring behind the crystal. Measuring the gap between the crystal holder cover and body with the cover retaining screws released will check the tension. The gap should be around 1mm and is adjusted by moving up or down the fingers on the spring to achieve this. Check all cables both inside and outside the process chamber.
MTM displays " or"	The coating thickness is out of range and is greater than 999.9nm. The display may not have been zeroed before the start of the process. The thickness is too great for the MTM. Increase the density value or reduce the tooling value to increase the measurement range.
MTM displays "- or"	The coating thickness is out of range and is less than -99.9nm.
Nothing on display	There is no power to the MTM, check the power cord assembly. The MTM has an internal failure (there are no fuses to be found inside the unit). Return the unit for repair.

8. Technical Data

ALL MODELS

Thickness range	-99.9 to 999.9nm
Update rate	10Hz
Resolution	Better than 0.1nm (density 0.50, tooling 8.00)
Density memory	4 values
Density value range	0.50 – 30.0gm/cm^3
Tooling factor memory	4 values
Tooling factor value range	0.25 – 8.00
Crystal frequency	6MHz
Crystal frequency shift	350kHz maximum
Supply voltage	100 – 120 or 210 – 240VAC (Factory set)
Supply frequency	50 – 60Hz
Power consumption	< 6VA
Temperature range	15 – 30 °C
Relative humidity	10 – 85 % non-condensing
Dimensions	W 210mm (8.3"), H 78mm (3.1") D 170mm (6.7")
Weight	1.5kg

MTM-10a only:

RS232 output	8 data, no parity, 1 stop bit Handshaking via CTS input
Cable length	30m maximum

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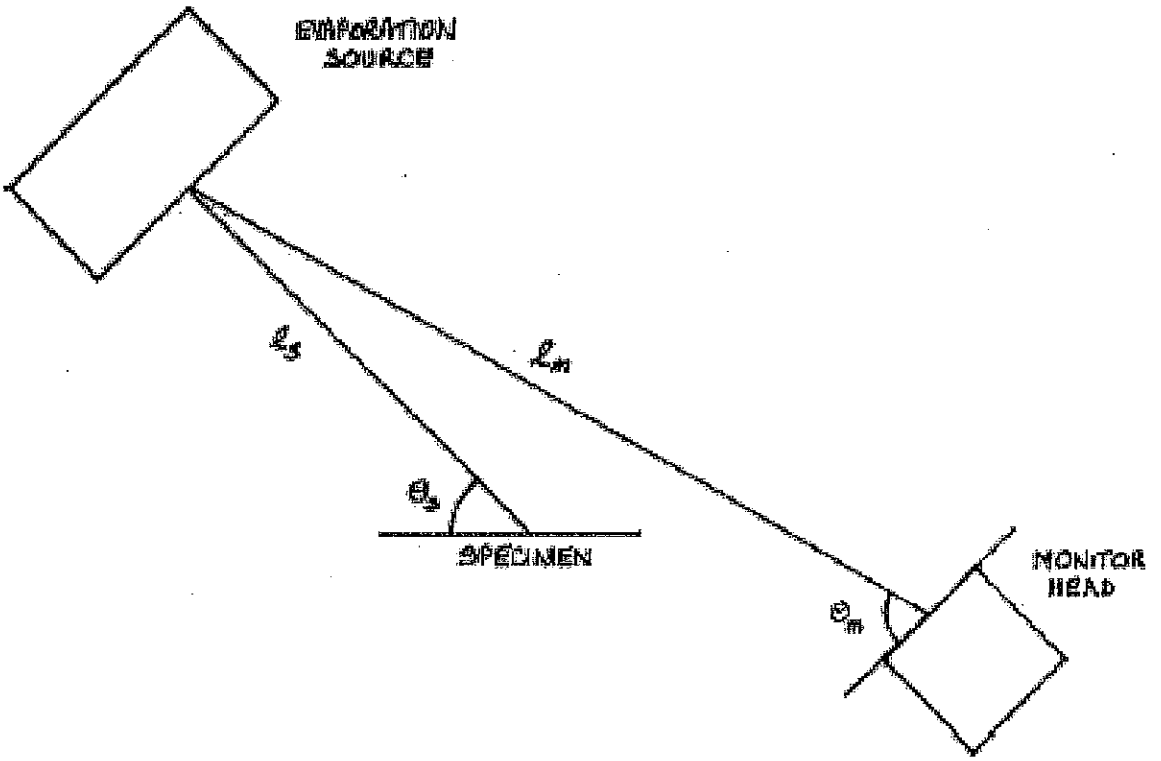
9. Appendix A

The following diagram and equation can be used to calculate the theoretical tooling value for a given layout of deposition source, crystal holder and specimen.



$$TF = \left(\frac{l_m}{l_s}\right)^2 \times \frac{\sin\theta_s}{\sin\theta_m}$$

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10. Konformitätserklärung
10. Declaration of conformity

Wir erklären hiermit, daß das folgende Gerät:
We herewith declare that the following device:

„Quarz-Mikrowaage" Schichtdicken-Meßsystem
"Quartz Microbalance" High Resolution Thickness Monitor

auf das sich diese Erklärung bezieht, mit den folgenden Normen oder normativen Dokumenten übereinstimmt:
to which this declaration relates is in conformity with the following standards or other normative documents:

EN 61326-1	Labor- und Leitgeräte *laboratory devices*
EN 61000-3-2	Oberschwingungen *harmonic current*

gemäß den Bestimmungen der Richtlinie ..89/ 336/ EWG (bzw. EMVG) und 73/ 23/ EWG.
(Niederspannungsrichtlinie)
Conformance of the product with Directive ..89/336/EWG (EMC) and 73/23/EWG (LVD)..

Frankfurt/M, den 2.11.2003

Dipl.-Ing. Andreas Gati