Ion Beam Sputterer
Model IBS/TM200S

R GROUP Incorporated, a design leader in specimen preparation instrumentation, has developed the ION BEAM SPUTTERER Model IBS/TM200S to provide artifact free ultra thin films to compliment the high resolving power of new electron and scanning probe microscopes.

Specimens examined in high resolution FESEM, TEM, and STEM demand fine grain ultra-thin coatings. Low voltage SEM specimens must frequently be coated with a conducting film to reduce charging and enhance surface contrast. Ultra-thin films on specimens for examination by both STM and AFM, are sometimes needed to decrease surface resistivity, bind small particles to a substrate, and reduce distortion from tip/specimen interaction.

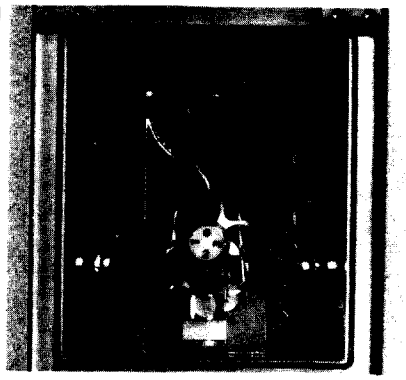
Standard coating techniques: DC diode sputtering or vacuum evaporation limits the resolving power of these microscopes since they produce artifacts clearly visible at high resolution. Magnetron sputtering, purported to eliminate such problems, will not produce the repeatable film quality on specimens that can be obtained only with ion beam sputtering.

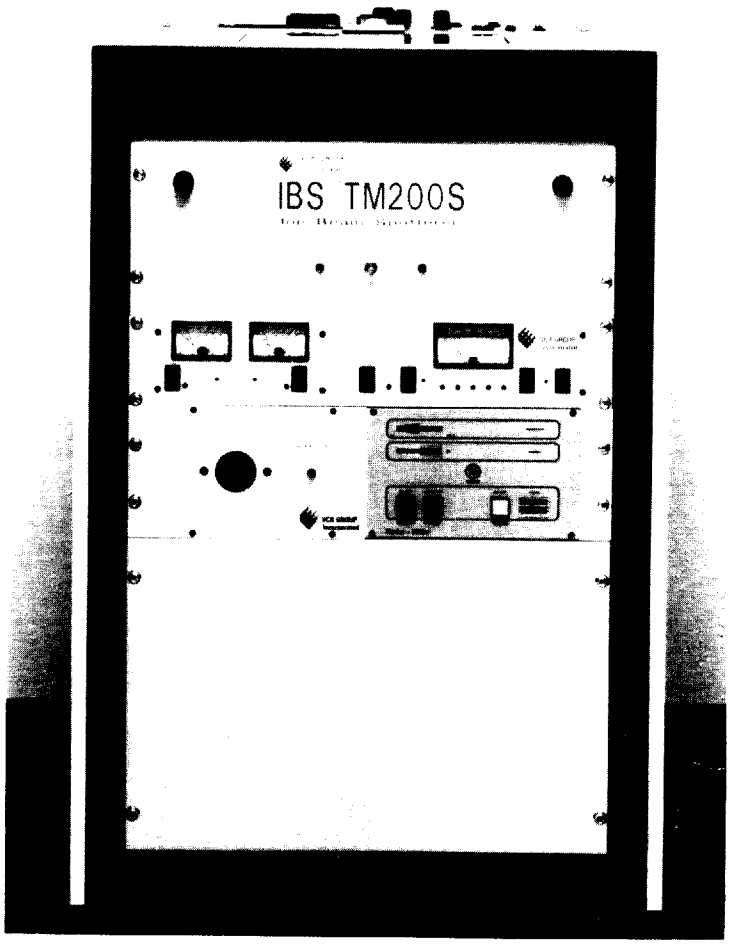
Ion Sources & Chamber

Ion beams from stable, easy to service ion sources obliquely strike a target in a small area. Target material is sputtered with ejection energies < 40eV onto specimens located on an Independent Rotate and Tilt Stage (IRT). High purity argon is the usual gas used for sputtering. Other gases can be ionized in the sources to produce oxide films or perform reactive sputtering. A four position target selector allows mounting three targets for sequential sputtering and a scintillator in one target location for beam observation. Access to the sputtering chamber for specimen exchange, target placement, Quartz Crystal monitor sensor positioning, and ion source cleaning is through the chamber lid.

The unique mechanical design of the IBS/TM200S is integrated with the system electronics to produce repeatable thin films. A dual mode, Preset Termination Timer automatically disables the high voltage terminating the sputtering process. Sputtering parameters are controlled with just one potentiometer and two precision needle valves. Ion source power is monitored on separate current and voltage meters. A resettable elapsed timer accumulates ion source run time for scheduling ion source maintenance.

When a QCM is supplied it replaces the Preset Termination Timer. The QCM utilizes a sensitive 6 Mhz oscillating quartz crystal sensor which is easily moved from the specimen carrier location to the sensor bracket. In the specimen carrier position sputter rates at 100% tooling are determined. The sensor is then moved to the sensor bracket and tooling factors are calculated so film deposition rate and real time thickness are continually displayed. The QCM will precisely monitor and repeatably terminate the sputtering process at preset film thickness or preset time which ever occurs first.





Typical Sputter Rates (Å/min)

Power	3mA, 8kV One Ion Source					6mA, 8kV 2 Ion Sources				
Tilt Range	EIRT1			EIRT2 (3)*		EIRT1			EIRT2 (3)*	
Target	0	±45°	±90°	±45°	±90°	0	±45°	±90°	±45°	±90°
Al w/o Trapping	5	5	3	5	3	12	10	7	10	6
Al w/Trapping	10	9	6	9	5	20	18	12	17	9
Ag w/o Trapping	15	13	9	13	7	36	30	20	30	15
C w/o Trapping	6	3	2	3	2	8	5	4	5	3
Cr w/o Trapping	8	6	4	6	3	14	12	8	12	7
W w/o Trapping	4	3	3	4	2	8	7	4	6	4
Au/Pd w/Trapping	5	4	3	5	3	11	10	7	8	5
W w/Trapping	3	3	2	3	2	6	5	4	5	3
Au w/o Trapping	16	14	10	14	8	32	26	18	26	14
Cu w/o Trapping	7	5	4	6	3	14	12	9	12	6
Pd w/o Trapping	11	10	6	9	5	20	18	12	17	9

Note: Sputter Rates accumulated w/Quartz Crystal sensor in specimen position. Tilt speed set at maximum, operating pressure 2×10^{-4} Torr
*Delay (3) selected.

pump on LN_2 trap
Rotary pump
TMP

Stage

The independent Rotate and Tilt Stage drives specimens under the sputterant with a wide range of parameters. Both tilt and rotate axes are independently controlled to uniformly coat specimens, and allow directional or rotary shadowing at a fixed angle. Either tilt or rotate speeds can be independently changed or stopped. The tilt range is selectable from 0° to ±99° or the specimen can be parked at any intermediate angle. Specimens rotate around an axis normal to the tilting plane. The center position of the specimen carrier is an eucentric point and customized specimen carriers are designed to position the specimen as close to the eucentric plane as possible. Specimen carriers are inserted into the IRT Stage mounting platform and will accommodate most SEM stubs or TEM grids. Specimens are parked at 99° to avert them while sputtering off target oxide before film deposition.

The standard IRT Stage digital control, supplied in EPROM, EIRT1, tilts the specimen holder with a linear drive so that the specimen spends the same amount of time going from one angle to the next. To further enhance specimen contrast and film uniformity, two additional non-linear drive motions are available. The Non-Linear Delay EPROM, EIRT2, tilts the specimen with 10 different selectable delays so the tilting action will slow with increasing delay at each degree as it goes from 0 to ±90°. The Cosine EPROM, EIRT3, tilts the specimen with a cosine drive. One, two, or all three tilt motions are available in one EPROM.

High Vacuum

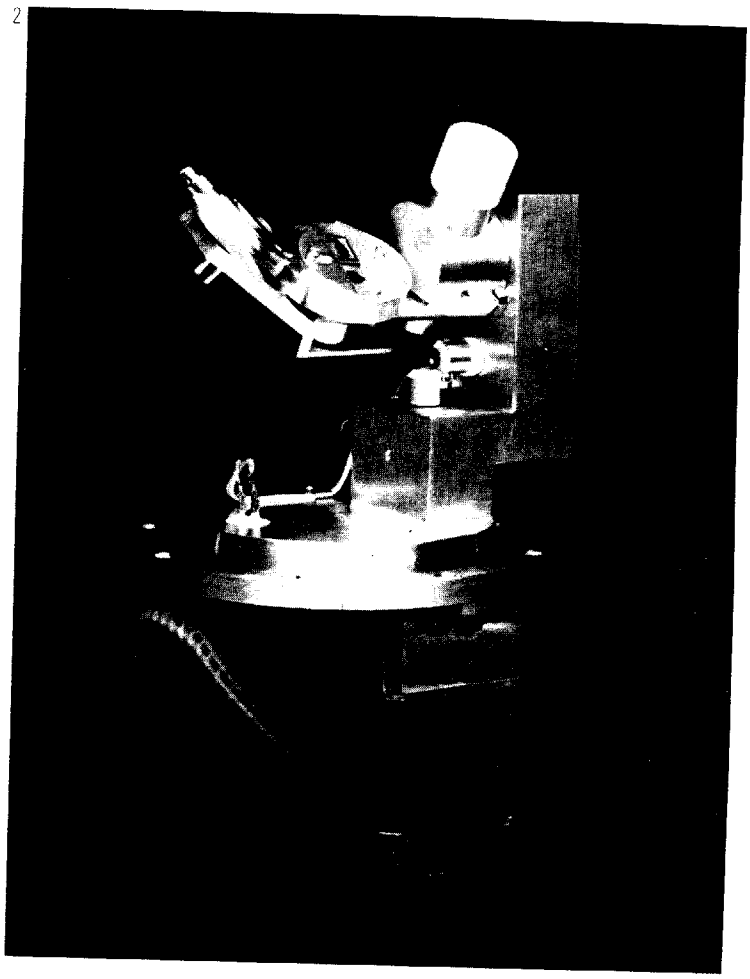
Clean, high vacuum is developed automatically by a turbomolecular pump minimizing specimen decoration artifacts from hydrocarbon contamination. To insure oxide free films when sputtering materials that readily form oxides and to capture water vapor desorbed from biological specimens an optional LN_2 trap is available. The LN_2 trap will improve vacuum by a factor of 10. A Bayard-Alpert ionization gauge displays high vacuum. Two TC gauges display low vacuum chamber and foreline pressures. An ON/OFF push button pumps and vents the system. Possible contamination is further minimized with a continuous, stainless steel gas delivery line, VCO couplings, and automatic control of N_2 when venting. In the event of a water or power failure all electrical and vacuum components are safely interlocked to automatically vent the system.

The IBS/TM200S employs the latest advancements in electronics, firmware, and mechanical design. The system is backed by engineering and support resources and covered by an eighteen month warranty.

Gun Life 100 – 300 hours
Cleaning

Saddle field guns

2



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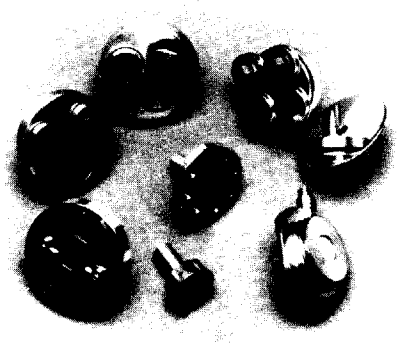


1 Work chamber with hinged sight glass.

2 IRT stage with Quartz Crystal sensor in sensor socket and a specimen carrier in position.

3 Seven specimens carriers and Quartz Crystal sensor.

Specifications

Ar SN

N Sources

Accelerating Potential . . . . . 2.5 to 10 kV
Operating Pressure . . . . . ~5x 10^{-5} Torr
Beam Flux 15mA/cm²

T Stage

Tilt Range Continuously selectable 0° to ±99°
Tilt Angle Continuously selectable 0° to 99°
Tilt Speed (EIRT 1) 0° to 90° 00:33 to 00:07
Tilt Speed (EIRT 2) 0° to 90° 02:48 to 00:11
Tilt Speed (EIRT 3) 0° to 90° 00:33 to 00:07
Rotation Speed 3.6 to 30 RPM

Vacuum System

Turbomolecular Pump . . . . . 200 l/s N_2
Rotary Pump . . . . . 195 l/m N_2
Operating Pressures . . . . X 10^{-5}, 10 ~~15~~ mins
X 10^{-6}, 15 20 mins
Base Pressure . . . . . 10^{-7}
LN_2 Trap Pressure . . . . . improved by factor of 10 in 5 minutes
Bayard-Alpert Ionization Gauge – High Vacuum
Two TC Gauges – Low Vacuum

Utilities

Argon Gas (99.999% pure)
2 sccm @ 5 to 7 psig
N_2 Gas for venting @ 5 to 7 psig
LN_2 Trap Consumption 2 liters/30 mins
110 VAC, 15 A, 50/60Hz or
220 VAC, 7.5 A, 50/60Hz
Water 30 GPH

Dimensions

23 1/2"W x 30"D x 37 1/2"H
(+ 11 1/4" with lid open)
Weight <500 lbs

dering Information

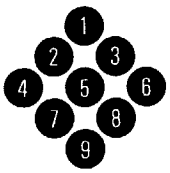
sic IBS/TM200S

- Integral work chamber, hinged lid with 3" sight glass
- IRT Stage, two specimen carriers: 1 1/4" diameter Platform Specimen Carrier with Spacer Rings and one specimen carrier for particular SEM
- One ion source and precision needle valve
- Four position target carrier
- Two targets (carbon and tungsten) and a KBr scintillator
- Initial spares pack
- HV Power Supply
- Preset Termination Timer
- IRT Stage Controller
- Power Distribution Panel with interlocking water switch
- Turbomolecular Pump & Controller with automatic vent valve
- N_2 gas vent automatic turnoff
- Rotary Pump
- Automatic gauge controller
- BA ionization gauge tube and two TC gauges
- System housed in single bay cabinet on four castors with optional lifters.

Options

- Second Ion Source – 4" OD flange port provided
- Quartz Crystal Monitor Model QCM-100-1" OD straight through port provided. The QC Monitor controller is mounted in the cabinet top adjacent to the IRT Controller and replaces the preset Termination Timer.
- LN_2 Cold Trap – NW 40 Kwik-Flange port provided
- Customized specimen carriers
- Assorted target materials: Ir and Cr suggested.
- EIRT 2 Linear Delay EPROM
- EIRT 3 Cosine Drive EPROM
- 8' precleaned S/S 1/8" line with mating VCO couplings to interface argon gas regulator to IBS
- Water chiller/recirculator

Cover Legend



1. STM Image: 0.4μm trench in photoresist coated with 10 nm Pt Reference: J.E. Griffith, D.A. Grigg, M.J. Vasile, P.E. Russell & E.A. Fitzgerald, J. Vacuum Science Technology A July/August (1992) 25 nm

2. JEOL SEM Image: MgO Crystals at 100,000X, 20kV coated with 4 nm Cr Courtesy K. Ogura, JEOL 100nm

3. JEOL TEM Image: Carbon black power on carbon supporting film at 250,000X coated with 4 nm Cr Courtesy K. Ogura

4. JEOL FEGSEM Image: Fibrillation on fibre surface coated with 2 nm Ir at 25,000X, 3kV Courtesy G. de Silveira .5μm

5. SEM Image: Celgard 2400 coated with 2.5 nm Pt at 50,000X, 5kV Courtesy Hoechst Celanese, M. Jamieson 100nm

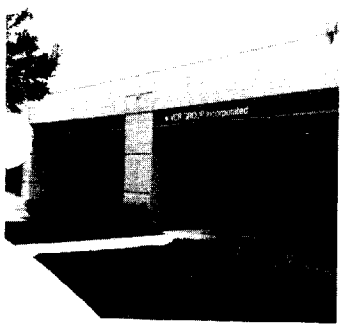
6. SEM Image: Polycarbonate Filter coated with 4 nm Cr at 10,000X, 5kV Courtesy K. Ogura, JEOL

7. Hitachi FESEM BS Image: 2 nm Pt on glass at 800,000X, 30kV Courtesy C. Fretham, University of Minnesota 19nm

8. Hitachi FESEM BS/2ndary Electron Images: Sperm membrame with 2 nm W at 800,000X, 20kV Courtesy C. Fretham, University of Minnesota 19nm

9. Hitachi FESEM Image SiO_2 passivation over alumina with 8 Å Cr at 30,000X, 3kV Courtesy A. Pillilo, DEC .5μm

Note: Additional references available on request



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