

MATERIALS PROCESSING SOLUTIONS



Ion Beam Sputter
Deposition and
Etching System

IBS/e

The Model IBS/e is a high vacuum thin film deposition system designed to precisely deposit sub-nanometer grain, conductive coatings onto specimens prior to examination in the electron microscope. Thin, conductive films are deposited onto specimens to prevent charging effects and to enhance contrast. Films are deposited using two ion beam sources directed at a target material, eliminating radiation or heating effects common with other coating techniques. Extremely thin, continuous metal or carbon films are deposited without risking damage to delicate features present on the specimen. Virtually any target material can be used for ion beam deposition with precise control over the deposition thickness. An optional third ion source allows specialized ion beam etching techniques to be employed. The ability to deposit amorphous, continuous films makes the IBS/e system ideal for high resolution electron microscopy techniques.

APPLICATIONS

Specimens examined in high resolution electron microscopes utilizing field emission electron sources demand fine grain, ultra-thin conductive coatings for image capture and specimen analysis. Low voltage SEM specimens must frequently be coated with a conducting film to reduce charging and enhance contrast in images. Ultra-thin films on specimens for examination by both AFM and STM are sometimes needed to decrease surface resistivity, bind small particles to a substrate, and reduce distortion from tip/specimen interaction. All of these techniques require uniform thin films to be deposited on the specimens of interest without heat or radiation. Standard coating techniques such as DC diode, vacuum evaporation, and other thermally driven methods are incapable of handling these requirements. The IBS/e is capable of precisely depositing thin films without exposing specimens to damaging photon flux. Additional applications include producing SEM samples for “channeling contrast”, Electron Back Scatter Diffraction (EBSD) Patterns, Orientation Imaging Microscopy (OIM) and multilayer deposition for research and development applications. Reactive etching and deposition can be achieved by introducing reactive gas such as oxygen or nitrogen through an optional micro-mixing valve.

Ion Sources

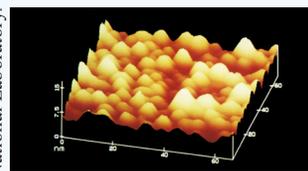
The IBS/e ion sources are specifically designed for simple operation and fast servicing. Both sources are directed at a target material which is sputtered with ejection energies of < 40 eV

onto the specimen. Operating at 10kV, the ion sources produce a beam flux of 15mA/cm² to produce a uniform distribution over the entire specimen. Ion beam current is displayed digitally for quick evaluation of the operating conditions. The sources are easily dismantled through the vacuum chamber door. 24 hour factory Quick Exchange Service is available for the anode assemblies.

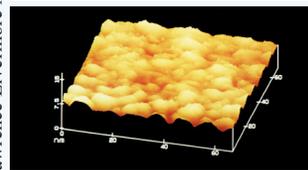


An etching ion source is optional for nano-machining samples prior to sputter deposition. Etching improves image contrast on highly polished cross section SEM samples and can expose interesting aspects of various types of biological samples.

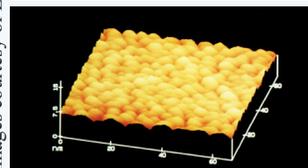
Images courtesy of Lawrence Livermore National Laboratory.



DC Magnetron Sputtered
Pd on Si



Vacuum Evaporated
Pd on Si



Ion Beam Sputtered Pd on
Si (Note the superior continuity
and uniformity of the Ion Beam
Sputtered sample)

Specimen Stage Control

The Independent Rotate and Tilt Stage (IRT) drives specimens under the sputtered material with a wide range of parameters. Both the tilt and rotate axes are independently controlled to uniformly coat specimens. The IRT allows directional or rotary shadowing at fixed angles as well as variable speed controls for both tilt and rotation. The variable tilt angle rate improves uniformity by decreasing the tilt rate as the tilt angle increases. Specimens can be parked at 180° to shield them during target oxide removal.

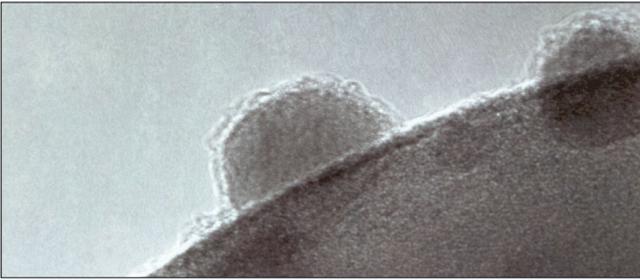
The standard specimen stage can accommodate 2" wafers as well as SEM mounts and TEM specimens. Using the Large Area Stage (LAS) accommodates specimen wafers up to 4" diameter for ion beam sputter deposition.

High Vacuum System

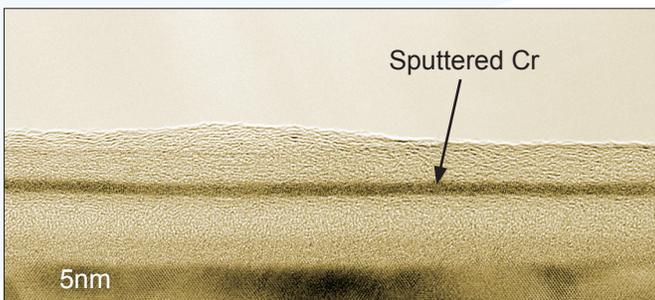
The Model IBS/e creates a clean, hydrocarbon free, high vacuum automatically using a turbomolecular pump. Vacuum level is displayed digitally using a cold cathode high vacuum gauge. The system reaches a base pressure of 10⁻⁷ torr within minutes, allowing oxide-free metal films to be deposited without the need for liquid nitrogen trapping.

Film Thickness Monitor

Monitoring the film thickness precisely is done with a quartz crystal thickness monitor (QCTM). The QCTM will precisely monitor and repeatably terminate the sputtering process at preset film thickness or preset time, whichever occurs first.



8 Angstrom W film deposited on Pd/SiO₂ sample. Slow deposition and precisely controlled specimen tilt and rotation enhances the uniformity of the tungsten film. (Image courtesy of Larry Allard, Oak Ridge National Laboratory and David Joy, University of Tennessee.)



TEM micrograph showing uniformity of chromium film deposited to protect carbon film on silicon. (Image courtesy of Haifei Wang, Read-Rite Corporation)

Targets

Four different target materials are selectable for deposition without breaking vacuum. Each target can be rotated into the sputter position simply by rotating a thumbwheel. The ability of the IBS/e to produce oxide free coatings without liquid nitrogen trapping allow refractory metals such as chromium, tungsten, and tantalum to be deposited without problems.

Typical Target Materials:

Chromium	Carbon
Tungsten	Gold
Tantalum	Gold/Palladium
Platinum	Palladium
Iridium	Silver

Specifications:

Vacuum System

Roughing Pump:	40 l/m N ₂
Turbo Pump:	250 l/s N ₂
Base Pressure:	10 ⁻⁷ torr
Operating Pressure:	x 10 ⁻⁵ torr (10 to 15 minutes)
Vacuum Gauge:	Cold cathode

Ion Sources

Beam Energy:	2.5 kV to 10 kV
Beam Flux:	15 mA / cm ²

IRT Stage

Tilt Range - Deposition Mode:	0 to +/- 99°
Tilt Range - Etch Mode:	0 to +/- 99°
Tilt Range - With Large Area Stage:	0 to +/- 17°
Specimen Stage:	2" Standard; 4" Optional
Tilt Angle Rate:	Variable
Rotational Speed:	0 to 40 RPM

Gas

Source Gas:	Ar, 99.999% pure
Pressure:	2 sccm @ 5-7 PSI
Vent Gas:	N ₂ @ 5 PSI

Power/Utilities

110 VAC / 15 A	50/60 Hz
220 VAC / 7.5 A	50/60 Hz

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