DANFYSIK

HIGH CURRENT IMPLANTER
SERIES 1090

- *Universal High Current Implanter for Surface Modifications with ion beams*
- *Extensive range of ion species, including refractory metals*
- *Magnetic mass analysis for pure ion beams*
- *Energy range from 5 to 200 keV*
- *Ion currents on target up to 10 mA*
- *Magnetic focussing and beam scanning for complete beam control*
- *Target chamber with water cooled sample manipulator*
- *Large area beam scanning up to 1600 cm²*
- *Optional computer set up and control of manipulator movements*
- *Optional combination with IBAD systems*

INTRODUCTION

Modification of material surfaces by means of ion beam techniques is a new "tool" to improve tribological properties of materials, such as wear resistance, surface hardness, and corrosion resistance. With ion beam techniques atomic species may be introduced into material surfaces in an almost arbitrary manner and thereby alloys may be created in the surface layer with compositions beyond conventional solubility limits. In this way surfaces with dramatically improved wear and corrosion resistance may be "engineered" without heating or changing the dimensions of the specimen. Or - in combination with PVD techniques - extremely hard ("diamond like") coatings may be produced.

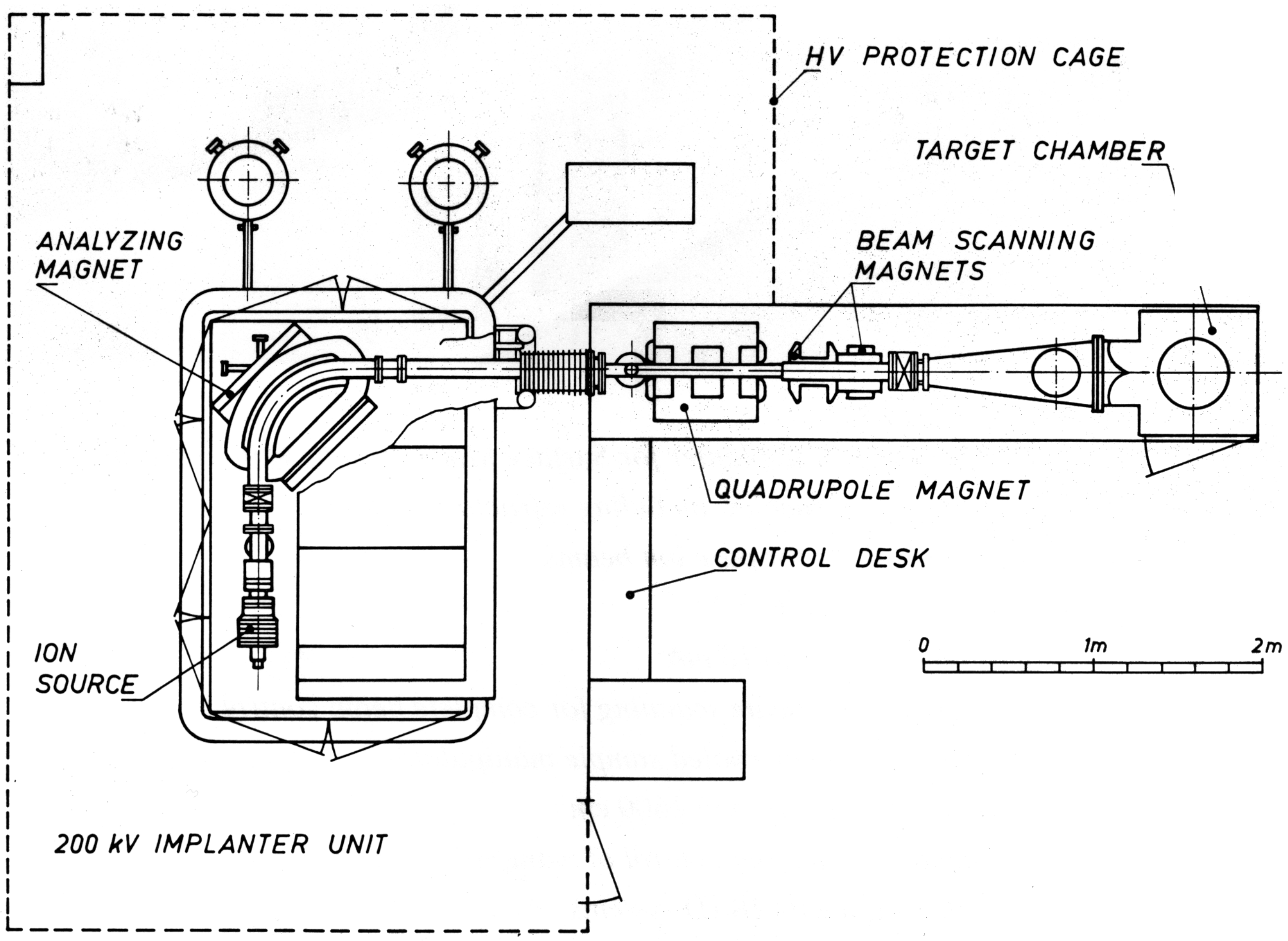
The SERIES 1090 HIGH CURRENT IMPLANTER has been designed for the specific application of ION BEAM MODIFICATION OF MATERIALS. It has the versatility in ion species, beam energy, beam intensity, and allowed sample geometry, which is a must in process research and development, and it has the throughput capacity which is required for treatment of "industrial" batches or large samples.

BASIC DESIGN CONCEPT

The layout of the SERIES 1090 HIGH CURRENT IMPLANTER is shown in the figure below. It is designed with mass separation at extraction level and subsequent post-acceleration, beam focussing, and large area beam scanning. The implantation chamber contains a water cooled sample manipulator with one linear and two rotating movements.

The ion optical system is designed for maximum transmission of the extracted beam to the target. Furthermore, care has been taken to ensure space charge compensation wherever possible in order to avoid beam instabilities and to maintain control of the beam at all beam intensities. Thus the extraction and acceleration structures are reduced to a minimum length and include electron suppression electrodes to avoid electrons being drained from the beam plasma. For the same reason, all beam handling components, such as analyzers, lenses, scanners, and steerers, are magnetic.

The SERIES 1090 HIGH CURRENT IMPLANTER produces mass analyzed beam currents in the 1 to 10 mA range of a large number of ion species within an energy range from 20 to 200 keV (with reduced currents even down to 5 keV and up to 600 keV or higher with multi-charged ions).



Layout of SERIES 1090 HIGH CURRENT IMPLANTER in the standard configuration.

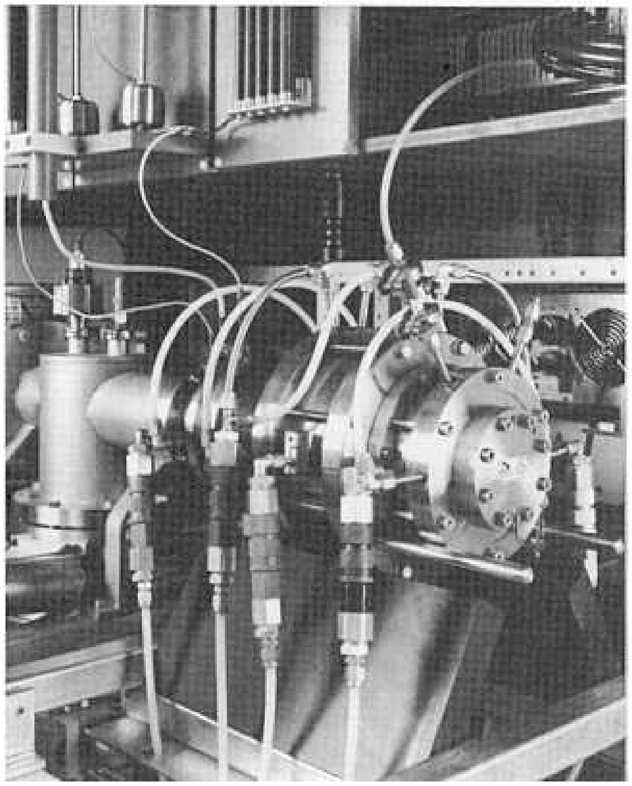
ION SOURCE AND EXTRACTION

The ion source used in the implanter is a MODEL 920 HIGH CURRENT ION SOURCE ("CHORDIS"), originally developed at GSI, Darmstadt. It is a magnetic multicusp plasma discharge ion source which produces stable beam currents of up to 40 mA in the single aperture configuration used for this application. The ion source assembly includes extraction and electron screening electrodes.

Ions may be produced from virtually all elements. Charge materials may be elemental or compound gases and vapours containing the atomic species to be implanted. An optional sputtering configuration of the source is specifically developed for the production of ions from high melting point metals, such as Ti, Cr, Ta, Mo, and W.

The operating parameters may be optimised for the production of higher charge state ions (at reduced intensity) allowing higher ion beam energies and thereby larger penetration depth of the implanted ions.

The ion source is remarkably easy to operate and maintain. Cathode filament lifetime is typically 100 hours, and the cathode may be replaced within 30 minutes.

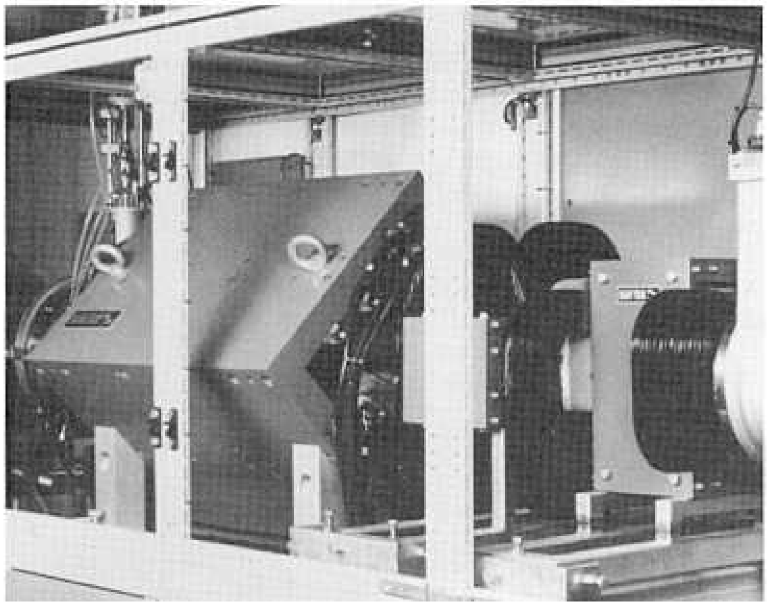


Model 920 High Current Ion Source

MASS ANALYSIS AND ACCELERATION

The extracted beam at up to 50 keV is mass analyzed in a double focussing 90° analyzing magnet with mass resolution of $M/\Delta M \approx 150$ to 250. A beam profile monitor and a remotely controlled analyzing slit allow control of the elemental and isotopic purity of the beam.

The analyzed beam is post-accelerated to a maximum energy of 200 keV for singly charged ions. The acceleration tube is specially developed to minimize space charge effects and hence avoid expansion of the beam in an uncontrolled manner. Furthermore, by blocking backstreaming electrons it minimizes X-ray emission from the acceleration section.



Quadrupole lens and beam scanning magnets

BEAM FOCUSSING AND SCANNING

The beam may be focused by means of a quadrupole triplet magnet to a diameter of 10 to 20 mm on target, or it may be defocused to larger dimensions (e.g. 100 mm diameter) in order to minimize instantaneous power loading on the sample surface.

With an electromagnetic two-dimensional beam scanning system the ion beams may be scanned for homogenous exposure over large areas. The maximum beam scanning area depends on the magnetic rigidity of the beam particle. For singly charged ions at 200 keV it is $40 \cdot 40$ cm^2 for ions up to mass 100 (amu) decreasing to approx. $30 \cdot 30$ cm^2 for mass 200.

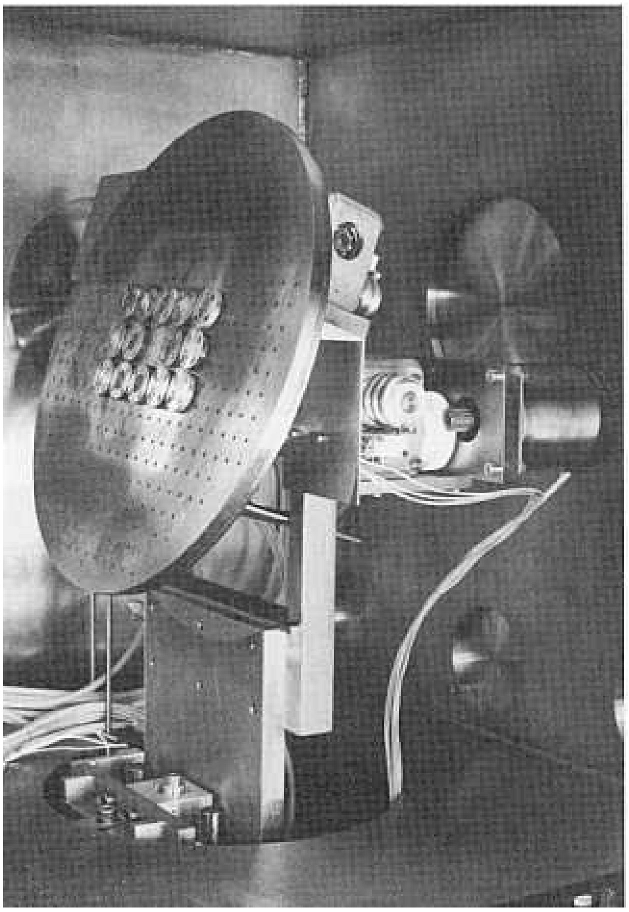
TARGET CHAMBER AND MANIPULATOR

The target chamber consists of a "conical" beam entrance tube of square cross section and a large (0.7 x 0.7 x 0.7 m^3) cubical implantation chamber. The entrance tube contains two moveable Faraday cups for beam diagnostics and a large ($40 \cdot 40$ cm^2) water cooled beam stop for setting up of the implanting beam pattern.

The implantation chamber contains a water cooled sample manipulator for specimens up to 50 kgs. The specimen holder disc may be rotated continuously around its axis of symmetry, and the disc axis may be rotated around a horizontal axis perpendicular to the beam. Finally, the specimen may be moved linearly in the vertical direction. All movements may be performed independently or simultaneously via manual pushbuttons. A computer control system for the sample manipulator combining sample movement and beam scanning is available as an option.

The samples are entered through a large access door covering one side of the implantation chamber. Several vacuum ports for diagnostics, auxiliary equipment or extensions are available. The vacuum system on the implantation chamber is dimensioned in such a way that implantation may start approx. 15 minutes after start of pump down.

As an option the chamber may be provided with an infrared detector for sample temperature monitoring and control.



Water cooled sample manipulator

CONTROL AND INTERLOCK

The implanter is operated from a control console in direct connection with the implanter and comfortably close to the implantation chamber. All operation parameters are displayed and may be set or adjusted at the control console if required.

The following main interlock systems ensure the safe operation of the implanter:

- Key activated door interlocks and a failsafe electrode grounding system ensure a reliable high voltage interlock system.
- Vacuum level controllers, pump and valve control and interlock units protect the vacuum system from improper operation.
- A thermal interlock system inhibits the beam extraction in case of lack of cooling of the ion source or any component which may be hit by the powerful ion beam. If the optional IR-detector is installed this will cause a beam stop to block the beam in case of sample overheating.

VACUUM SYSTEM

The implanter is delivered with vacuum system including monitors and controls. The vacuum pumps may be the basic system with oil diffusion pumps and with cryobaffle on target chamber, our optional system with cryopumps in beam line and target chamber, or customer specified. With the cryopump option the basic pressure in the implantation chamber is in the 10^{-7} mbar range and the working pressure during implantation is 2 to $5 \cdot 10^{-6}$ mbar.

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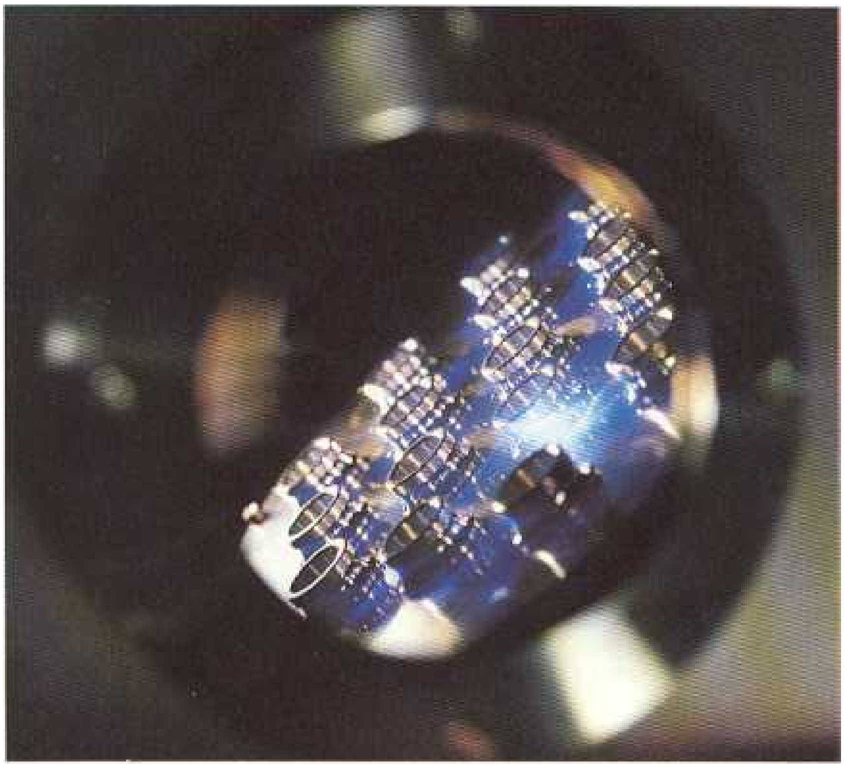
SPECIAL CONFIGURATIONS

From ion source to target the 1090 HIGH CURRENT IMPLANTER is modularized and may be delivered in various optional configurations including:

- Basic implanter without focussing, beam scanning and target chamber
- Basic implanter with focussing and beam scanning without target chamber
- Complete implanter with focussing, beam scanning and standard target chamber
- Complete implanter with switching magnet and two standard target chambers
- Basic implanter with custom designed beam line(s) and/or target chamber(s)
- Combined ion implantation and IBAD chamber



Ion implantation in progress

SPECIFICATIONS

Beam energy: From 20 keV to 200 keV for singly charged ions (down to 5 keV with reduced current and up to 600 keV for multiply charged ions).

Beam current: From 1 to 10 mA depending on ion species and beam energy.

Examples of guaranteed mass analyzed beam currents on target focused to ≤ 20 mm dia:

N^+, Ar^+ ≥ 5 mA
C^+, P^+, Al^+, Cr^+ ≥ 3 mA
Ti^+, Y^+, Ni^+ ≥ 2 mA

(Some elements require sputter version of the ion source.)

Mass analysis: Mass resolution M/ΔM, 150 to 250 depending on beam current.
Mass range at 200 keV, 1 to 250 amu.

Beam focussing: Min. beam spot on target 10 to 20 mm diameter.

Beam scanning: Max. scan area 40 · 40 cm^2 up to mass 100 amu decreasing to 30 · 30 cm^2 for mass 200 amu, all at 200 keV.

FACILITY REQUIREMENTS

The following values are valid for the standard implanter configuration with one target chamber.

Overall dimensions: Approx. 8 m (long) x 6 m (wide) x 3 m (high).

Electrical power: Three phase, 380 V, approx. 70 kVA. (Other voltages on request).

Cooling water: Min. 3 bar pressure drop, approx. 60 l/min., max. inlet temperature 20°C.

Compressed air: Min. 6 bar (for pneumatic valve operation).

(Specifications are subject to change without notice.

DANFYSIK CAN ALSO OFFER YOU:

- Complete beamline systems covering Analyzing Magnets, Quadrupole Magnets and Switching Magnets with solid or laminated core.
- Precision Magnet Power Supplies in 0.1,   or 10 ppm stability classes.
- Ion Implanters and a range of Ion Sources.
- Precision Current Transducers.
- A wide program of Beam Diagnostic Instrumentation.
- Precision Teslameters.
- Complete consultancy and design service from basic optics to finished documented products.

For further information on any product please contact:

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