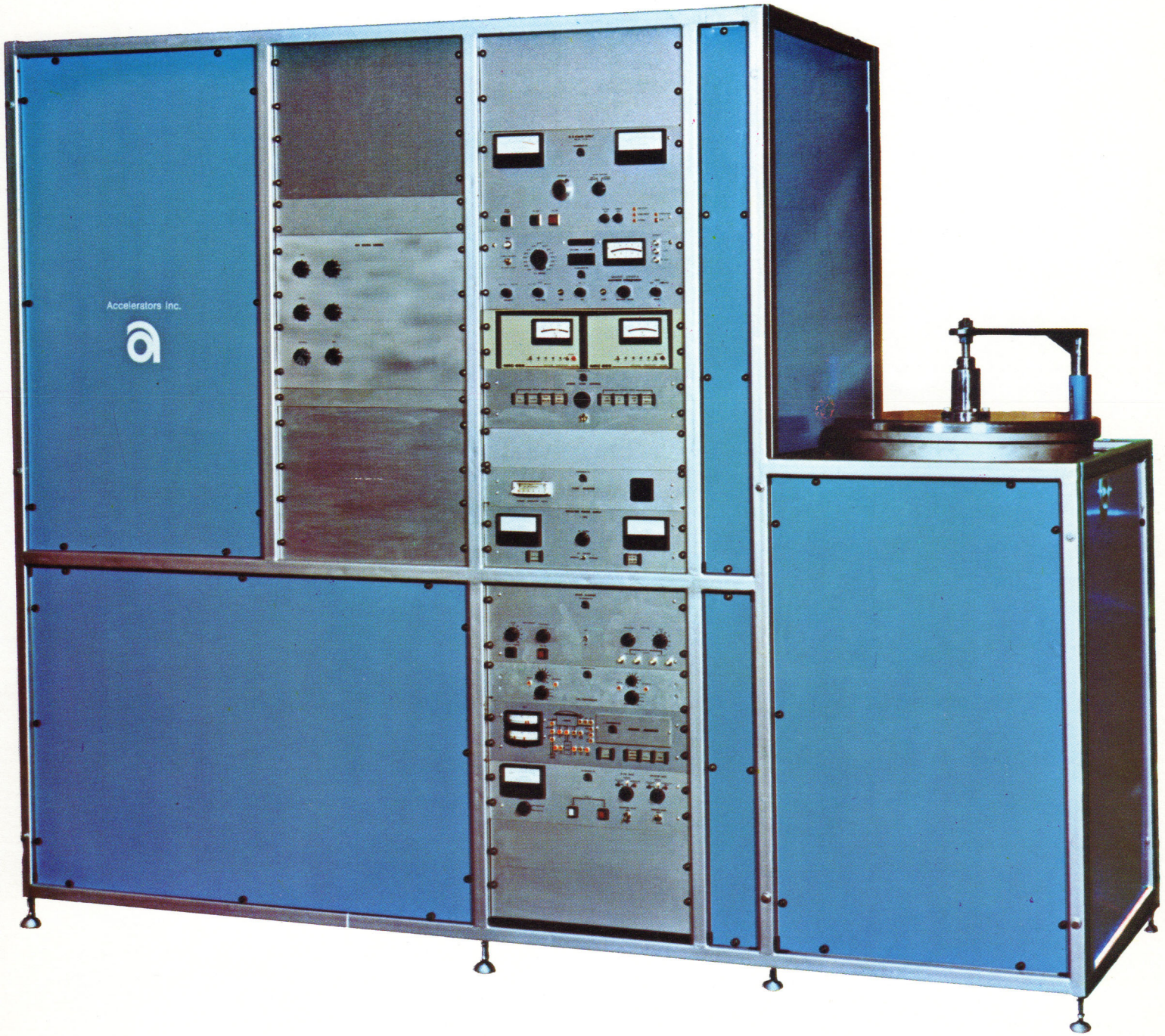
MODEL 80-TA
ION IMPLANTER



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MODEL 80 TA IMPLANTER

FEATURES

- Batch Scanning
- High Throughput
- Fully Enclosed Compact Unit
- Engineered To Prevent Radiation and High Voltage Hazards
- Fully Automatic
- Air Insulated For Easy Access For Fast Maintenance

DESCRIPTION OF HYBRID SCANNING AND WAFER-THROUGHPUT CONSIDERATIONS

Straightforward target chamber design and a hybrid scanning technique* are combined in the Accelerator, Inc. Implanter to form a wafer handling system unexcelled in simplicity of construction and speed of wafer processing.

The hybrid scanning technique consists of electrostatic scanning of the beam in the verticle, while a batch of wafers are rotated on a carousel in the perpendicular direction.

In low-dose applications, throughput is limited by the fact that the implant time must be sufficiently long to average out non-uniformity caused by fluctuations in beam current and fluctuations in exposure time. If the averaging process is carried out on a batch, as in hybrid scanning, rather than on each individual wafer, higher beam currents can be used and substantial economy realized in implant time per wafer.

Additionally, hybrid scanning requires overscan in one dimension only, as opposed to two dimensions with x-y scanning, resulting in half as much current loss due to overscanning.

It is evident that with hybrid scanning, no time is lost in the indexing and positioning of individual wafers.

And since rotary motion is the simplest motion to produce, it follows that hybrid scanning is the most reliable technique for wafer processing.

*Patent Pending

SAFETY AND INTERLOCKS

A primary goal in the design of this implanter was the elimination of problems due to operator error or equipment failure.

Personnel Protection: Radiation external to the enclosure is guaranteed not to exceed 0.25 mr/hr, which is well within all state and federal limits. The enclosure serves to protect personnel against high voltage shock.

The access door to the enclosure is electrically interlocked, and is also provided with a mechanical key-lock. Opening the access door automatically shuts off the high voltage.

Equipment Protection: The vacuum system is provided with a complete set of interlocks to prevent damage to the pumps or contamination of the system with pump oil.

Power to each diffusion pump is cut off if its cooling water exceeds a preset temperature, if the cooling water flow rate drops below a preset limit, or if foreline pressure is too high.

If power to the machine is lost, all gate valves will automatically close.

In addition, pressure gradient conditions that could force pump oil into the beam lines are monitored and are promptly isolated by the closing of the appropriate gate valve. Manual override of these vacuum interlocks is provided for maintenance purposes.

Protection to electrical components includes overcurrent and overvoltage trips on the high voltage power supply. There is a full complement of circuit breakers on the power circuits and all low-level electronic circuitry is fully protected against damage by overloading transients.

Wafer Protection: An implant can not begin, or will be terminated at any time, if all of the following conditions are not met:

1. The vacuum in the target chamber and beam line must be below high-vac set points;
2. The amount of scanned beam current striking the wafers must be within certain adjustable limits;

If one or more of these conditions is not met, the "fault" switch will illuminate and an audible tone will sound.

The fault can be quickly traced by observing appropriate indicator lights.

DESCRIPTION OF SUBSYSTEMS

Hybrid Controller (Hybrid Scan Control): The Hybrid Scan Control is the main control center for the wafer implantation process.

The unit contains all of the circuitry to:

1. Control the vent and pump down cycles of the target chamber.
2. Check the necessary interlocks for a successful implant and stop the implant if necessary.
3. Emit an audible alarm when a fault occurs or when a batch has been implanted.
4. Automatically track scanner and deflector with energy.
5. Start the current integrator and reset it when the implant is complete.

During the implant cycle, the interlock circuitry is monitoring to verify that the H.V. is on (implies good vacuum at source end); the gate valve is open (implies target chamber vacuum and beam line vacuum good); and that the overscan monitor is within tolerances.

High Voltage Power Supply: Requirements on stability and precise control of the ion beam make the high voltage power supply one of the most critical components of the system. Designed and manufactured by Accelerators, Inc., specifically for ion implantation systems, these high voltage power supplies provide the low ripple and precise regulation required for beam purity and reproducible implants. The high frequency design reduces peak-to-peak ripple and decreases the supply's stored energy, thereby increasing system reliability.

The high voltage power supply also provides auxiliary power through an isolation transformer for operation of equipment in the high voltage terminal.

Specifications:

High Voltage Output (continuously variable)	20-80 KV
Output Current	1.0 mA
RMS ripple (Full Volts and Full load)	0.05%
Regulation (for 10'2 line Variation)	1.0%
Isolation Transformer	1 KVA
Insulation	Oil

High Voltage Terminal: The high voltage terminal contains the ion source, handling system for feed gas, and adjustable power supplies for control of the source and beam focusing parameters. This includes:

1. A stainless steel gas handling system, consisting of a lecture bottle, pressure regulator, roughing valve for purging of the gas line, on/off valve, and mechanical leak valve.
2. All the power supplies appropriate for operation of the ion source, the gap lens, and focus lens.

The valves and power supplies are actuated by direct mechanical couplings mounted on the accelerator control panel which operate the controls in the high-voltage terminal through nylon insulating rods.

Power for the terminal is supplied through an isolation transformer located in the high voltage power supply.

The entire terminal is enclosed in a light-weight aluminum zero box. The box minimizes risk of sparks from the terminal to ground, and reduces power losses due to corona.

Cold Cathode Ion Source—The Al cold cathode ion source is supplied as standard equipment on ion implanters. Developed by Al for reliability in producing stable beams of boron, this workhorse has an average operating lifetime of well over 100 hours at currents in excess of 20 uA. At operating currents of 5-10 uA, lifetimes of over 400 hours have been observed. To rejuvenate the source, it is necessary only to replace the beryllium exit canal, which can be done simply and quickly.

Operation: An appropriate gas, BF3, is fed into a chamber which has an exit canal on one wall. This wall is the insulated cathode or "probe." A negative potential difference of 0-10-KV is applied between this cathode and the source enclosure. Electrons collide with the gas molecules and a self-sustaining glow-discharge of ionized atoms and molecules is formed. Some of the ions are accelerated through the exit canal into the evacuated region beyond where they are further accelerated and focused by the gap lens and focus lens.

A distinctive and attractive feature of the cold-cathode source is the relative simplicity of the mass spectrum it produces, with much of the current concentrated in the elements desired.

Accelerating Column: The Al accelerating column is the result of many years of experience in design and operation of ion accelerators. A multiple gap configuration is used to minimize high voltage arcing. A voltage gradient of less than 20 KV per one-inch gap is maintained.

The column is constructed of aluminum electrodes separated by pyrex glass spacers and sealed with Viton O-rings. Compression of the 0-rings for vacuum tightness is assured by three epoxy-filled glass rods which extend the length of the accelerating column.

The distribution of potential along the column is provided by the flow of current from the high-voltage end to ground through a string of identical resistors, each connected to a pair of electrodes on the accelerating column.

An electrode, which serves the function of preventing electrons from being accelerated from ground potential to the high voltage end of the tube, (resulting in rapid erosion of the ion source and generation of radiation) is located just beyond the output of the accelerating column. This electrode is biased at a constant potential below ground of a few keV.

Analyzing Electro-Magnet and Power Supply: The 90° analyzing magnet is double focusing, with a homogeneous field provided by hydro-genannealed Armco iron poles.

Specifications:

Deflection angles: 90° - single port
Mass energy product: .22 @ 90°
Field strength: 3.33 kilogauss
Coil coolant: Water or Air
Pole gap: 0.75 inches
Pole gap to width ratio: 2.67

Each analyzing system comes with its own Al designed highly regulated power supply, with the following specifications:

Stability: One part in 10^{-5}
Regulation: 0.1%
Current Output: 20 Amperes
Cooling: Air
Ripple: 0.001%
Noise: 0.001%

Neutral Trap: Located in the beam line between the scanner and target chamber is a permanent 7° bend. Inside this bend are located a pair of curved plates to which a DC bias is applied causing the ion beam to be deflected through 7° while neutrals continue in a straight line to collide with a beam stop.

In the automatic tracking mode, the DC bias is varied linearly with the accelerating voltage to maintain proper deflection.

DC voltage is variable from 0 — 5 kv continuously.

Target Chamber: The target chamber is designed to accommodate forty - 3 inch wafers or sixty - 2 inch wafers in a single loading on a double deck carousel. It is fabricated of stainless steel and is equipped with three viewing ports and an automatic lid lift mechanism.

Each deck of the double-deck carousel is removed individually by grasping two handles on the carousel and lifting until it clears the keyed shaft.

Each wafer is held in position on the carousel in two V-grooves. Wafers can vary slightly in thickness and diameter without presenting a loading problem. A small spring clip on each wafer holder **may** be used to secure very small or broken wafers. The angle between normal to the wafer and the direction of the ion beam is optional over an angular range of 10 degrees.

The carousel rotates at 100 RPM. The drive shaft enters through the bottom of the chamber and uses a differential pumping collar to eliminate vacuum seal problems around the shaft.

Beam current flows through the carousel, the carousel drive shaft, the drive shaft support bearing and race (all insulated) and into the current integrator.

Current Integrator: Ion implantation places stringent requirements on the current integrator. It must be highly reliable; should withstand high voltage transients without damage; should provide good accuracy over a wide current range; and be able to integrate pulses. The Al current intergrator provides all of these parameters.

This current integrator is the same model used by the National Bureau of Standards and features fifteen ranges from 2 nA full scale to 20 mA full scale in a 2-6 sequence. Accuracy is an unprecedented 0.02% on all ranges. A special input-charge storage feature enables the instrument to integrate pulses with peak values up to 20 mA on any range without saturation.

The internal counter has a four decade, seven segment LED display and a floating LED decimal point that automatically shifts as the scale factor is selected. A four-digit, decimal thumbwheel switch provides for precise presetting of the four decades.

The instrument receives automatic start/stop-reset commands from the Hybrid Scan Controller.

Vacuum Sequencer: The automatic vacuum pump control for the target chamber will initiate a pump down or vent cycle when it receives the proper command signals from the front panel controls or the remote controls. A graphic display with indicator lights on the front panel gives a constant indication of gauge, valve, and interlock status.

The vacuum sequencer will close the proper valves in the event of a vacuum loss or power failure and restore the system to a standby condition when the power returns.

Vacuum Pumps: The Model 80-TA uses two pumping stations: one at the exit of the magnet, and one at the target chamber. Each pump station consists of a roughing pump, an oil diffusion pump, cold trap, and associated valves and vacuum gauges.

Specifications:

I. Roughing pump:
Type: Two stage, oil sealed, rotary
Vacuum: 10^{-2} torr
Pumping speed: 15.88 chamber; 9.88 terminal

II. Diffusion pump: NRC
Type: oil jet
Size: 6"
Vacuum: 10^{-7} torr
Pumping speed: 1500 liters/second
Cold Traps—Circuits Processing Apparatus, Inc.

Scan Monitor: The Scan Monitor consists of a current meter with two adjustable trip points and a window with two lights which represent the amount of overscan on each side of the wafer.

These two lights vary in intensity in proportion to the amount of current received at each overscan monitor strip. The matrix of four strips is located just in front of the wafer positions.

Scan Set-up: To set up the scanner, the amplitude of the vertical scan signal is increased until the vertical pair of lights is illuminated, indicating sufficient over-scan to insure uniformity of dose at the edges. If one light comes on much before the other, it suggests that further mechanical alignment of the beam is necessary. The relative intensities of these lights give a good indication of the symmetry of the overscan. The lights will not come on unless a minimum amount of overscan exists.

The high current trip point can now be set. If the scanner amplitude decreases (causing insufficient overscan) the current striking the wafers will rise, tripping the interlock. The low current trip point is set to prevent deflector drift from causing improper overscan or current drift from causing undesirably long implant times.

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