Varian, Inc.
Vacuum Technologies

Vacuum Solutions for Electron Microscopy Applications

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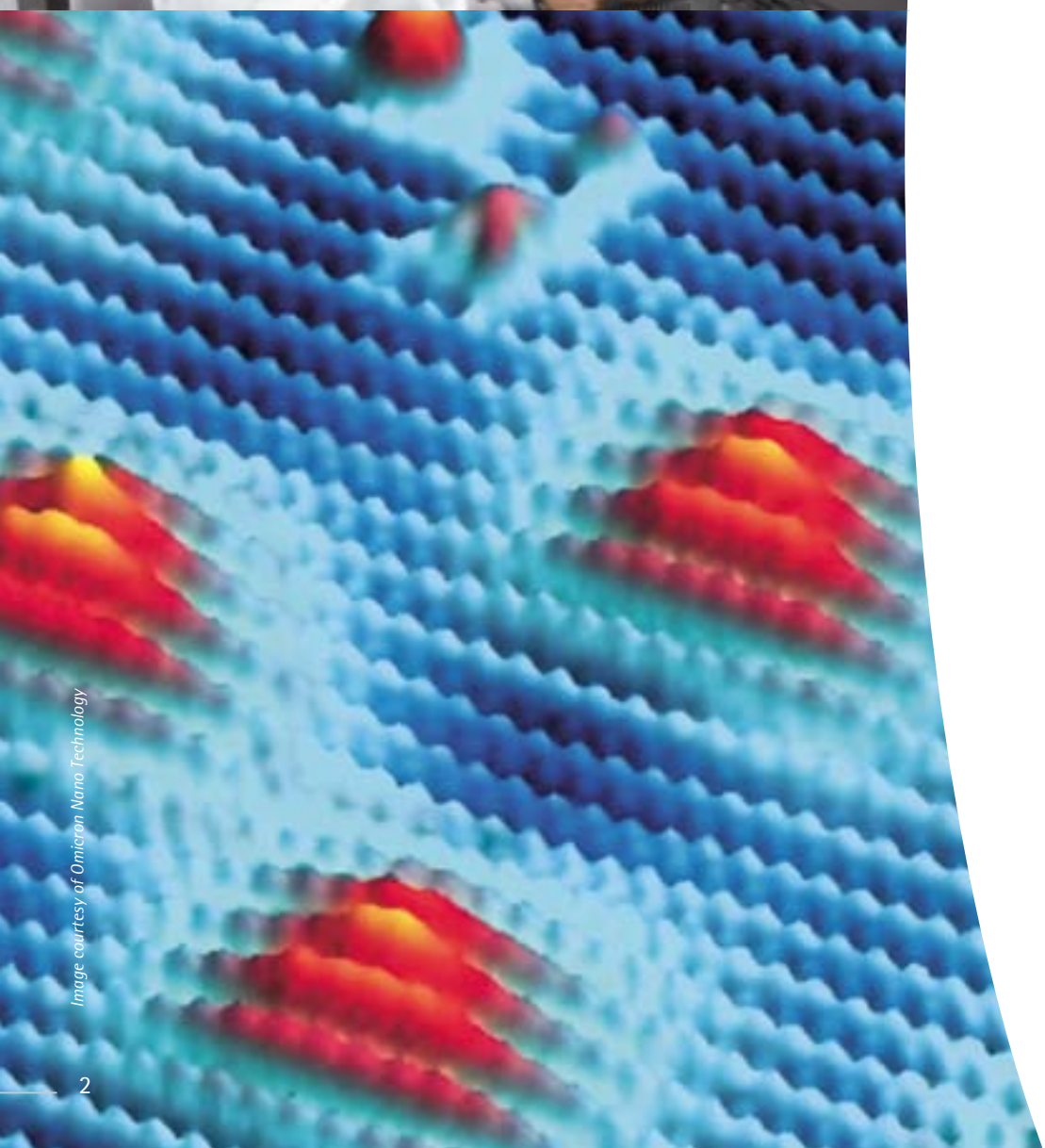


Image courtesy of Omicron Nano Technology

Ready for the Nanotech Era

Varian Vacuum Technologies is established as a world leader in the design, manufacturing, and customisation of performance-driven vacuum products ranging from high energy physics and research to the most difficult industrial processes. The Conflat® flange, Vaclon® pump, Contra-Flow™ leak detector and TriScroll™ pump, as well as the MacroTorr concept in Turbo pump technology were all invented by Varian; today, the technology found in each has been adopted as the industry standard.

Varian has long experience with supplying vacuum components to instrumentation manufacturers of focused beam systems such as Scanning Electron Microscopes (SEM) and transmission electron microscopes (TEM).
This broad vacuum product line provides the focused beam system designer with the ability to choose a pump with the optimal combination of size, performance and cost for the multiple vacuum levels commonly found in these instruments.
Finally, Varian`s 50 years of vacuum pump experience makes the company and its talented designers team uniquely qualified to supply customized solutions for these special applications.

Focused beam analytical instrumentation has been used for decades starting with research applications. Although extremely useful for detailed analysis of many different materials, for many years, these instruments stayed in the laboratory due to their expense and complication.

Modern electronics and improved manufacturing techniques have greatly improved the accuracy, operability and economy of these devices. Today, there is a wide range of these highly sensitive and accurate devices from many different manufacturers available for many different applications.

Although focused beam analytical instrumentation remains a mainstay of fundamental and practical research, the growth and utility of these instrumentation has coincided with the growth of high technology manufacturing. These coincident developments have greatly expanded the application of focused beam systems. Today, modern semiconductor manufacturing depends on the use of SEM's, and represents the largest application of these instruments.

SCANNING ELECTRON MICROSCOPES (SEM)

- Critical dimension
- Defect review
- Environmental SEM
- Variable pressure
- Basic & industrial
- Research & development
- Semiconductor manufacturing

TRANSMISSION ELECTRON MICROSCOPES (TEM)

- Basic research
- Life sciences
- Industrial process development

FOCUSED ION-BEAM SYSTEMS (FIB)

- Material research
- Process development
- Semiconductor repair
- Failure analysis & 3D analysis

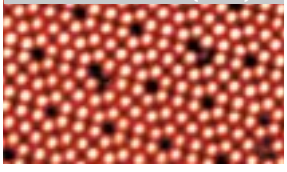
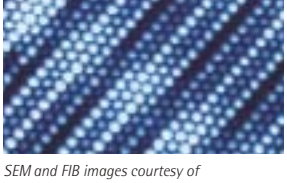
SURFACE ANALYSIS

- Basic & industrial
- Research & development

Above and cover images courtesy of Carl Zeiss SMT AG

Varian Products for SEM Systems

Analytical systems that use focused beams require high and ultra-high vacuum pumping. The most common applications of this type include electron microscopes (SEM and TEM), focused ion beam tools (FIB), and surface analysis systems. All these applications can have very stringent performance requirements for sensitivity, resolution, sample throughput and measurement repeatability. These requirements are driven by the need to analyze ever-smaller samples, especially in semiconductor, life-science, and other high technology applications. End users of these systems analyze all types of substances from organic compounds to semiconductor wafers.
In the Semiconductor industry, in particular, more sensitivity for better sample resolution is required.

Electron Microscopes Applications	Turbo Pumps	Ion Pumps
SCANNING ELECTRON MICROSCOPES (SEM) 	V 701/551 SEM V 301 SEM	8, 25, 35, 55 l/s SEM
TRANSMISSION ELECTRON MICROSCOPES (TEM) 	V 301 SEM V 70	8, 25, 35, 55 l/s SEM
FOCUSED ION BEAM SYSTEMS 	V 1001 SEM V 701/551 SEM V 301 SEM	20,45 l/s StarCell
SURFACE ANALYSIS 	V 701/551 SEM V 301 SEM V 70	8, 25, 35, 55 l/s SEM

SEM and FIB images courtesy of Carl Zeiss SMT AG - TEM and S.A. images courtesy of Omicron Nano Technology

Varian can supply all the vacuum components required for electron microscopes. Additionally, Varian has extensive knowledge concerning this application, and the ability to customize vacuum products to meet the highly demanding needs of systems using charged particle beam technology. These dedicated products include SEM Turbo, Integrated Double Dampers, SEM Ion pumps and control systems.

All of them are tailored to the low electromagnetic noise and vibration requirements of the SEM, TEM and Dual Beams next generation. Additionally, Varian offers a full line of rough vacuum pumps (both wet and dry), valves and vacuum measurement components to meet any designer's requirement.

Special care is paid to After Sales Support, in order to meet customer requirements and to reduce cost of ownership.
Varian offers three convenient Service Plans to help you maximize your productivity: Repair Program, Advance Exchange and Upgrade Program.

- The Repair Program takes care of your Turbo Pump in need of a factory repair.
- The Advance Exchange allows you to receive a replacement Turbo Pump without any need to stop your production.
- The Upgrade Program allows you to replace a Varian Turbo Pump with the most recent model of a similar size.

(For products other than Turbo Pumps please contact Varian Technical Support).

Backing Pumps	Valves	Gauging
TS 300, TS 600, SH 110, DS 42, DS 102, DS202, DS 302, DS402	Small Aluminum Block Valves	CT 100, EyeSys Mini-BA, EyeSys IMG
DS 102, DS 202, SH 110	Small Aluminum Block Valves	CT 100, EyeSys Mini-BA, EyeSys IMG
TS 300, TS 600, SH 110	Small Aluminum Block Valves	CT 100, EyeSys Mini-BA, EyeSys IMG
TS 300, TS 600, SH 110	Small Aluminum Block Valves	CT 100, EyeSys Mini-BA, EyeSys IMG

The table shows the broad range of products that Varian offers specifically for manufacturers of charged particle beam analytical systems. Products include a full range of specially designed SEM ion pumps:
from 0.4 l/s up to 500 l/s. Varian also has a full range of low vibration turbo pumping systems that are specifically designed for focused beam systems, having lower vibration level than equivalent Magnetic Levitated products.

Focused Electron Beam System

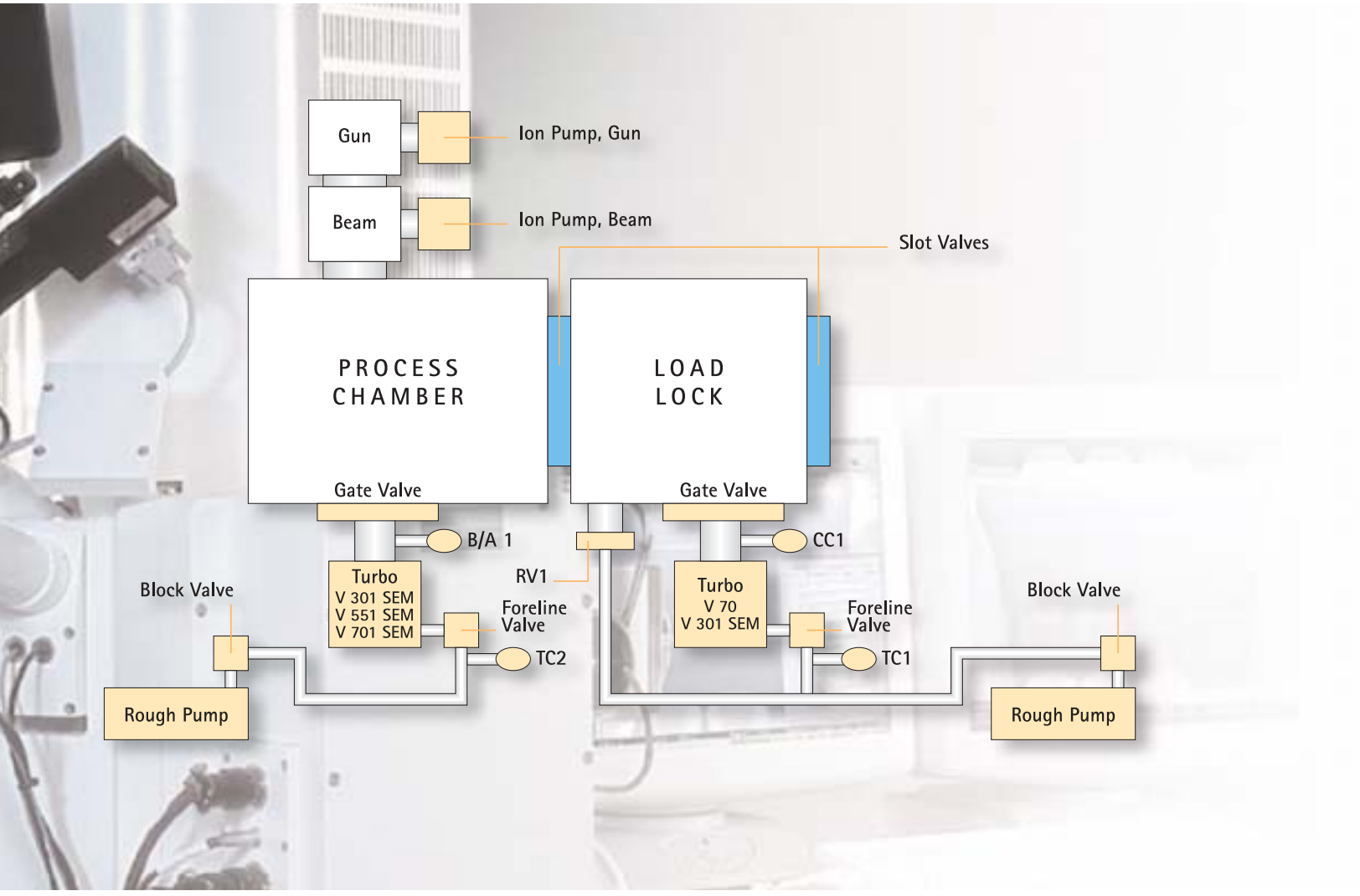
In order to better understand the applicability of Varian products on focused beam systems, a typical instrument is shown on the right. This figure represents a typical SEM or TEM. A sample that has been prepared for analysis is first placed inside the loadlock that is pumped down to operating vacuum, after which the sample is mechanically transferred to the process chamber. In the high vacuum chamber, an electron beam scans the sample for analysis. The electron beam is generated and focused in the column. These three major subsystems all require vacuum pumps that Varian can supply.

The column is typically divided into at least two parts: the ultra-high vacuum electron gun which generates the electrons, and the high vacuum column which focuses the electron beam. The electron filament in the gun lasts longer if the vacuum is stable. The vacuum in the column area is typically lower than that of the gun, especially if the sample in the chamber area is prone to out-gassing, such as in the case of organic materials. Varian's line of high performance VacIon ion pumps are well suited for the vacuum requirements of modern transmission electron microscope (TEM), scanning electron microscopes (SEM) and focused Ion Beam (FIB) systems. These vacuum pumps are described in the next section of this brochure.

Load-locks are used in many modern SEM's to accelerate the sample processing time by quickly transferring the sample from atmosphere to the high vacuum chamber. Sample chambers typically require high vacuum and fast pumping times to permit high

Image courtesy of Carl Zeiss SMT AG

sample throughput in order to lower the cost of ownership of these instruments. In modern applications such as semiconductor manufacturing, both loadlocks and chambers require completely dry vacuum, and very low vibration levels so as not to contaminate a sample or disturb the measuring equipment while the system is in operation, and therefore have very similar vacuum requirements.



Vacuum Solutions for the Column

Image courtesy of Carl Zeiss SMTAG

Column Requirements

- No vibrations
- Low charged particle emissions and magnetic emissions
- High differential pumping
- Accurate pressure measurements

Varian Solutions

- SEM Ion Pumps and StarCell Ion Pumps
- Application specific pumping solutions
- Application specific, multi-channel controller solutions

Columns often require multiple levels of ultra-high vacuum to insure proper beam operation. Varian's 10 l/s to 70 l/s ion pumps provide the necessary pumping levels in the compact size needed for this application. Additionally, Varian's Vaclon ion pumps are available with two different pumping elements, specifically designed for sensitive column applications: SEM ion pumps with patented diodes designed to reduce pump interference on the column; the StarCell® which has the improved pumping curve of a triode type element that is suitable for high differential pump in ESEM (environmental SEM) or high gas loads found in FIB type columns. Finally, Varian can apply its extensive knowledge of focused beam systems and flexible manufacturing capabilities to produce special ion pump designs that are custom made to a specific system.

Varian completes its offering to the microscope manufacture with a full line of controller/power supplies that have full control features and multiple channels. Multi-channel controllers can operate column pumping systems that provide flexible and cost effective control for the multiple levels of vacuum required in the FIB columns. In fact, Varian is currently the only supplier offering 3 channel ion pump controllers. Varian`s application specific ion pumping systems, including special controller protocols and custom body configurations, ensure that Varian`s ion pumps can meet the most stringent column requirements in an economic fashion.

SEM Ion pumps

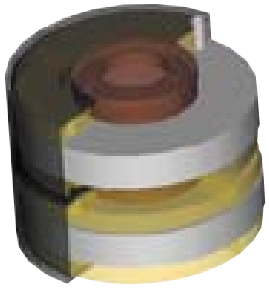
Varian is the only manufacturer to offer specially designed SEM ion pumps. These pumps are ideal for the high vacuum guns where stable vacuum and low leakage current is required to control and preserve the charged particle filament. The key to this superior performance is Varian's patented anode design which uses contoured cells and simplified electrical elements. This insures stable current readings and lower particle generation.

When combining the SEM ion pump on the gun with a StarCell ion pump on the lower column, Varian ion pumps can offer a powerful combination optimised for modern E-beam columns.

Features	Benefits
New anode geometry	• Low leakage current; current stability
Improved internal design to reduce field emission	• Pressure stability with no voltage/current spikes
Optical baffle (optional)	• Low charged particles emission from the pump

Application Specific Ion Pumps

Varian's long experience with ion pumps has made us the traditional supplier to manufacturers of focused beam systems. This in turn has given us long experience with the unique requirements of these instruments, and has enabled Varian to offer its customers highly application specific designs. Some recent custom products include:



Features	Benefits
Integrated ion pump/column	• Balanced weight and magnetic field • Lower conductance loss
Ion/Neg combination	• Very high pumping speed • Compact size and modular design

Varian Ion Pump Power Supplies

In addition to Varian's standard ion pump power supplies, we can offer customized units that are tailored to specific applications. These designs are the result of Varian's long experience with focused beam systems. Recent examples have included:

Features	Benefits
ICPU-3 3 channel integrated controller	• Only 3 channel controller presently on the market • Saves space at a lower cost
Battery power supply	• Enables service without breaking vacuum • Allows for shipping under vacuum for sustained periods

Vacuum Solutions for Load Locks and Main Chamber

Chamber and Load lock Requirements

- Fast pump down
- Low vibrations
- Compact size

Varian Solutions

- Wide range of dedicated Turbo Pumps
- Application specific, vibration isolation systems
- Optimized vacuum design
- Dry primary pumps

Varian offers a full range of high vacuum pumps and components designed especially for the demanding requirements of all focused beam systems including SEM's, TEM's, FIB's and surface analysis systems. These application specific, low vibration turbo pumping systems have been designed based on Varian's extensive experience with focused beam applications. In fact, Varian maintains a complete applications lab with state-of-the-art vibration simulation and testing equipment for the most sensitive microscopy applications. Varian also has a full range of integrated pump controllers that offer the highest control flexibility with near zero electromagnetic noise generation.

Last but not least, our experts can team with your system engineers to define application specific performing and cost effective solutions.

SEM Turbo Pumps

Varian offers a full range of application specific designed SEM turbo pumps including 70 l/s, 300 l/s, 550 l/s, 700 l/s and 1000 l/s speeds. All of Varian's SEM turbo pumps designs can be verified in Varian's application lab. Finally, each SEM turbo pump is tested in production before being shipped to the customer.

Features	Benefits
Specially designed ceramic bearing suspension systems	• Low vibration response at low cost (lower than MagLev)
Full range of pumping speeds	• Maximum design flexibility for the smallest or largest systems at lower cost
Enhanced vacuum performance with MacroTorr Stages	• Smaller roughing pump required
Purge option available	• Suitable for applications with process gas
Lowest magnetic signature	• Virtually no interference with the beams
Oil free design	• Maintenance free

Application Specific Damping Systems

Modern focused beam systems can be so sensitive to vibrations that highly effective dampers are mandatory. Varian applies damping technology as an integral part of its SEM turbo pumping system. That is, when Varian designs a turbo pump for a focused beam instrument, the damper is designed to match the turbo pump with the instruments vibration profile. The design is then verified in Varian's application lab.

Features	Benefits
Special materials to tune vibration characteristics	• Provides superior vibration response
Application specific designs	• Provides higher conductance in less space

Scroll Pumps

Features	Benefits
Dual voltage IEC power connection with On/Off switch and available international power cords	• Flexible electrical connections for easy installation worldwide
Built-in vacuum pump isolation valve	• Isolates the pump during vacuum system upset conditions. Prevents contamination of the vacuum system.
Single scroll pump	• Quick and easy maintenance and high efficiency
Hermetically sealed design	• Prevents leakage of process gasses
Light weight and compact package	• Easily adaptable for multiple system configurations
Quiet operation	• Suitable for the most demanding high-tech installations

Varian new SH-110 scroll pump has been designed to provide reliable, dry vacuum in a small, economical package.

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