IntegraTorr | Sputtered Non-Evaporable Getter

saes® getters

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IntegraTorr Sputtered Non-Evaporable Getter

Courtesy of European Synchrotron Radiation Facility

saes getters

HIGHLIGHTS

General Features

- ☐ True high speed distributed pumping
- ☐ High total pumping speed
- ☐ Simpler vacuum chamber geometry (no need for antechambers for pumping and reduction of external ports)
- ☐ Activation achieved with a low-temperature baking process (180 °C)
- ☐ Drastic decrease of thermal and photon-induced outgassing
- ☐ Reduction of conditioning time and bremsstrahlung
- ☐ Lower Secondary Electron Yield
- ☐ Multiple air exposure and reactivation possibility

Applications

- ☐ Particle Accelerators
- ☐ Heavy Ion Rings
- ☐ Synchrotron Radiation Facilities
- ☐ Insertion Devices
- ☐ Beam Lines

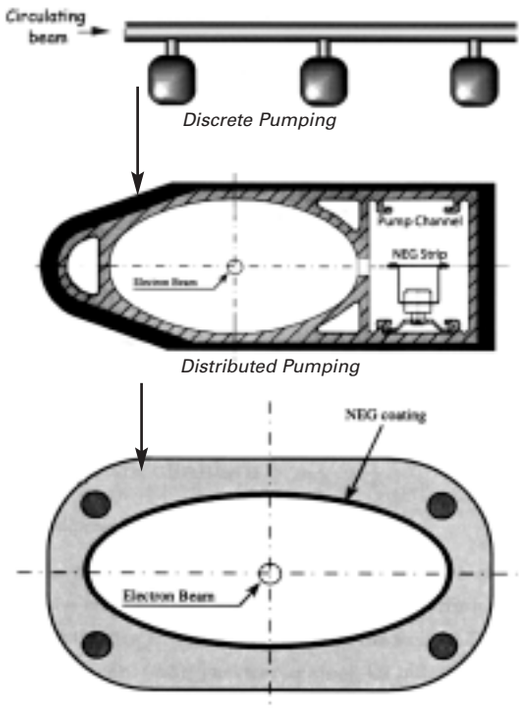
Integrating Vacuum Pump with Vacuum Chamber

The technique of sputtering thin-film coatings of Non-Evaporable Getters (NEG) for use as vacuum pumping for particle accelerators was originally developed and patented at CERN, in order to meet specific needs which emerged in the Large Hadron Collider (LHC) project. Thanks to a specific license agreement, and after a successful technology transfer process, this technology is now commercially available under the brand name of IntegraTorr through the SAES Getters Group.

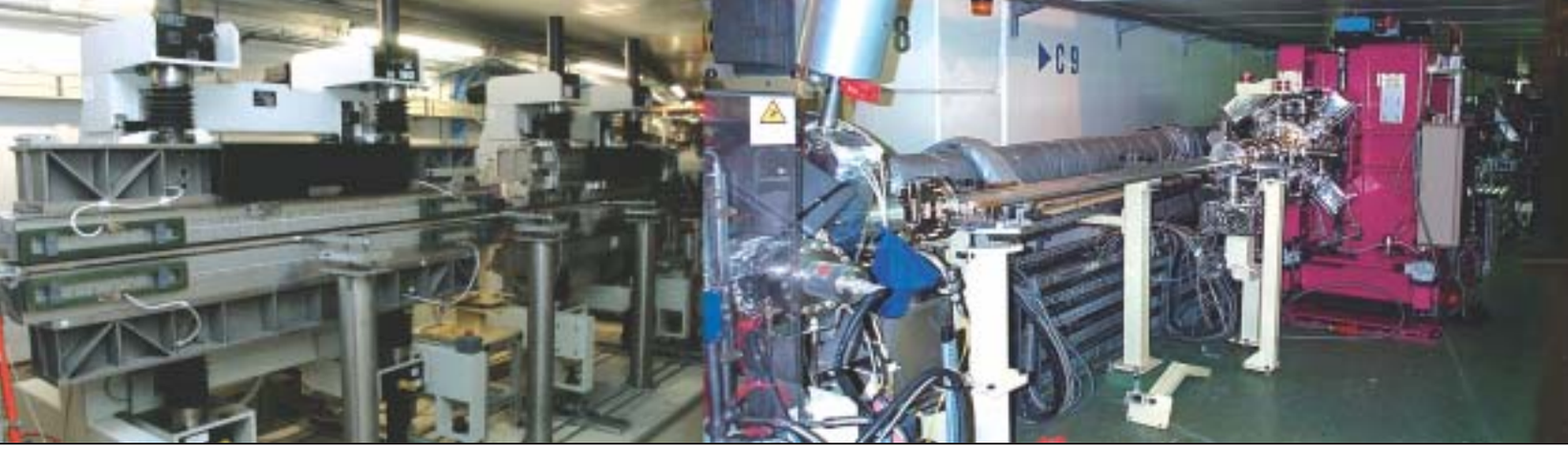
IntegraTorr is a revolutionary way to integrate non-evaporable getter pumping into a particle accelerator vacuum chamber. It is achieved by depositing a Sputtered Non-Evaporable Getter (SNEG) coating onto the surface of the vacuum chamber. The result is that the surface of the vacuum chamber, normally an outgassing source, becomes a vacuum pump.
IntegraTorr thus provides an ideal UHV pumping solution, especially for the highly conductance-limited vacuum chambers, such as those utilized in Insertion Devices.

From Discrete Pumps to SNEG Coatings

It is possible to identify a typical evolution in the pumping approach of accelerator vacuum chambers. The start phase involved the use of discrete pumps, mounted at defined intervals along the chamber length.
This evolved to the development of distributed pumping solutions especially useful for narrow andconsequently, conductance-limited vacuum chambers, as those used in electron storage rings and synchrotron light sources.

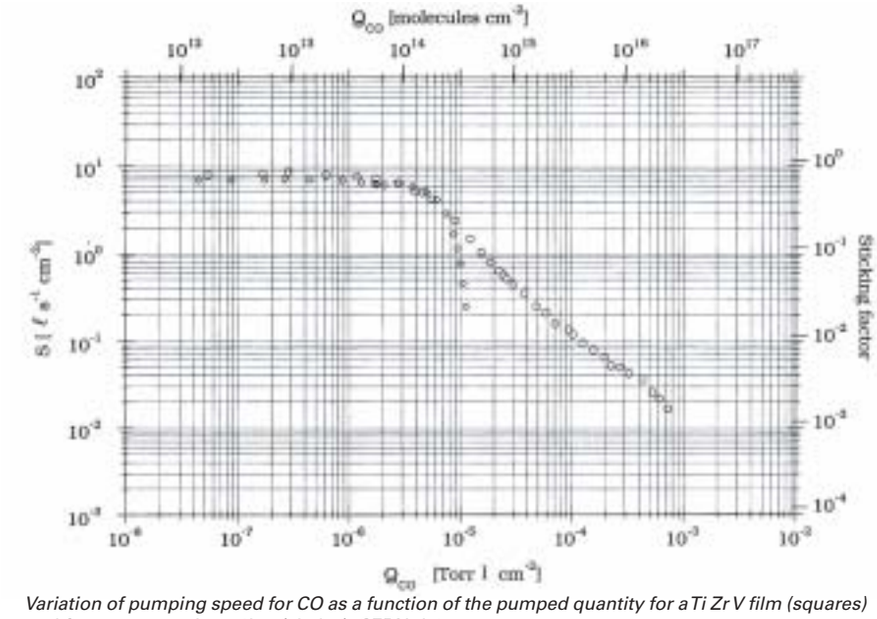


NEG materials in the form of lumped pumps or distributed strips have found widespread use in particle accelerator vacuum technology, due to effectiveness and simplicity of implementation. The coating of the inner surface of the accelerator vacuum chamber with a NEG film, which can be activated with an in-situ baking at moderatetemperatures, is the latest step in this evolution process.
The evolution toward an "integrated" pumping solution provides many advantages over previous pumping approaches, either based on the use of discrete pumps (SIP, TSP or NEG), or on the utilization of distributed pumps (DIP, NEG strip).

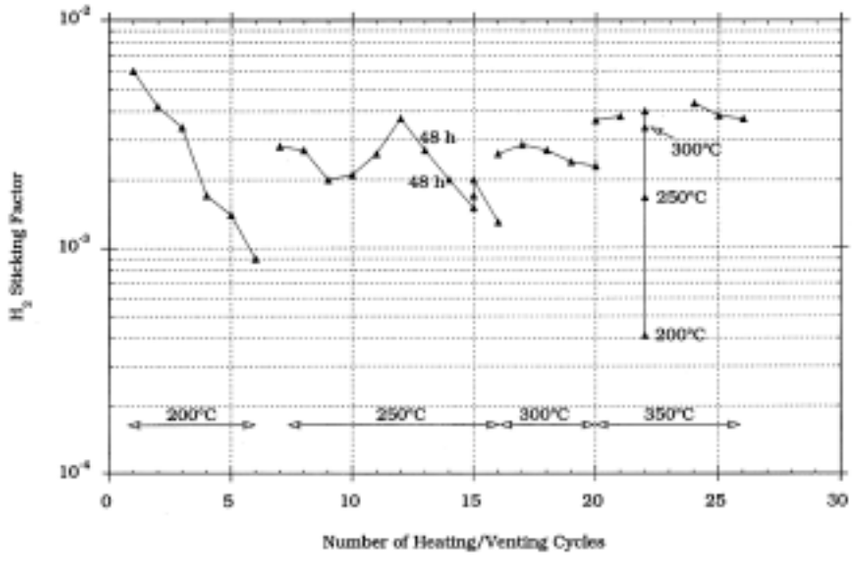


Typical Performance

The main function of IntegraTorr is to provide a means of pumping within a vacuum chamber. For this reason the basic indicator of the IntegraTorr performance is the pumping speed that can be achieved by the SNEG film, taking into account that the pumping performance is also a function of the substrate material, its condition and surface characteristics. An additional parameter, which is of fundamental importance with respect to the IntegraTorr performance, is the number of air exposures and successive reactivations that the film can go through without an excessive degradation of its pumping capability.



Variation of pumping speed for CO as a function of the pumped quantity for a Ti Zr V film (squares) and for a very rough coating (circles). CERN data.



Variation of the H_2 sticking factor for a 5 m thick Ti Zr V film as a function of the number of activation-air-venting cycles.

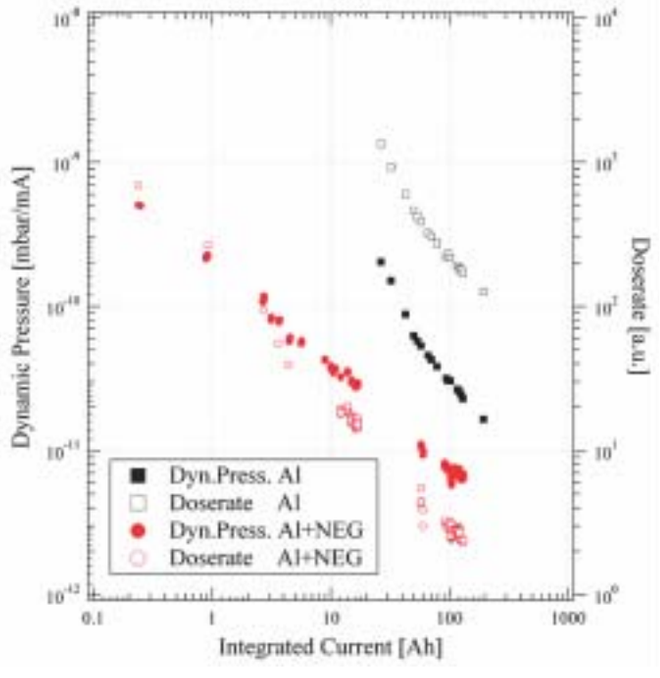
Key Projects

IntegraTorr applications are primarily for conductance-limited vacuum chambers as found in particle accelerators.

Aluminum Insertion Device vacuum chamber with InteraTorr SNEG coating.

At the moment, there are several Insertion Device vacuum chambers coated with a sputtered non-evaporable gettering operation at synchrotron radiation facilities such as ESRF in Grenoble, France and ELETTRA, in Trieste, Italy. The same kind of coatings will be applied on the LHC room temperature vacuum chambers, including those of the interaction regions.

Additional synchrotron radiation machines, both in operation or being planned, are considering the use of this technology.
The use of this technique is also being considered for the new generation of heavy ion rings, where extreme high vacuum conditions are necessary.



Comparison between the dynamic pressure and the bremsstrahlung of two aluminum vacuum chambers for Insertion Device, one with an IntegraTorr SNEG coating and the other one without, installed at ELETTRA

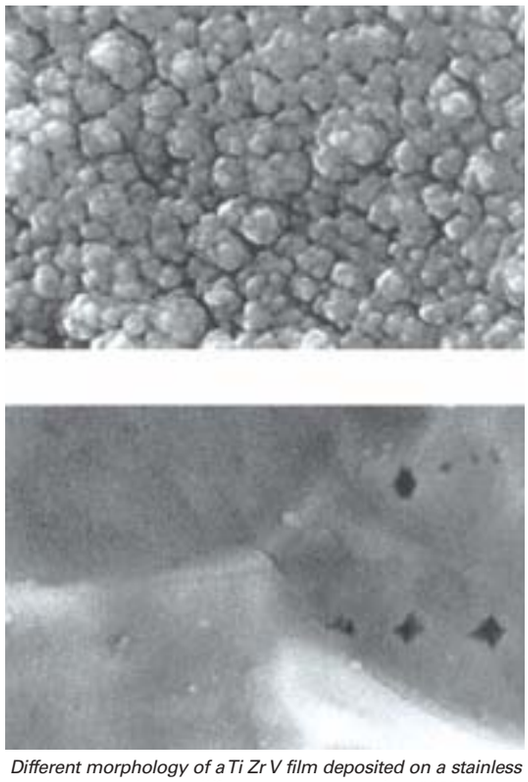
Detail of the SAES sputtering system used to apply the IntegraTorr SNEG coating, capable to process up to 7-meter long chambers.

Courtesy of Sincrotrone - Trieste SCpA

A Revolutionary Pumping Solution

The IntegraTorr film is obtained by the co-sputtering of titanium, zirconium and vanadium. This is a combination that guarantees the best performance in terms of oxygen solubility and diffusivity. Temperatures as low as 180 °C applied for 24 hours during a standard in-situ baking process are sufficient to fully activate this SNEG film. This allows the film to be deposited on various kinds of substrate materials including the ones of relevance for particle accelerator applications such as stainless steel, copper and aluminum.

Once activated, the film operates as a typical getter material, removing the active gases which impinge on its surface. If the totality of the vacuum chamber is coated with this film, a true, fully distributed pump with huge pumping speed is achieved. In addition, the IntegraTorr active film provides a physical barrier to the outgassing species coming from the substrate material. In these conditions, it is possible to achieve pressures in the eXtreme High Vacuum (XHV) range, below 1 x 10^{-13} mbar.



Different morphology of a Ti Zr V film deposited on a stainless steel substrate kept at different temperatures (top 300°, bottom 100°)

Advantages of the IntegraTorr Approach

Besides providing a true, fully distributed pumping system, the IntegraTorr coating film also reduces the degassing induced by ion, electron and photon bombardment, making it particularly suitable for synchrotron radiation light sources.
These features help also in shortening the conditioning time of newly installed vacuum chambers and, in addition, the improved vacuum conditions guarantee much lower bremsstrahlung.

The adoption of the IntegraTorr also allows a much simpler chamber design without the need to add frequent pumping ports for discrete pumping or separate antechambers for distributed pumping.

Active SNEG films have been also demonstrated to have a lower Secondary Electron Yield, reducing the risks of multipacting phenomena.

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