VACUUM TECHNOLOGY
Hositrad

Choice of Pumping Element Technology

1. Diode

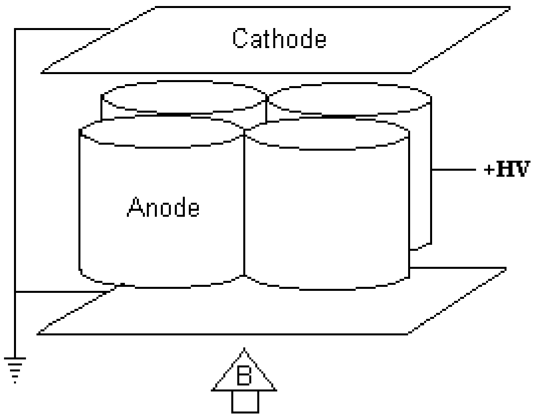


Figure 1 Diode Sputter-Ion Pump Configuration
In the description of Figure 1 above the most common configuration of sputter-ion pumps, the diode, is described. Both cathodes are made of titanium and the structure is simple and rugged.
For most applications, where active and/or residual gases comprise the main load on the pump, this configuration works well. This applies to Nitrogen, Oxygen, Water Vapor, Carbon Dioxide and like chemically active gases. In the case of pumping some specific gases, however, variations of the structure are useful.
For noble gases, such as argon, either as the main gas load or as the result of sustained air leaks (argon comprises approximately 1% of air), the diode pump can develop problems. Since argon is chemically neutral, it is pumped by burial only. After prolonged operation, some of the previously buried argon gets re-emitted due to the sputtering action. The pressure rise causes additional sputtering, which causes additional argon to be re-emitted, etc. and the pressure rises more and more rapidly, up to the point where the pressure reaches about 10-4 Torr. At this point the electrical discharge changes mode into a more diffuse form, the argon gets slowly pumped into other areas of the pump and the pressure slowly falls over a few minutes. At a certain point, the discharge shifts back into the confined Penning mode, and the pressure falls rapidly to the base pressure of the system. This behavior, called “argon instability”, continues in a periodic fashion, with a period which increases as the size of argon load decreases. To stabilize this behavior, the balance of sputtering/burial/re-emission must be shifted. This is accomplished by two variations: the Galaxy Diode and the Noble Diode (Differential) pump.

2. Galaxy Diode

The new Galaxy ion pump technology uses two titanium cathodes penetrated with spiral patterns which are axially co-located beneath the anode cells. Noble gas ions, such as argon, strike the spiral elements at grazing incidence, resulting in sputtering and neutralization. The neutralized atoms are permanently buried in inactive areas of the pump. An image of a Galaxy cathode is shown below.

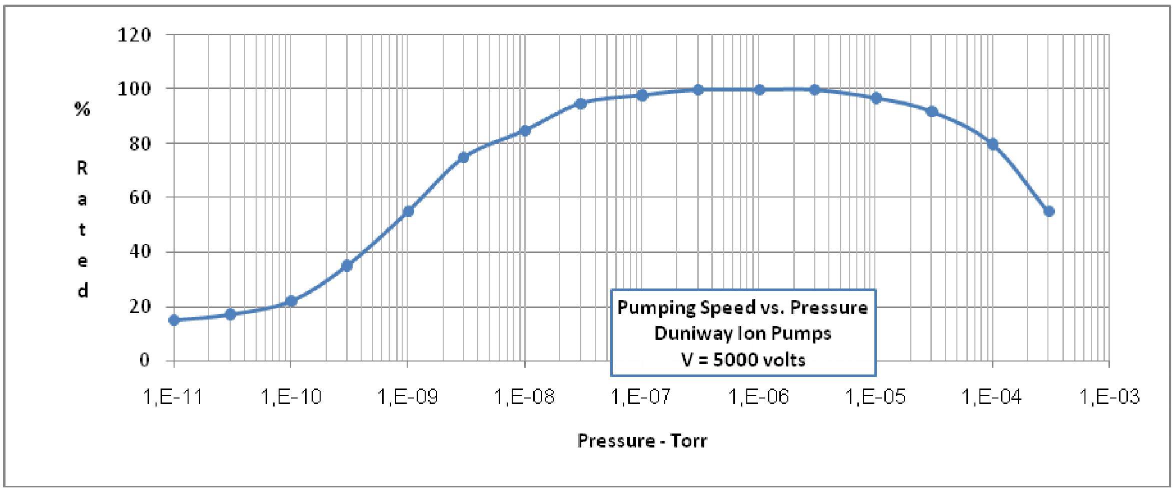
1. **Pumping speed for active gases:** The Galaxy pumping speed and capacity for air, hydrogen and water is the same as for the standard diode (two flat titanium cathodes).
2. **Stability for air pumping:** The Galaxy pumping speed for air is stable for all pressures and extended times measured.

Figure 2 Galaxy Diode Element

3. **Pumping speed for argon:** The Galaxy pumping speed for argon is ~ 10% of its pumping speed For air. This represents ~ 65-70% of the pumping speed for argon of the same geometry DI (Differential Ion), Noble Diode, Starcell or Triode ion pumps. Galaxy operation for argon is stable for all pressures and times measured, except at argon operating pressures above about 2 X 10-5 Torr.
4. **Lifetime:** Accelerated and extrapolated lifetime tests with air and argon indicate that the lifetime Of the Galaxy elements is in the same range quoted for other ion pump element technologies, i.e. 40,000 to 50,000 hours at an operating pressure of 1 X 10-6 torr. Galaxy elements plus new and rebuilt ion pumps are available.

3. Noble Diode/Differential

Another variation for stable pumping of noble gases, is called the noble diode or differential ion pump. In this diode configuration, instead of two cathodes, both made of titanium, one of the cathodes is made of tantalum. Tantalum is a heavier element (atomic weight 181 versus titanium at 48), and thus sputters at a slower rate than titanium. This differential sputtering again shifts the areas of burial and net build-up of sputtered material to an extent which results in stable pumping of noble gases.



Speed is % of Rated Pumping Speed