



VACUUM COMPONENTS

National Electrostatics Corp.

Titanium Sublimators

Applications

Titanium sublimation pumping is ideal for fast pump down and high loads of chemically active gases. A variety of lead designs are available to meet specific space and power.

Complete systems are available which combine the high speed of titanium sublimation with the ability of the sputter ion pump to pump chemically inert gases. A unique hydrogen pump is also available which provides long term pumping of hydrogen without the problems associated with other types of pumps or those previously associated with titanium hydrogen pumping.



High loads of active gases -

The NEC sublimation system was originally designed to handle applications where active gases were being continuously fed into an ultra-high vacuum system. However, the sublimator cartridges can be cycled repeatedly to handle very high bursts of active gases without requiring standby power.

High speed for static systems -

The very high speed of the titanium sublimation system when combined with a small ion pump allows for a very efficient method of pumping a static system well into the ultra-high vacuum range. An individual sublimator is capable of pumping approximately 2×10^9 liters of active gas at 10^{-6} Torr.

Arrays of sublimators are typically used to provide very long lifetimes.

Rapid pumpdown -

Typically, power can be applied to the sublimation system as soon as system pressure has dropped below 50 microns.

Pumping in hostile environments -

NEC sublimation systems are in use in areas that experience intense RF radiation, high pressure insulating gas and occasional power outages. The use of turbo pumps, cryopumps or ion pumps would be very difficult under these conditions.

Principle of Operation

Titanium sublimed from a cartridge condenses on the container wall. Active molecules of gas impinging on the surface are trapped and chemically bound. Inert gases do not react and must be removed by other types of pumps.

Sticking probabilities for oxygen and nitrogen molecules remain high up to combination ratios approaching those of stable compounds. With adequate titanium sublimation, pumping rates for oxygen, nitrogen, carbon monoxide, carbon dioxide, hydrogen and water vapor are very high and are usually limited by the conductance of the throat into the container.

Pumping speeds of a few liters/second per cm^2 of pump wall area are possible and can result in speeds of thousands of liters/second for a modest sized container. A sublimator cartridge contains about 0.4 moles of titanium, enough to pump about 2×10^9 liters of active gas at a pressure of 1×10^{-6} Torr. At 10^{-8} Torr, the pumpable volume is 2×10^{11} liters to provide fast pumping of an active gas over a very long period; more than six years at 1,000 liters/second.

Design

The NEC titanium sublimator is a simple and dependable two terminal cartridge. It is designed to mount in any orientation on a simple support to allow ease of replacement after the cartridge is expended.

A conservatively driven inner element heats the outer titanium cylinder to sublimation temperatures. Radiation from the element transfers heat effectively at even poor vacuum starting conditions, up to 50 microns. There are no undesirable discharges and the performance is not dependent on stable electron beam free path as in electron bombardment type sublimation systems. The heating element lifetime is several times that of the titanium outer shell. In addition, the element is shielded so that as the titanium is expended, there is no direct opening between the heating element and the pumping volume. This prevents burn-through holes in the cylinder wall, which would lead to hotspots that can adversely affect the pumping rate.

This unique design allows a rating of up to 75% usage of the titanium available. Some customers have reported routine usages of up to 90% of the available titanium.

The unique inner structure of the cartridge has an additional benefit in allowing a large number of on/off cycles without standby power. NEC titanium cartridges have been tested to over 800 cycles. This is very useful when the gas load is expected to be periodic.

SPECIFICATIONS

	50g
Available Titanium:	50 grams
Maximum Sublimation Rate:	0.5 gram/hr
Lifetime at Maximum Sublimation Rate:	70 hours
Recommended Container Size:	10" (25.4cm) I.D. 14" (35.6cm) long
Maximum Power Required	750W

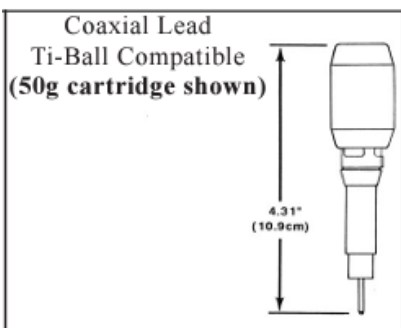
SUBLIMATION RATES AND LIFETIMES

Lifetime based on 75% utilization of available titanium, 90 utilization not uncommon.

	Current (AC amperes)	Average Rate (mg/hr)	Lifetime (hours)
50g	28	5	7000
	31	25	1400
	33	80	440
	36	500	70

CONSUMPTION RATES AND PUMPING SPEED

Gas	Titanium Consumption ¹	Maximum Gas Load ²	Sublimation Rate ³	Typical Pumping Speed ⁴
H ²	5.7	86	500	2100
O ²	8.6	58	500	800
N ²	11.0	45	500	1100



¹ Recommended sublimation rate in milligrams of Ti per atmospheric cm³ of gas (mg/cm³).

² In atmospheric cm³/hour.

³ Recommended sublimation rate in mg/hr for maximum pumping speed.

⁴ In liters/sec for high conductance inlet chamber, 6" (15cm) diameter.

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