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 sublimator cartridge sizes and array designs are available to meet specific space, power and pumping requirements.

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. The sublimators have been demonstrated to over 800 on/off cycles.

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 20 gram sublimator is capable of pumping approximately 2 x 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. For example, a 20 gram sublimator cartridge contains about 0.4 moles of titanium, enough to pump about 2x 10^9 liters of active gas at a pressure of 1 x 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. However, 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.

OPTIONS

Three sizes of titanium sublimator cartridges are available. For applications where minimal power and space are available for pumping, the 10g cartridge is recommended. For requirements where longer or higher levels of sublimation are required, the 20g cartridge is recommended. The largest size is the 50g model, which is a physical replacement for the Varian Ti-ball*.

Standard and customized sublimation systems are available to meet your specific requirements.

ACCESSORIES

NEC provides complete pumping systems with single cartridges or multi-cartridge arrays in custom vacuum housings complete with the NEC titanium sublimation power supply. Typically, the sublimators are used in arrays where multiple cartridges can be used at one time. Switching is done externally without breaking vacuum.

NEC also manufactures a unique titanium sublimator pump for handling large quantities of hydrogen without the difficulties of peeling on the container walls.
Contact NEC for further information.

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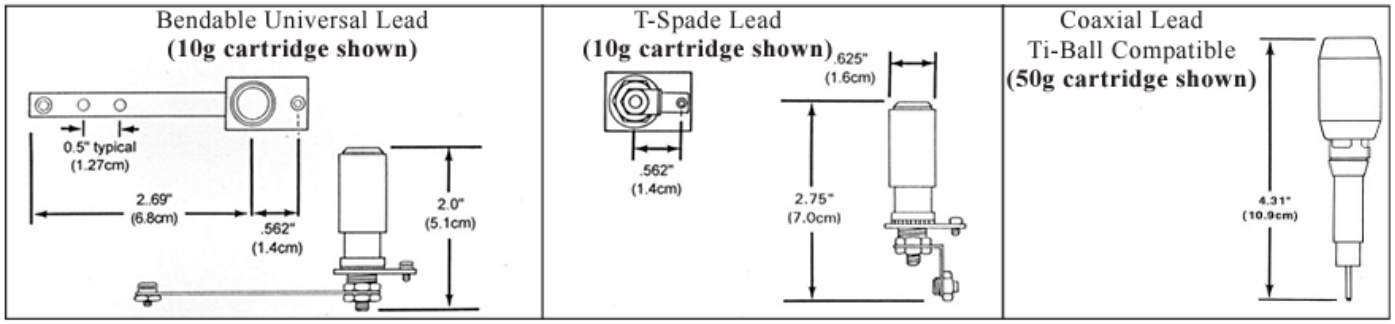
SPECIFICATIONS

	10g	20g	50g
Available Titanium:	10 grams	20 grams	50 grams
Maximum Sublimation Rate:	0.1 gram/hr	0.3 grams/hr	0.5 grams/hr
Lifetime at Maximum Sublimation Rate:	75 hours	50 hours	70 hours
Recommended Container Size:	6” (15cm) I.D. 10” (25cm) long	8” (20.3cm) I.D. 12” (30.5cm) long	10” (25.4cm) I.D. 14” (35.6cm) long
Maximum Power Required	315W	600W	750W

SUBLIMATION RATES AND LIFETIMES

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

Model	Current (AC amperes)	Average Rate (mg/hr)	Lifetime (hours)
10g	15 17 19.3	3 15 100	2500 500 75
20g	30 33 36 39	4 15 60 240	3750 1000 250 63
50g	28 31 33 36	5 25 80 500	7000 1400 440 70



CONSUMPTION RATES AND PUMPING SPEED

Gas	Size	Titanium Consumption[1]	Maximum Gas Load[2]	Sublimation Rate[3]	Typical Pumping Speed[4]
H^2	10 g 20 g 50 g	5.7 5.7 5.7	17.3 52 86	100 300 500	900 1500 2100
O^2	10 g 20 g 50 g	8.6 8.6 8.6	11.7 35 58	100 300 500	350 600 800
N^2	10 g 20 g 50 g	11.0 11.0 11.0	9.0 27 45	100 300 500	500 800 1100

[1] Recommended sublimation rate in milligrams of Ti per atmospheric cm^3 of gas (mg/cm^3).

[2] In atmospheric cm^3/hour.

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

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

Contact NEC

www.pelletron.com +1 (608) 831-7600 nec@pelletron.com

7540 Graber Rd, Middleton, WI 53562-0310 USA