User Guide for Ion Implantation

The alternative low pressure delivery package for pyrophorics, flammables, and corrosives
What is the VAC® package?
The VAC package is a standard, steel alloy compressed gas cylinder which utilizes internal set pressure regulators to dispense gas at sub-atmospheric pressures from the cylinder valve outlet connection. The gas is stored at high pressure just like standard compressed gas cylinder packages and fully compliant with USDOT regulations.

How is the VAC package connected and used on our system?
This package was designed to be installed on a high pressure gas stick. It gets connected like normal gas cylinders, but utilizes a special pin indexed cylinder outlet connector which must be properly oriented when welded to your system (see installation details).

It utilizes a ‘one time use’ metal gasket (nickel 200) connection for high integrity and must be tightened with a torque wrench to 35 ft-lbs. Standard purge/vacuum cycling should be used for installation and removal of cylinders. The connectors and torque wrenches are available from ATMI (see installation details).

How do we measure pressure in the VAC package?
Currently, cylinder pressure cannot be directly measured by the user. However, there are provisions for ATMI to do this.

How do we know when the VAC package is empty?
The VAC package delivers a dynamic pressure of approx. 450 torr, with an equilibrium set point, or closure point of 500 torr. Once the contents are used, you will see the pressure start to decrease from this point. We recommend the installation (or rescaling) of a pressure measuring device to signal the empty condition at 400 torr (7.7 psia). At this point, there is still approx. 800 cc’s of usable gas left in the cylinder so a timely change-out can be scheduled.

How long will the VAC package last?
The standard 1000 gram VAC BF₃ package contains 357 liters of gas. At a process flow of 2 sccm’s, lifetime is expected to be approximately 2975 running hours.

How safe is the VAC package?
At first glance, the VAC package is equivalent in safety to standard high pressure cylinders. However, due to the internally reduced, cylinder outlet pressure, the risk reduction in operating this package has been shown to be approximately 900 times less likely to have an incident/failure than a standard high pressure package, (see the independent 'Fault Tree Analysis' report by Omicron Safety and Risk Technologies, Inc.).

Does the VAC package utilize a restrictive flow orifice (RFO)?
Yes, the VAC package utilizes a 0.25mm (0.010”) RFO for the implant gases.
Will the high pressure regulator and standard flow controllers be a problem?
No, since the VAC package delivers a constant 500 torr, the pressure drop associated with the high pressure regulator and standard flow controller/metering valve won’t inhibit full use of gas in the cylinder. The high pressure gas stick capability is necessary in the event of a VAC package failure. The existing high pressure regulator should be left, preset to its’ normal delivery pressure which is typically 5–15 psig.

What happens in the event of a VAC package failure?
The most probable failure mode for the VAC package is that the set pressure regulators will ‘creep’ or allow gas to pass through instead of closing shut. This result will be full cylinder pressure exiting the cylinder and entering the gas stick. In essence, the VAC package would act like a standard high pressure cylinder.

Why does the VAC package valve look different?
Like standard cylinder valves, there is a primary handwheel for operation and a well labeled outlet connection for the special pin indexed outlet connector. Additionally, there is a safety device mandated by USDOT, a manufacturers tamper proof access/fill port and the associated tamper proof handwheel for use by the manufacturer.

Pressure Measurement
The VAC package delivers a dynamic pressure of approximately 450 torr. This pressure will remain fairly constant throughout the cylinder life. As the overall pressure reaches the set delivery point, it will continue to drop as the gas is used. It is recommended to establish an ‘empty point signal’ at 400 torr. Once this point is reached, there is still approximately 800 cc’s of gas remaining in the cylinder.

The challenge is to provide a 0 – 1000 torr measuring device, which can also withstand potential high pressure exposure. We have found one such device which is listed below (1).

The preferred scheme is to place the pressure measuring device downstream of the existing high pressure regulator on the implant gas stick. This offers yet another layer of protection from potential high pressure.

(1) United Electric – Staset® model EA15. This device incorporates pressure sensing (4 – 770 torr) and a single point contact switch.

Installation Details
The VAC valve outlet drawing shows the specific orientation of the outlet connection. For BF₃ it is SA-B. Pin X should be oriented to the 12 o’clock position for welding to system tubing. This assumes the cylinders stand vertically in the gas box.

Note: Pin B is 170˚ from top dead center (or 10˚ to the right of six o’clock)