Why is Andor's UltraVac™ Process Essential to a Scientific CCD?

A fundamental question for any scientific imaging application is how long the CCD camera will last before the sensor underperforms. Andor have perfected a proprietary Permanent Vacuum Head, essential not only to optimise sensor performance, but to ensure that this performance is retained year after year.
Only Andor have shipped 1000's of vacuum systems over the past 10 years, enabling us to unequivocally substantiate our claims with real data.

Unless protected, Cooled CCD sensors will condense moisture, hydrocarbons and other gas contaminants that will attack the CCD surface. If that happens, CCD performance will decline proportionally and will eventually fail.

Fortunately, the integrity of the sensor can be preserved by housing it in a protective enclosure. However it is important to understand that all such environments are not the same and the underlying technology used can seriously impact camera life – and performance.

UltraVac™

Assembled in a state-of-the-art Class 10,000 cleanroom facility, Andor's UltraVac™ vacuum process combines a permanent hermatic vacuum seal (no o-rings), with a stringent protocol to minimize outgassing, including use of proprietary materials. UltraVac™ is critical for sustained vacuum integrity and to maintain unequalled cooling and QE performance, year after year.

No Leaks
Minimal Outgassing
No Re-pumping
No Maintenance
No Drop in Performance
No Tricks!

Andor UltraVac™ - Permanent Vacuum Head….. Minimal Outgassing… …..Sustained Performance

A permanent hermetic vacuum head is an essential component of high-end imaging and spectroscopy CCD cameras. A permanent vacuum requires not only a hermetic seal, but also low outgassing. These criteria are what Andor's UltraVac™ vacuum process uniquely ensures. **It is the Low outgassing that is the real challenge and, in reality, what sets the real limit on long-term performance.** Andor has developed the UltraVac™ process over more than 10 years, so it is proven with 1000's of systems in the field and a measured Mean-Time-Between-Failure (MTBF) of 100 years; that means it will take 100 years for half of them to fail….and this is based on measurements, not simply because Andor feels 'confident'.

There are no other camera manufacturers with the length and depth of experience on Permanent Vacuum Heads than Andor. We have shipped 1000's of vacuum-sealed systems over the past ten years, and have a MTBF of 100 years based on real data – proven reliability.

Furthermore, Andor's rigorous, proprietary vacuum process is carried out in a Class 10,000 clean room - this means less than 10,000 particles of less than 0.5 micron dimension per cubic meter. The air is fully replenished every minute. We welcome visitors to inspect our state-of-the-art facility.

Benefits of Andor Permanent Vacuum Head

- ✓ Sustained vacuum performance over many years operation – proprietary process to minimize outgassing.
- ✓ Benefit from a thoroughly proven solution. 10 years of shipping vacuum systems to the field and a negligible failure rate - MTBF of 100 years. No one else can make or substantiate this claim with real data.
- ✓ Performance improves because the temperature of the chip can be reduced significantly. Better cooling (down to –100ºC with an enhanced thermoelectric peltier design) translates into substantially lower darkcurrent and fewer blemishes.
- ✓ Such darkcurrent performance is particularly critical to EMCCD technology, where even a single thermal electron is detected as a spurious noise spike.
- ✓ Elimination of condensation and outgassing means that the system can also use only a single entrance window, with antireflection coating – you can believe the QE curve.
- ✓ The permanent hermetic vacuum ensures that peak quantum efficiency and cooling will not degrade, even after years of operation.

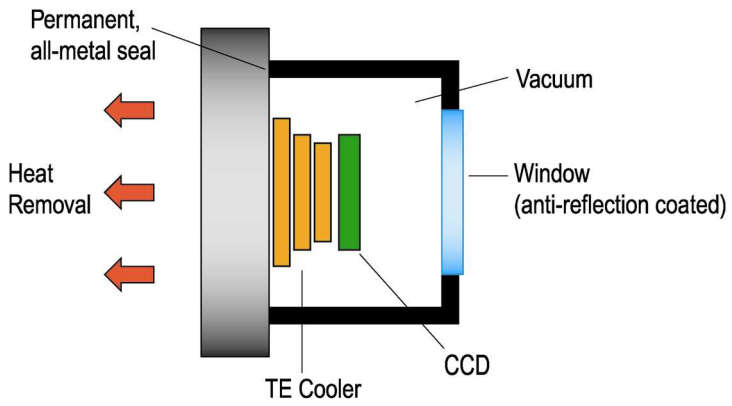

Fig. 1 Diagrammatic cross-section through hermetic sealed vacuum head of metal, glass and ceramic construction. The three stage TE cooler shown here enables cooling to –90°C. A four stage cooler reaches –100 °C. Note the one-window design.

What is Outgassing?

Outgassing is the release of a gas trapped in material. It is a problem encountered in high-vacuum applications. Materials not normally considered absorbent can release enough molecules to contaminate vacuums and damage with optical sensors or window coatings. Even metals and glasses can release gases from cracks or impurities, but sealants, lubricants, and adhesives are the most common cause. Left unchecked, cooling performance and therefore darkcurrent would steadily degrade. Furthermore, resulting electrochemical reactions would eventually destroy the CCD.

O-rings and inert gas simply won't do!

A strategy adopted by some CCD manufacturers is to place the CCD sensor inside a simple 0-ring sealed metal housing, settling for an inert gas environment rather than a vacuum. Ridiculously, to protect the sensor from moisture in this configuration, some manufacturers even go as far as placing silica gel bags inside the dewar— it is ludicrous to imagine that this makeshift solution would protect a state-of-the-art sensor at sub-zero temperatures!
Not only is this method of sealing ineffective, and cooling performance significantly compromised, but levels of outgassing from plastic and o-rings is substantial. These materials cannot be effectively purged of these gases, which is why o-rings should only ever be used in actively pumped systems. In such systems, one solution to the outgassing problem is to use sensors with extra protective windows, usually added in a dry gas environment. As a result, the windows cannot be antireflection-coated since the coating would simply degrade with time. With this type of imager, the "stated" peak quantum efficiency should be downgraded by at least eight percent. Even then, moisture etc. will continue to build up on the window, ultimately obscuring the image. The system will require vacuum pumping, which means sending the camera back to the manufacturer on a regular basis.