www.sge.com

TECHNICAL ARTICLE

TIPS for optimizing Multiplier Lifetime

ETP Electron Multipliers

Kevin L. Hunter, Ph.D. Research Scientist

Electron Multipliers are extremely sensitive, high performance devices. Their working lifetime may be affected by a number of operational and system parameters such as handling techniques, operating gain, pressure and composition of residual gasses.

This article is intended as a working guide for scientists and laboratory technicians for obtaining the best possible operating life and long term gain stability from their electron multiplier.

NOTE: *ACTIVE FILM Multipliers™* are no more susceptible to contamination than other types of electron multipliers. The procedures outlined here apply equally to all detectors. Many commercial mass spectrometers and other instruments do not, in fact, incorporate oil free pumping systems because of cost.
ACTIVE FILM Multipliers™ will typically last from 35% to 100% longer than conventional Channel Electron Multipliers (CEM) detectors in these applications.

Storage and Handling

ACTIVE FILM Multipliers™ can be stored in their original packaging for a guaranteed period of two years from ETP's shipping date. If you need to store the multiplier after it has been removed from its original packaging, it should be kept in a dust free, dry environment. Ideally it should be stored in a glass desiccator containing Silica Gel.

When handling an *ACTIVE FILM Multiplier™* it must be treated as a clean, high-vacuum component. Use normal high-vacuum handling methods to keep the multiplier clean and free of contamination. Always use gloves when handling an electron multiplier; disposable powder free plastic gloves are best, although clean, lint-free cotton gloves may also be used.

Installation and Initial Operation

Care should be taken to minimize exposure of the multiplier to airborne particles such as dust or lint. When installing a multiplier leave it in its sealed plastic cover until you are ready to place it in the vacuum system.

Avoid exposing the multiplier to high humidity environments, as this can result in noisy operation. If the multiplier is exposed to high humidity it can be dried by baking it in vacuum for 3 hours at 250°C. If baking is carried out in air the temperature should be limited to 150°C.

Although *ACTIVE FILM Multipliers™* require no pre-conditioning, it is recommended that the applied high voltage not exceed 2.2kV for the first day of operation. This allows time for the multiplier to become totally settled in the vacuum system before being stressed.

The Vacuum System

The principal aging mechanism for an electron multiplier is the "*stitching*" of hydrocarbon contaminants in the vacuum onto the high gain surfaces of the multiplier[1] during use. By removing or reducing the partial pressure of hydrocarbon contaminants in the vacuum, this mechanism of gain loss can be slowed significantly.

The main source of hydrocarbon contaminantion is usually the pumping system. Backstreaming rotary pump oil is a recurring culprit for introducing contaminants into the vacuum chamber (even in systems incorporating turbomolecular pumps). A foreline trap between the rotary backing pump and the main (turbo or diffusion) pump is recommended. An ***oil-free*** pumping system gives the best results.

In diffusion-pumped vacuum systems, chilled baffles above the diffusion pump will prevent pump oils from entering the vacuum chamber, and extend multiplier operating life.

How effective these steps are in extending multiplier life for a particular system, depends on how *"dirty"* the system was initially, and on how effective the trapping measures are in removing the contaminants. This, of course, will vary from system to system, so it is difficult to make a quantitative prediction. However, we can say with certainty that: *the cleaner the vacuum system, the longer the multiplier will last.*

It is important to note that hydrocarbon contamination that is bonded to the high gain surfaces of the multiplier while it is operating **cannot** be cleaned off and any resultant damage is permanent. If contamination occurs while the multiplier high voltage is turned off, the multiplier may be cleaned provided it is **not operated** before cleaning. Refer to ETP application note PD-0223-A for details of cleaning procedures[2].

If the vacuum accident involves the multiplier high voltage being left switched on when the chamber pressure rises above $1x10^{-3}$ mbar, then the high voltage on the multiplier will cause a glow discharge to occur. In this case the active surfaces are irradiated with an extremely high flux of electrons, effectively using up the multiplier's life in just minutes. Multipliers that experience this situation usually do not recover and must be replaced or refurbished.

Multiplier Operation

During normal operation, the rate at which a multiplier is "used up" depends directly on the rate at which electron charge is drawn at the multiplier output.

The electrical current, $\boldsymbol{I}$, seen at the output of the multiplier is determined by:

$$I = q\,N\,G$$

where $\boldsymbol{q}$ is the charge on an electron, $\boldsymbol{N}$ is the number of ions per second being detected, and $\boldsymbol{G}$ is the gain of the multiplier. So, the amount of electrical current supplied by the multiplier is directly related to the number of ions detected, and the operating gain of the device.

Consequently, if a multiplier is operated at higher gain than is required for good signal-to-noise, then its life will be used up more quickly than it would be if it were operated at a lower gain. For example, if the ion count rate remains constant and the multiplier gain is increased by a factor of 2, its output current will be twice as large, and it will be used up at twice the previous rate.

This effect can be particularly dramatic in pulse-counting systems. In pulse-counting applications, good detection efficiency occurs when the large majority of output pulses from the multiplier are above the set threshold of the detection electronics. For longer multiplier life it is desirable to operate at as low a gain as possible while maintaining sufficient pulse amplitude to exceed the threshold of the detection electronics. In this case, the optimal operation is obtained by setting the threshold as low as possible without increasing the background noise level. This will allow good detection efficiency to be obtained while operating the multiplier at the lowest practical gain.

References

1. ETP Publication TA-0072-A, *"The Aging Mechanism in Electron Multipliers and Operational Life"*, 42nd ASMS, Chicago, 1994.

2. ETP PublicationTA-0098-A, *"Maintenance, Storage and Handling of ACTIVE FILM Multipliers"*, 1994.

Visit www.sge.com to download a free copy.

A DIVISION OF SGE GROUP OF COMPANIES

SGE International Pty. Ltd.
Tel: +61 (0) 9837 4200
Fax: +61 (0) 9874 5672
Email: techsupport@etpsci.com

SGE, Incorporated (USA)
Toll Free: (800) 945 6154
Fax: (512) 836 9159
Email: usa@sge.com

SGE Europe Ltd
Tel: +44 (0) 1908 568844
Fax: +44 (0) 1908 566790
Email: uk@sge.com

ETP Electron Multipliers
www.etpsci.com

www.sge.com