Ion Feedback

This Document should give an overview to the causes, behavior and damages of Ion Feedback within the Multi-Channel-Plates (MCP) of image intensifiers. Image intensifiers consists of the photocathode, the MCP and a phosphor screen and are one of the core elements of intensified CCD (ICCD) cameras.

What causes ion feedback?

The **ion feedback effect** within the Micro Channel Plates (MCP) is caused by the growing electron avalanche as it is propagating through the MCP-channel. On its way through the channel the electrons hit the channel wall to extract more and more electrons. Due to an increasing electron avalanche atoms from residual gas or adsorbed atoms on the channel wall can be ionized. The ions then are accelerated by the MCP bias voltage towards the photocathode. These free, moving ions are called ion feedback.

What damage is aimed by ion feedback?

Accelerated ions within the MCP channel can either hit the channel wall or move all the way through the channel to the image intensifier photocathode. When the ion hits either, it does create a secondary electron avalanche. This artificial signal is considered as “ionic”-noise. The accelerated ions can achieve enough energy to release electrons many more electrons than a incoming photon. This lead to a second electron avalanche and hence to locally increased signal on the ICCD camera which is usually huge compared to the singnal produced by a single photon. The artificial signal is considered as “ionic”-noise. Moreover, the ion feedback could damage the photocathode and decrease the intensifier’s sensitivity over time.

How to avoid ion feedback?

During the last decades, the evolution of image intensifiers involved techniques to reduce the ion feedback effect. The ion feedback effect was reduced by using shorter channels and with slightly tilted channel arrangement against the bias field direction. So, the averaged free moving distance was reduced and, therefore, the energy of the ions at the collision is reduced. Furthermore, several MCP stages are stacked in such a way that the relative angle between pores is maximized for neighboring MCP. This condition is fulfilled in so-called “Chevron or V-stack” (2 MCPs) or “Z-stack” (3 MCPs) configuration. Image Intensifier of the 3rd Generation (GenIII) are using an ion barrier film in front of the photocathode to prevent damage to the photocathode caused by ion feedback. Though, the ion barrier

Europe: Paul Hoess KG
Entenbachstr. 14., 81541 Munich, Germany
Phone: +49 (89) 652029, Fax: +49 (89) 654817
E-mail: europe@stanfordcomputeroptics.com

USA: Stanford Computer Optics, Inc
780 Cragmont Avenue, Berkeley, CA 94708 - USA
Phone: (510) 527-3516, Fax: (510) 558-9582
E-mail: info@stanfordcomputeroptics.com

film reduces the total quantum efficiency of the image intensifier, because a significant amount of the photo electrons - usually more than 50% - is flowing to ground potential after the photocathode via this protection film.

Considerations for the image intensifier selection

The way an image intensifier and a ICCD camera performs depends on the overall amount of light, the contrast within the scene, the temporal dynamics and the spectral characteristics of the illumination. On the other hand the performance of a image intensifier and ICCD camera is described with the signal to noise ratio (SNR), the limiting resolution (lp/mm) and photocathode sensitivity and quantum efficiency.

The consideration of the ion feedback effect and therefore the “ionic”-noise has a major impact in performance of image intensifier. Especially, in a low light environment the double MCP stage raise the image quality of an ICCD camera significantly. This environment also supports the increased gain of the double MCP stage. For further information on the image intensifier selection Stanford Computer Optics provide detailed consulting for the image intensifier selection.

Technical Note Download:
http://www.stanfordcomputeroptics.com/download/ion-feedback.pdf

Europe: Paul Hoess KG
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