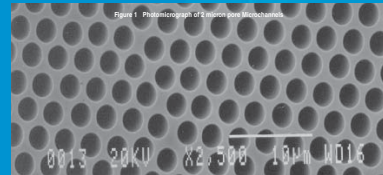


The Development of Novel Microchannel Plates for Analytical Instrumentation Applications

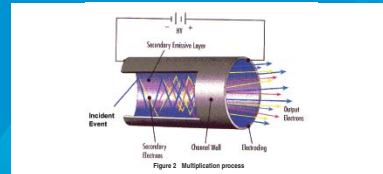
Bruce N. Laprade, William Netolicky and Reginald Farr

Background

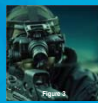
Microchannel Plates (MCPs) are solid state detectors consisting of parallel arrays of tiny single channel electron multipliers all fused together in a parallel array. Channel densities are typically 1 – 10 million channels per cm² (Figure 1). These devices can be used to detect Ions, Electrons, UV Photons, and soft and hard X-Rays.



In operation, an input event (ion, electron, photon etc...) impinging on the focal plane will trigger an avalanche of electrons resulting in an amplification factor of up to 100,000. Cascading a second or third array can result in an amplification factor of up to 100,000,000 with less than 1 count/sec/cm² added noise. (Figure 2).



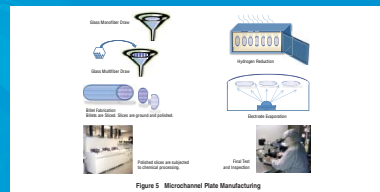
Microchannel Plates were originally developed for use in image intensifier tubes for night vision applications. (Figure 3).



Today, the 18mm round format for night vision is the most widely produced format, but MCPs can be produced in a wide variety of shapes and sizes ranging from 2 mm – 160 mm. (Figure 4).



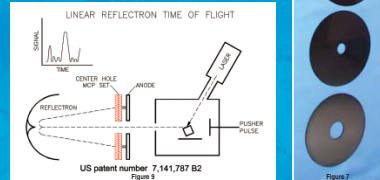
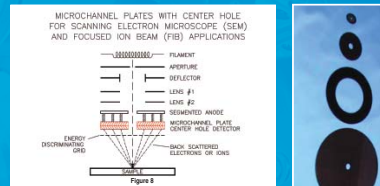
Novel Fabrication



Microchannel Plates can be fabricated (Figure 5) in large wafers (Figure 6) and then formed in complex shapes by diamond milling, laser cutting or laser ablation.

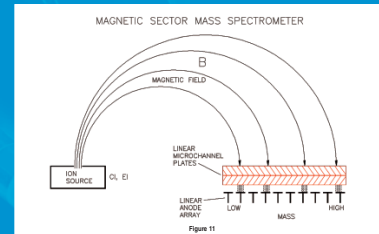
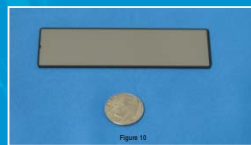
Microchannel Plates can be shaped to match focal planes and optimize the detection efficiency.

Microchannel Plates can be fabricated with center holes (Figure 7) which enable through plate sample interrogation.

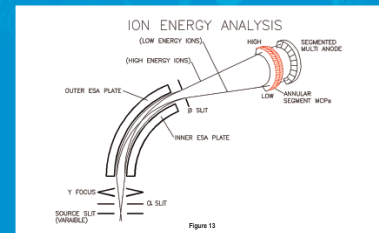
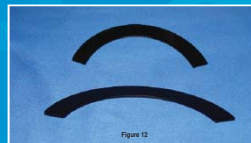


This capability is especially useful for Scanning Electron Microscope (SEM), Focused Ion Beam (FIB) and Linear Reflectron Time-of-Flight Mass Spectrometry. (Figures 8 and 9).

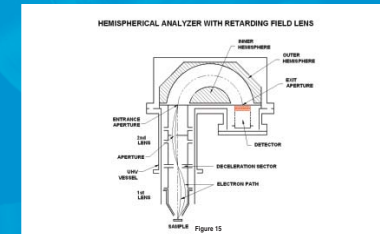
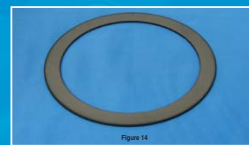
Narrow Arrays (Figure 10) are ideal for use in Magnetic Sector Mass Spectrometers. (Figure 11).



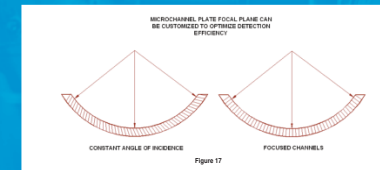
Microchannel Plates fashioned in Arc Sections (Figures 12) are ideal for use as the detector in an ion or electron energy analyzer. (Figure 13).



Annular Ring Staped Microchannel Plates (Figure 14) are ideally suited as the detector in a Hemispherical Energy Analyzer system. (Figure 15).



Microchannel Plates need not be flat. They can be spherically (Figure 16) or cylindrically curved in order to match the focal plane of the instrument. This is especially useful in Vacuum Ultraviolet Spectrometers where the radius of curvature can be matched to the Roland Circle. (Figure 17).

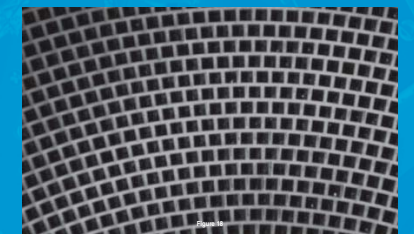


Micro Pore Optics

Highly Specialized Microchannel Devices known as Micro Pore Optics have been developed which consist of millions of square channels arranged in a well defined order. (Figure 18).

The surfaces inside the square channels have a near perfect flatness and a very low roughness.

X-Ray and UV photons can be focused, concentrated or collimated by virtue of total internal reflection at grazing incidence angle inside the micro pore channels.



Summary

Microchannel Plates can now be fabricated in sizes ranging from 2 – 160 mm.

The advent of diamond milling and laser cutting and laser ablation has enabled complex shapes to be easily fabricated.

Microchannel Plate geometries including centerholes, annular rings, rectangular arc segments and trapezoidal formats have been produced.

Trapezoidal segments are useful in creating very large area Mosaic detectors.

Microchannel Plate geometries are limited only by the imagination of the instrument designer.

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660 Main Street • Post Office Box 1159
Sturbridge, Massachusetts 01566-1159
sales@usa.photonis.com • www.photonis.com
+1 (508) 347-4000