Extreme surface area microchannel plate device fabricated with ALD

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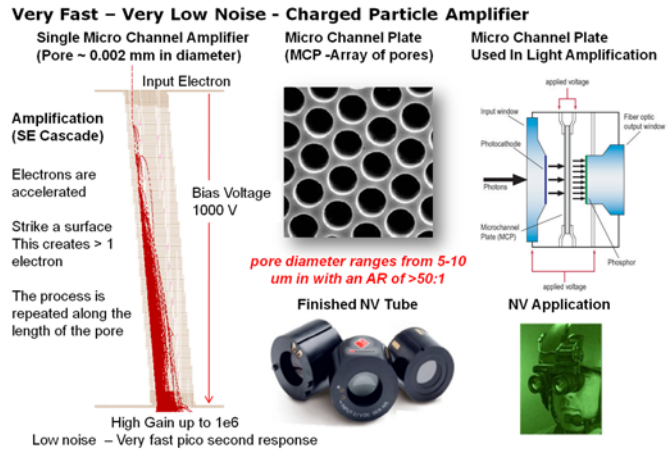
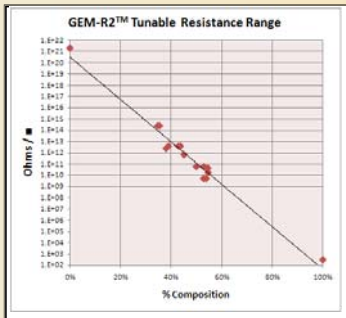
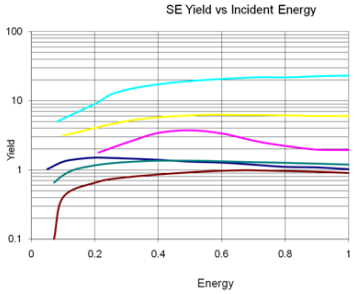
Microchannel Plate Overview



Commercial MCP technology is the result of decades of work with lead-glass, fiber optics, fundamentally unchanged from 1970. Functionalization requires high temperature, hydrogen reduction of the pore surface, forming electrically active, conductive and secondary electron (SE) emissive layers, neither of which can be optimized independently. With the development of ALD nanofilms it is possible to independently tune the MCP mechanical, resistive and emissive properties for very large surface area devices at a fraction of the cost of existing commercial technologies. ALD nanofilm technology is enabling significant opportunities in the Scientific, Medical and Homeland Security market places.

ALD Nanofilms*: Conductive & Electron Emissive





Conductive nanofilms
- Zn doped CuO formed in a nanolaminate structure with alternating layers of Al_2O_3
- Pt nanoclusters formed within an Al_2O_3 nanoalloy

Emissive nanofilms
- Thin, conductively doped Al_2O_3
- Thin MgO
- Thin MgO – TiO_2 nanolaminate

*Technology Covered by U.S. Patent Nos. 5,729,244; 6,522,061; 7,408,142; 7,759,138; 7,855,493; 8,052,884; 7,977,617 and 8,134,108 and other Pending U.S. and Foreign Patents.

Experimental Method: GEMStar-8 ALD Equipment

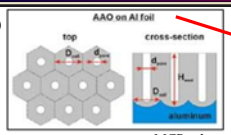
GEMStar-8 system is designed for extreme surface area, high aspect ratio structures: Multi-channel precursor delivery system isolates & distributes precursors combine with a tapered exhaust to provide exceptional nanofilm uniformity.

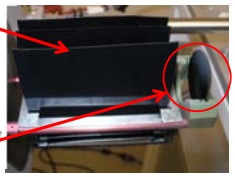
The differentially pumped system seals eliminate gas permeation which along with separate and actively heated Oxidant and Metal-Organic manifolds eliminate parasitic nanofilm production.

Metrology Interface for QCM, ellipsometry , FTIR, OES and room for up to six high capacity precursor cylinders (2 heated) with 2 independent gas lines, maximizes system productivity.

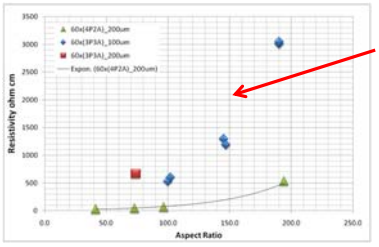
Experimental Method: Process Development

Suface Area Surrogate: (AAO)
Anodized Alumium Oxide:
- 2- sided
- 60mm²
- 50nm diameter pores
- 251 nm pore pitch
- 50µm pore thickness



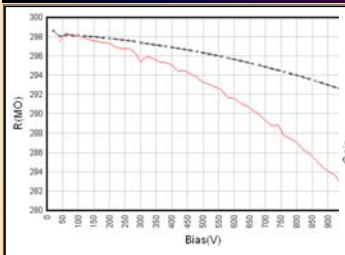


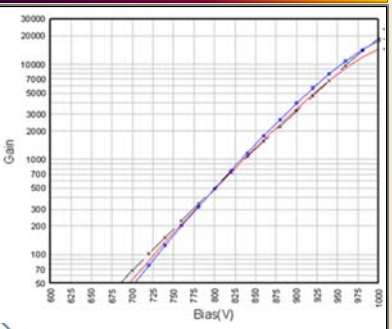
MCP substrate placement

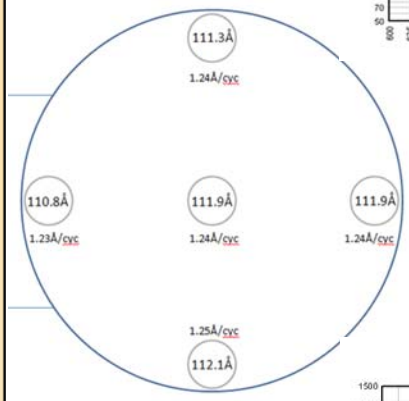


AAO aspect ratio (AR) 300:1 (MCP=60:1)
•Electrical & process characterization for AR Penetration of conducting film into fiber optic structures of constant diameter & varying length. The resulting resistance measurements demonstrate ALD nanofilm capability for coverage into ARs exceeding 200:1
•Mechanical assessment, using specialized fiber optics and index matching, optically locating the depth of penetration. Internal fiber diameter (pore width) is 14.9µm and the length of penetration is measured to be 4803µm, resulting in AR coverage of 322:1.

Results



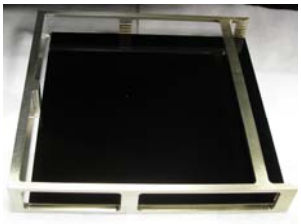




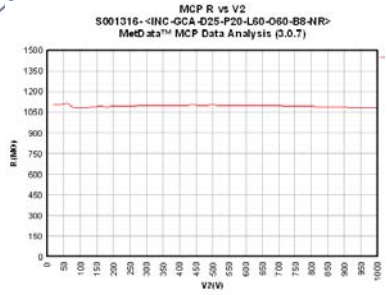
Graph Above Left :
R of AAO surrogate process test MCP.

Graph Above Right:
MCP Gain of single & multiple AAO surrogate runs shows equivalent performance of extreme surface area MCP run. All test MCPs: 20um pore, 60:1, 25mm diameter

Figure Left:
Sample measurements locations and results for 200mm nanofilm uniformity and growth rate test



Fully processed 8" MCP



1 GΩ R of Pilot MCP Processed alongside 8" MCP
Provides R of 10 MΩ for 8" equivalent resistance

Summary

Building on research using conventionally sized MCP devices, MCP performance has been demonstrated using conductive and emissive ALD nanoalloy and nanolaminate films, incorporating surface areas in excess of 8.3 m^2 for MCP devices with aspect ratios in excess of 60:1. In addition to independent tuning of device properties, we have demonstrated capability for film uniformity across a 200mm substrate. These results establish the capability to achieve exceptional MCP device performance (high gain, long lifetime) in the extreme surface area and aspect ratio environment.

Acknowledgements

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