Advances in Microchannel Plates and Photocathodes for Ultraviolet Photon Counting Detectors

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ABSTRACT

A new method of fabricating microchannel plates has been investigated, employing microcapillary arrays of borosilicate glass that are deposited with resistive and secondary emissive layers using atomic layer deposition. Microchannel plates of this kind have been made in sizes from 33 mm to 200 mm, with pore sizes of 40 µm and 20 µm, pore length to diameter ratios of 60:1, bias angles of 8°, and open areas from 60% to 83%. Tests with single MCPs and MCP pairs have been done and show good imaging quality, gain comparable to conventional MCPs, low background rates (~ 0.085 events sec^{-1} cm^{-2}), fast pulse response, and good ageing characteristics. The quantum efficiency for bare and alkali halide coated MCPs is similar to conventional MCPs, and we have also been able to deposit opaque GaN(Mg) cathodes directly onto these MCPs.

Keywords: Microchannel Plates, Imaging, Photon Counting, Photocathodes.

1. INTRODUCTION

Microchannel plates (MCPs) have been used as electron multipliers for many decades and are particularly useful in imaging photon counting detector schemes[1-8] for applications in a wide variety of fields. MCPs can be used in open face detectors and in sealed tube sensors at high vacuum with photocathodes[9] for detection of charged particles, neutrons and photons in both analog and event counting modes. Sensors with MCPs have beeen constructed with spatial resolution as small as 5 µm, event time recording down to ~ 10 ps, with background rates of < 0.03 events cm^{-2} sec^{-1}, gain up to 10^8, lifetimes of up to 10's of Coulombs cm^{-2}, quantum efficiency of >60%, and formats of up to 150 mm. The basic methodology for fabrication of MCPs[8] has changed very little for many years. Glass filled glass tubes (proprietary lead glass compositions) are made and drawn down to small sizes in a furnace, cut, stacked and fused into hexagonal bundles, which are sometimes drawn down again, and stacked together then fused to form a block. This is cut into slices at a set bias angle, then polished. The core glass is subsequently etched out, and the clad glass is reduced in a hydrogen furnace to produce surfaces with high secondary emission coefficient and to make the MCP resistive (MΩ). Lastly the top and bottom surfaces are coated with a metal layer (usually NiCr) to allow a high voltage to be applied across the MCP. Although this process is highly successful it can also lead to problems in some performance parameters[9,10] and can be quite expensive for some custom and large MCP configurations. Alternate solutions for fabrication of MCPs have been investigated for many years, including silicon[11] based MCPs and anodic alumina[12] MCPs. These have had