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A novel atomic layer deposition method to fabricate economical and robust large area microchannel plates for photodetectors

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Microchannel plate (MCP)-based photodetectors have a combination of unique properties like high gain, high spatial resolution, and high temporal resolution. They can be used in wide variety of applications including imaging spectroscopy, photo detectors, astronomy, Time-of-Flight mass spectrometry, molecular and atomic collision studies, and cluster physics. The same MCP-based technology is used to make visible light image intensifiers for night vision goggles and binoculars. We demonstrate a cost-effective and robust method to fabricate large-area microchannel plate (MCP) detectors, which will open new prospectives in larger area MCP-based detector technologies. For the first time, using our newly developed process flow we have fabricated large area (8"x8") MCPs. Among the various thin film processes we have selected atomic layer deposition (ALD) for functionalizing borosilicate (non leaded) glass capillary arrays as a route to fabricate cost effective MCPs. ALD provides exquisite thickness control and conformality using sequential, self-limiting surface reactions between gaseous chemical precursors and a solid surface to deposit films in an atomic layer-by-layer fashion. This strategy yields monolayer-level thickness and composition control as well as continuous, pinhole-free films. The self-limiting aspect of ALD yields conformal deposition on very high aspect ratio structures such as MCP pores. ALD processing is also extendible to very large substrates and batch processing of multiple substrates. All of these ALD process capabilities are important for the fabrication of clean, batch-to-batch reproducible, economical, fully functionalized large area MCPs. The self limiting growth mechanism in ALD allows atomic level control over the thickness and composition of resistive and secondary electron emission layers that can be deposited conformally on high aspect ratio capillary glass arrays. We have developed several robust and reliable ALD processes for the resistive coatings and secondary electron emission (SEE) layers to give us precise control over the resistance (106-1010Ω) and SEE coefficient (up to 5). This novel approach allows the functionalization of microporous, insulating substrates to produce MCPs with high gain and low noise. These capabilities allow a separation of the substrate material properties from the electronic properties. Here we will discuss a complete process flow to fabricated working large area MCPs.

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