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Development of an alkali transfer photocathode for large area microchannel plate-based photodetectors

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Abstract

The goal of the Large Area Picosecond Photodetector collaboration is to produce 8-inch by 8-inch microchannel plate-based photodetectors, with fast timing resolution of the order of 1-100 ps and high spatial resolution of 0.1-10 mm. At Argonne, the transfer photocathode process being developed is based on a recipe for manufacturing photomultiplier cathodes. Starting with a commercial PMT fabrication facility, the photocathode recipe and growth system will be scaled up using a custom-built glass vessel to produce transfer photocathodes. This leads to the production of the 8-inch by 8-inch photocathode that will be incorporated with the photodetector assembly system.

Alkali photocathode; transfer photocathode; large area photodetector; visible light photodetector

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1. Introduction

There are several motivations for the need to develop a new generation of large-area, high-gain photodetectors. This includes the need for inexpensive, fast, high resolution photodectectors in medical applications and scientific research, particularly for very large water Cerenkov detectors used in high energy physics [1]. Recent advances in materials science and high speed electronics have opened the doors for the production of such photodetectors. The Large Area Picosecond Photodetector (LAPPD) project [2] is a multi-disciplinary, multi-institution effort whose goal is to produce large (8 inches by 8 inches), flat, fast, photodetectors that can be tiled together to form large area arrays. The microchannel plate (MCP)-based photodetectors are designed to have time resolutions of the order of 1-100 picoseconds and spatial resolutions of the order of 0.1-10 millimeters. A schematic layout of a photodetector tile is shown in Figure 1.

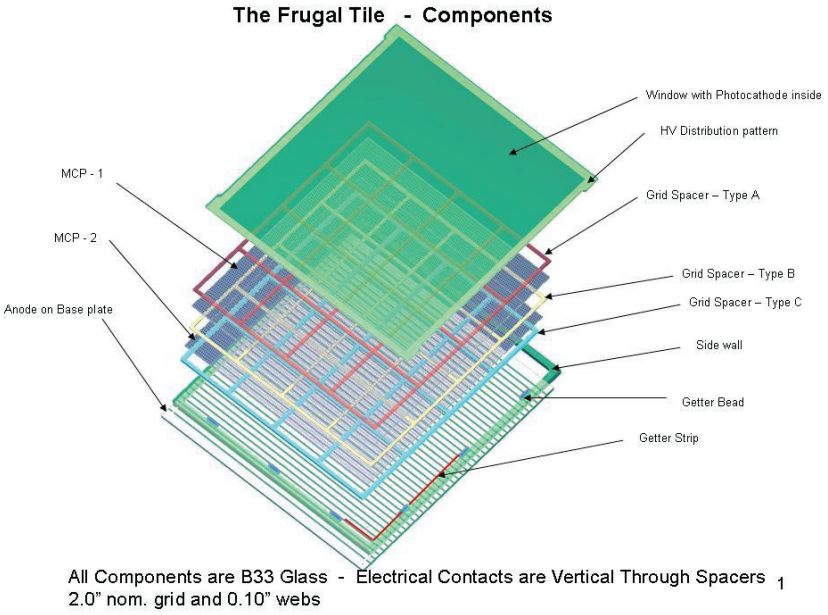

Figure 1. Schematic construction of the LAPPD photodetector tile. The photocathode is on the inner surface of the top window, shown in green at the top of the drawing..

An essential component of the photodetector is the photocathode. In the LAPPD project, the goal is to produce a transfer photocathode [3] with a quantum efficiency (QE) and dark-current comparable to commercial tubes (20-25% QE, dark current ~100-1000 electrons/sec/cm^2), a long lifetime, and a spatial uniformity of better than 5%. A longer-term goal is the further development of photocathodes with QE greater than 50%.

The photocathode development within the LAPPD collaboration consists of two parallel efforts. One of these is being carried out at the Space Science Laboratory, University of California-Berkeley [4]. That