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Constructing Microchannel Plates from Thin Patterned Laminae

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We have proposed a method of construction and simulated the performance in TOPAS [1] of large-area microchannel plates (MCPs) assembled by stacking thin, patterned laminae on edge to form laminar microchannel plates (LMCPs^{TM}) [2]. The laminae are first patterned with channels of arbitrary shape and size so that when stacked, they form pores as in a traditional MCP. The laminae are typically coated with resistive and secondary-emitting materials to support electron multiplication in the pores, and since they are coated before stacking, methods other than atomic layer deposition (ALD), such as chemical vapor deposition (CVD), can be used. Functionalization of the pores is completed before stacking, introducing additional parameters for controlling the shower development, for example, non-uniform resistivity and customized voltage differences between strike surfaces along the pore. Unique slab geometries are also possible: The LMCP can be non-planar, allowing curved surfaces in both lateral dimensions. The laminar construction creates the possibility of incorporating structural elements in the LMCP for modular assembly in large-area arrays.

The LMCP construction allows for the use of substrates optimized for the direct conversion of various incoming particles to electrons in the bulk. For example, LMCPs built from thin laminae of high atomic number (high-Z) material, like lead glass, can be used in gamma ray detection via surface direct conversion. TOPAS simulations predict an efficiency for conversion of 511 keV gamma rays of $\geq$ 30% for a 2.54 cm-thick lead-glass LMCP. Large arrays of LMCPs would provide high resolution space and time measurements in searches for kaon and rare η decays and in shower-max detectors at the LHC and EIC. Since conversion happens in the bulk, a photocathode is not necessary, allowing assembly at atmospheric pressure and packages with reduced vacuum requirements.

[1] B. Faddegon, J. Ramos-Mendez, J. Schuemann, J. Shin, J. Perl, H. Paganetti, *The TOPAS tool for particle simulation, a Monte Carlo simulation tool for physics, biology and clinical research*, Eur. J. Med. Phys. 72 (2020) 114-121.

[2] K. Domurat-Sousa, C. Poe, H. J. Frisch, B. W. Adams, C. Ertley, N. Sullivan; *Surface Direct Conversion of 511 keV Gamma Rays in Large-Area Laminated Multichannel-Plate Electron Multipliers*; Nucl. Instr. and Meth. A, v. 1055, Oct. 2023, 168538.

Early Career

No

Primary author: DOMURAT-SOUSA, Kepler (Enrico Fermi Institute, University of Chicago)

Co-authors: POE, Cameron (Enrico Fermi Institute, University of Chicago); FRISCH, Henry (Enrico Fermi Institute, University of Chicago); ADAMS, Bernhard (Quantum Optics Applied Research); ERTLEY, Camden (SouthWest Research Institute); SULLIVAN, Neal (Angstrom Research, Inc.)

Presenter: POE, Cameron (Enrico Fermi Institute, University of Chicago)

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