Contribution ID: **84** Type: **Poster Presentation**

Investigation of the secondary electron emission characteristics of alternative dynode materials for imaging photomultipliers

Wednesday 14 September 2011 09:00 (1 hour)

The requirement to accurately detect and image very high speed photon events is crucial for many applications across a range of disciplines. Photon imaging detectors often make use of the planar geometry of MCP' s for high resolution imaging. However, the inherent rate limitations of MCP's provide opportunities for discrete dynode devices where rapid recharge times and high throughput are required. Non-conventional dynode materials and designs offer the possibility to further improve event time resolution and pulse height distribution.

Significant performance advantages can be achieved by increasing the gain of each dynode stage by utilizing less conventional materials such as CVD diamond. Secondary electron emission (SEE) coefficients for polycrystalline CVD diamond have been reported as 45 for Hydrogen terminated surfaces [1] and >80 for Cs terminated surfaces [2]. These values are far in excess of currently used materials such as AgMgO(Cs) and CuBeO(Cs) which have SEE coefficients <15 [3].

Polycrystalline diamond is a widely available, relatively inexpensive material that can be deposited over large areas on appropriate substrates, making the manufacture of large format imaging detectors a practical possibility.

The application of new dynode designs for imaging photomultipliers requires knowledge of the secondary electron emission characteristics of the material. We describe a facility to measure the relevant characteristics of novel dynode materials and designs with 2D imaging capability, and discuss the significant challenges, intricacies and complexities involved with SEE coefficient measurements. We present secondary electron emission measurements for a variety of dynode materials and designs and discus their application in imaging photon-counting devices.

[1] Lapington et al. Nucl Instrum Meth A 610 (2009) 253-257
[2] Yater et al. J Vac Sci Tech A 16(1998) 913
[3] Photonis PMT handbook

Preferred medium (Oral/poster)

Poster

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Session Classification: Poster Session