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Position Sensitive Radiation Detector Based on Glass Gas Electron Multiplier with Pulse Counting System for Beta Ray Imaging

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Beta-ray imaging is now widely employed for autoradiography of living plants. Developing a cost-effective real-time imaging system for such applications remains challenging, given the requirements of low-energy detection, large sensitive areas, immunity to ambient light, and energy-resolving capabilities. Gas Electron Multiplier detectors (GEMs) show great promise in meeting these needs. In this study, a Glass Gas Electron Multiplier (G-GEM)-based imaging system was developed for beta-ray imaging using photosensitive etchable glass substrate. The system incorporated 2D individual strip-pad electrodes with a 500 μm pitch, along with a multiplexer-based pulse counting system for efficient data collection. The drift gap and induction gap were optimized at 5 mm and 3 mm, respectively. The detector system was operated with an Ar/CH4 gas mixture at a flow rate of 20 mL/min, a pressure of 0.1 MPa, and at room temperature. The effective gain and energy resolution were characterized based on the 5.9 keV mean peak and escape peak of the 55Fe energy spectra. The G-GEM achieved an impressive single-stage effective gain of 47,000, and the optimum energy resolutions were around 18% Full Width at Half Maximum (FWHM). Beta-ray imaging demonstration was conducted using metal objects with a 90Sr beta emitter placed at 216 mm in front of the cathode. The detector demonstrated its capability to accurately reconstruct differences in the shape and thickness of objects. These results highlight the promising potential of the G-GEM as a beta-ray imaging system.

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