Recently, atomic layer deposition (ALD) technology has emerged as a disruptive method that shatters the conventional paradigms of traditional lead-silicate glass microchannel plates (MCPs).

This study reports on the comprehensive performance evaluation of novel ALD-MCPs, demonstrating their revolutionary potential for diverse applications, including quantum beam experiments, space missions, and rare-event searches.

Our experimental results revealed that ALD-MCPs, fabricated using low-Z borosilicate glass, successfully suppressed the gamma-ray background to one-tenth of that of conventional MCPs.

Furthermore, they exhibited exceptional vacuum ultraviolet (VUV) detection efficiency comparable to CsI-coated MCPs, while completely eliminating the issue of deliquescence, ensuring robust long-term stability.

The ALD-MCPs also showed capabilities for high-speed, high-spatial-resolution neutron imaging when utilizing neutron absorption reactions.

These findings highlight paves the way for their implementation in next-generation extreme-environment detection systems.