Interface engineering in Halide Perovskite Single Crystal (PSC) devices for enhanced Gamma Spectroscopy

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All-inorganic halide perovskite single crystals, particularly $CsPbBr_3$, have emerged as promising candidates for room-temperature radiation detection owing to their high atomic number, large carrier mobility–lifetime product, and excellent optical properties[1]. In this work, we report a systematic comparative study of $CsPbBr_3$ single crystals fabricated via the vertical Bridgman method and solution growth techniques, focusing on their structural quality, charge transport behavior, and gamma-ray detection performance. Crystals grown by the Bridgman technique exhibit superior bulk uniformity and mechanical robustness, while solution-processed crystals demonstrate higher optical transparency and smoother surfaces, offering complementary advantages for detector fabrication.
Radiation detectors were fabricated using asymmetric electrode configurations with deliberate interfacial engineering and electrode replacement to optimize charge selectivity and suppress carrier injection [2]. Devices were operated under reverse bias conditions, leading to a reduction in dark leakage current and improved charge collection efficiency. The charge collection efficiency (CCE) of $CsPbBr_3$ single-crystal radiation detectors was analyzed using the Hecht equation describing carrier transport and trapping effects under an applied electric field. Furthermore, surface treatment including chemical passivation and surface polishing were employed to mitigate surface trap states, resulting in improved signal-to-noise ratio [3][4].
A direct correlation between crystal growth methodology, interface quality, and detector performance is established. This study highlights the critical role of crystal growth control, interface engineering, and device biasing in advancing $CsPbBr_3$ single-crystal perovskites toward practical, low-noise, room-temperature radiation detection applications.

References:
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