

Growth of ZnO microwires on BGO substrate for scintillation heterostructures

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Time-of-Flight Positron Emission Tomography (ToF-PET) has become a prominent tool for the early diagnosis of multiple diseases. Reducing the coincidence time resolution (CTR) of scintillation detectors significantly improves instrument sensitivity, enabling lower radiotracer doses and faster acquisition times, which are crucial for effective clinical evaluation [1]. One of the promising approaches to improve the TOF-PET timing is fabricating scintillating heterostructures. These hybrid materials combine a high-density matrix that effectively absorbs energy from incident γ -rays with a fast-emitting component that promptly converts secondary carriers into scintillation photons [2].

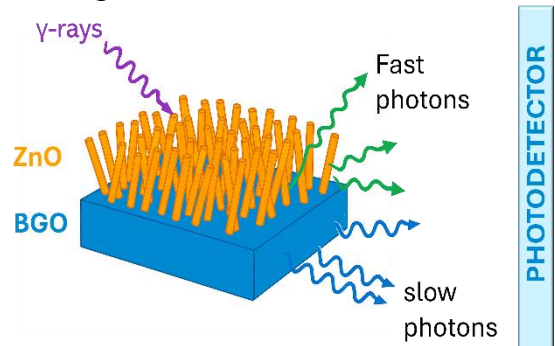


Fig.1. Schematic illustration of BGO/ZnO heterostructure

This study was pointed at the preparation of BGO/ZnO heterostructures combining a high light yield and stopping power of bismuth germanate (BGO) with the ultrafast luminescence response of ZnO. ZnO and Ga-doped ZnO microwires were grown on BGO single crystals by a low-temperature hydrothermal method. The influence of synthesis parameters (temperature, Ga-doping level, synthesis time) on the morphology, structure, photoluminescence, and scintillation performance of the synthesized heterostructures was studied. The structural properties of BGO/ZnO were analyzed using SEM and XRD, revealing a strong correlation between synthesis parameters, crystallographic texture, and microwire morphology. A process of ZnO:Ga microwire growth was optimized to obtain films with a thickness of up to 27.4 μm and a degree of crystallinity 80.8 %. PL measurements showed a dominant near-band-edge UV emission around 375 nm with suppressed defect-related visible bands. The combination of moderate Ga content (0.5 wt.%) and PEI-assisted axial growth at 95°C was shown to be particularly effective in reducing deep-level defects and promoting excitonic recombination. For optimized BGO/ZnO heterostructures, the CTR was improved by 11% with respect to the pure BGO substrate.

These results indicate that controlled growth of ZnO microwires on BGO is a promising strategy for engineering fast scintillation heterostructures and provides insight into structure–property relationships relevant to the design of next-generation ToF-PET detectors.

1. M. Conti, “Focus on Time-of-Flight PET: The Benefits of Improved Time Resolution.”, *Eur J Nucl Med Mol Imaging* **38** (6), 1147, (2011)
2. P. Krause, et al. “Design Rules for Time of Flight Positron Emission Tomography (ToF-PET) Heterostructure Radiation Detectors.” *Heliyon*, **8** (6), e09754 (2022).

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