RADIATION RESISTANCE AND IMPROVED RESPONSE TIMES OF ZNO SCINTILLATOR AFTER GAMMA-RAY IRRADIATION

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For the diagnostic of fusion plasma, various detectors such as scintillator have been required. We report the radiation resistance and improved response times of bulk zinc oxide (ZnO) single crystals after gamma-ray irradiation for scintillator development. Bulk ZnO crystals are proven to have excellent scintillation properties with 1.0 ns response time regardless of the optical excitation source [1]. In order to realize its scintillator applications, the radiation effects on the material properties are particularly interesting. Hydrothermal-grown ZnO samples are then irradiated with gamma-rays from a cobalt-60 (^{60}Co) source carrying 1.17 to 1.33 MeV energies. Compared before irradiation, gamma-rays affect the crystals' near-band-edge ultraviolet (UV) emission. After irradiation, the emission peaks are blue-shifted shifted by 5 to 6 nm, and the response times improve by 140 to 440 ps [2]. We attribute the modified UV emissions to radiation-induced defects on the bulk ZnO crystals. Gamma-rays can create defects through collisions with a lattice ion and subsequent ion displacement. But even with these radiation-induced defects, visible transmission degradation, absorption bands or color centers, and defect-related visible emissions are not observed. The defect concentration may be low or insufficient to cause these altered visible emission properties. The insufficient defect concentration may be due to ZnO's apparent amorphization resistance with its wurtzite crystal structure and piezoelectric property [3]. All of our results nevertheless imply that hydrothermal-grown ZnO is a good scintillator material under gamma-ray irradiation. Bulk ZnO single crystals can have promising scintillation performance in high energy radiation environments because of their radiation resistance and improved response times.

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