Heavy ion irradiation introduced defects in CdZnTe crystals and their effects on carrier transport properties

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Understanding the effects of heavy ion irradiation is significant for materials and devices applied in the field of space exploration. The relationship between heavy ions (Cl) and electric performance in CdZnTe crystals has been investigated here. A damage layer is introduced ~6 μm below the crystal surface and dominated by donor defects according to SRIM calculation and Hall results. The current-voltage (I-V) characteristic after irradiation is asymmetrical, which is attributed to the n+/n homojunction formed between the damage layer and the bulk crystal. The barrier height of the homojunction increases with irradiation fluence. For low irradiation fluences, the I-V curves follow the Schottky emission model at a bias of 0~100 V because of barrier lowering due to the applied field and the image force. When the irradiation fluence is greater than 2.5×10^{12} n/cm^2, the increasing leakage current after 40 V conforms to the Poole Frenkel (PF) effect caused by deep traps. The carrier mobility largely decreases due to the scattering of ionized impurities. And the energy resolving capability of γ-ray deteriorates by the trapping effect. The photopeak of the γ-ray spectrum could not be recognized when the fluence reaches ~10^{13} n/cm^2. This study could also provide important irradiation protection reference data for CdZnTe devices in various high-fluence application fields, such as nuclear physics, medical imaging and so on.