CREATION OF OXYGEN FRENKEL PAIRS IN α-Al_2O_3 SINGLE CRYSTALS VIA IRRADIATION BY ENERGETIC XENON IONS

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Corundum (α-Al_2O_3) exhibits exceptional properties, making it ideal for various technological applications, including its use as window material in future *D-T* fusion devices. The degradation of optical materials under intense irradiation by fast neutrons, electrons, and ions is linked to the formation of Frenkel defects. While oxygen-vacancy-related defects in corundum, such as *F* and F^+ centers and F_2 dimers, have been well characterized [1], recent EPR studies have identified a charged oxygen interstitial − a complementary defect to the F^+ center − in neutron-irradiated corundum [2]. Thermal annealing correlated the F^+ EPR signal with a 5.6-eV optical absorption band, while further annealing kinetic modelling suggests that the 6.6-eV band may be associated with neutral oxygen interstitials [2,3].

This study examined the radiation-induced optical absorption spectra (1.5-8.3 eV) of α-Al_2O_3 crystals irradiated with 231-MeV ^{132}Xe ions at fluences ranging from 5×10^{11} to 1×10^{14} ions/cm^2. Spectral decomposition into Gaussians showed that defect concentration, including those responsible for the 5.6-eV and 6.6-eV bands, increased with ion fluence, confirming their radiation-induced origin. The F^+ center concentration was determined using the EPR method. Additionally, the accumulation of single and dimer *F*-type defects was analyzed through cathodoluminescence (CL) spectroscopy at 6 K. The distinct emission lifetimes of the *F* and F^+ centers allowed for both steady-state and time-resolved CL measurements. Furthermore, the study discusses the limitations of using the specific CL bands for radiation damage detection, in line with previous neutron-irradiation studies [4]. This study was supported by the Estonian Research Council grant (PRG-2031) and H2020-MSCA-RISE-2019 Project 872494 (RADON).

References

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