IMPURITY INFLUENCE ON THE CREATION AND THERMAL ANNEALING OF RADIATION DEFECTS IN BINARY AND COMPLEX OXIDES

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Transparent materials with high tolerance to radiation are highly sought after in field of nuclear materials as inert matrices for nuclear materials and diagnostics/optical windows for various future fusion projects (ITER, DEMO, PROTO). Aluminium oxide (Al_2O_3) and magnesium aluminate spinel ($MgAl_2O_4$) are attractive candidates for this purpose and understanding the processes of defect creation under irradiation and subsequent thermal annealing are of great importance in predicting material properties and stability under irradiation [1,2].

In complex oxides such as $MgAl_2O_4$ the main as-grown structural defects are antisite defects. The creation of these defects have comparably low energy required and are result of cationic disorder - Mg ions occupying Al sites and vice versa [3]. The present study deals with a study of the cathodoluminescence spectra for virgin and neutron-irradiated samples. Manifestations of as-grown antisite defects in crystals with different stoichiometry have been revealed.

The elastic collisions of fast neutrons and crystal lattice results in creation of interstitial-vacancy Frenkel pairs. The effects of thermal annealing for F-type centres (anion vacancy with trapped electrons) in Al_2O_3 single crystals have been investigated via means of optical absorption and EPR methods. The annealing curves (defect concentration dependence of annealing temperature) has shown slightly different decay curves for F and F^+ centres that could be attributed to the availability of the oxygen interstitial – complementary Frenkel defect for the F centre [4]. The oxygen interstitial has been proven to be very difficult to observe in Al_2O_3, however EPR data has revealed a novel hole trap centre that has been identified as single superoxide ion - O_2^- molecule occupying one oxygen site.

References:

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