ANALYTICAL ELECTRON MICROSCOPY STUDY OF ION IRRADIATED SPINEL

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The effects of ion implantation on stoichiometric magnesium aluminate spinel have been studied using analytical electron microscopy. In specimens irradiated with swift heavy ions (electron stopping power > 8 keV / nm at the specimen surface), there are three distinct regions of the irradiated zone: an amorphous region at the surface; a metastable phase; and a spinel region exhibiting cation disorder as a result of the irradiation. This third zone forms in a region where the heavy ions have slowed and the electronic stopping power is reduced. A spinel specimen irradiated with 72 MeV I ions was examined in cross section to enable characterization of these distinct regions. Atom location by channeling enhanced microanalysis (ALCHEMI) performed near the Bragg condition of the spinel 220 planes in this third zone indicates that ~30% of the Mg^{2+} cations sit on the octahedrally coordinated sites. This level of disorder is similar to that measured in spinel irradiated with 2.4 MeV Mg ions, with lower stopping powers, and is substantially larger than the degree of disorder in unirradiated synthetic spinel (~15% of the Mg on the octahedral sites). The metastable phase that forms in the second zone of the swift heavy ion irradiated specimen has been characterized by ALCHEMI and convergent beam electron diffraction (CBED). Preliminary ALCHEMI analysis of the metastable phase indicates no discrimination between the Mg^{2+} and Al^{3+} cations along 220 planes, which would be indicative of the random cation distribution (67% of Mg^{2+} on the octahedral sites) in spinel. However, CBED patterns indicate that the structure of this metastable phase may have the higher symmetry Fm3m space group.

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