

Damages in MAl_2O_4 spinels irradiated with swift heavy ions (M=Mg or Zn)

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Abstract - The spinel MgAl_2O_4 is a ceramic with relatively high thermal conductivity and results on good behaviour under irradiation by neutrons had been published since twenty years. This material is therefore among the inert matrix studied for nuclear uses for the future : targets for the transmutation of the actinide nuclear wastes, and plutonium nuclear fuels without uranium. Unfortunately, unexpected important swellings (up to more than 20%) had been measured after some of our recent irradiations with neutrons and fission products in nuclear fission reactors. On the other hand, these results on swelling are not systematically reproducible. This study has been done to determine the influent parameters on the behaviour of the ceramics under irradiation and particularly on the swelling.

The polished surface of different disks of sintered polycrystalline spinel have been irradiated at room temperature and 500°C, at different fluencies between 10^{11} and $5 \cdot 10^{16}$ ions/cm², with different heavy ions (from S to Pb) of energy up to more than 1 GeV. Disks of ZnAl_2O_4 spinel have been also irradiated in the same conditions for more accurate characterisation of the irradiated zone by grazing XRD. The influence of electronic stopping power and fluence on the deviation of the lattice parameter of the oxides will be analysed : the lattice parameter variation presents a maximum for dE/dx near 7keV/nm. The conditions for amorphisation will be discussed, and the damages produced by nuclear stopping power or electronic stopping power will be compared. Characterisation of the defects has been done by optical spectroscopy before and after irradiation, and the results will be reported. The influence of the spinel tested (purity, grain size, density and internal stress) on the behaviour under irradiation will be analysed. Outline of mechanism of ceramic damage under irradiation will be presented.