Modifications of yttria fully stabilized zirconia thin films by ion irradiation in the inelastic collision regime

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Yttria fully stabilized zirconia (FSZ) is a candidate material for nuclear inert matrix fuel cell and nuclear waste containment due to its isostructure with UO_2 and PuO_2 and its outstanding radiation resistance. Amorphous and polycrystalline cubic FSZ thin films of thickness around 400 nm were deposited on (100) Si by ultraviolet pulsed laser ablation and irradiated with 2.6 GeV uranium ions at fluences between $2x10^{11}$ and $1.2x10^{12}$ ions cm^{-2}. The films were characterized before and after irradiation using scanning electron microscopy, atomic force microscopy, grazing incidence x-ray diffraction, and x-ray photoelectron spectroscopy (XPS). Amorphization, followed by partial recrystallization, is observed for irradiated crystalline films, whereas the amorphous films remain unaltered. A shift in the relative position of the XPS Zr 3*d*, Y 3*d*, and O 1*s* core lines is observed upon irradiation both in the crystalline and amorphous films, indicating differences in the local chemical environment at the surface as well as in near-surface layers. Such changes are ascribed to oxygen migration at the film surface, which may promote the recrystallization of as-deposited crystalline films but does not affect amorphous films.