INFLUENCE OF GRAIN ORIENTATION ON RADIATION INDUCED STRAINS IN UO2 POLYCRYSTALS

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Abstract

Light ion implantations have generated a lot of interest over the years since they have major technological applications. In nuclear materials studies, they offer the prospect of understanding
radiation effects in detail or developing new materials with enhanced radiation resistance properties. Indeed
without using costly remote handling and characterization facilities, ion implantation techniques enable the
study of effects resulting from neutron irradiations that make samples highly active.
The primary effect of loading the surface of a material with foreign elements is to generate swelling of the
crystal structure. However, the sample is generally not bulk irradiated but presents an implanted layer the
thickness of which typically ranges between a few nanometers and a few microns. The question of how to
relate expected swelling in a bulk or surface irradiated sample is therefore essential and we discuss here the
first step towards understanding this relationship. Characterization of this swelling effect is usually performed
using monochromatic high resolution X-Ray diffraction. However, it does not enable a comprehensive
characterization of the strain field in the surface layer loaded with foreign elements for polycrystals. Also, the
mechanical models adopted to interpret experiments are usually either simplified (eg. isotropic model) or apply
to simplified situations (eg. textured materials) which fails to highlight the more general case in which grain
orientation has a major contribution. As a consequence both extensive characterization and accurate
modeling of the mechanical state of the implanted layer are required.
In this communication, the selected characterization technique (micro-XRD in Laue mode) is first shown to be
an efficient method to obtain the strain tensor in the implanted layer at several points within

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each grain of the
polycrystalline samples. Then the strain tensor is demonstrated to be strongly dependent upon crystal
orientation. Finally an anisotropic elastic mechanical model involving a free swelling is used to rationalize all
the experimental data.

Keywords: Properties/Mechanical/stress/strain relationship, Composition & Microstructure/Bulk Techniques/x, ray diffraction (XRD), Composition & Microstructure/Material Type/nuclear materials