Multilayer coating radiation tolerance revealed by IBA

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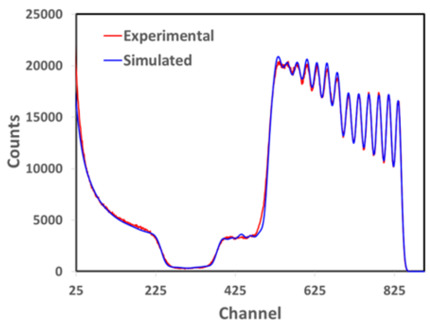
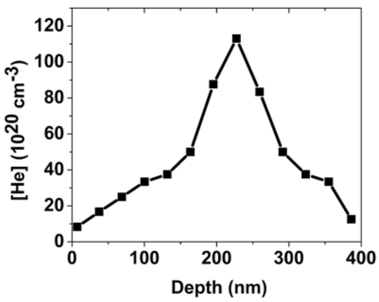
Nanostructuration has opened the way for designing materials with improved properties by taking advantage of multiple interfaces providing enhanced local physical properties. In this frame, nanostructured materials are envisioned for nuclear applications owing to severe environmental conditions (radiation, temperature, corrosion…). Here we report a study based on IBA (RBS and NRA) of a nanometric Cr/Ta multilayer coating demonstrating an extremely high radiation tolerance. TEM and X-ray diffraction were also performed to confirm RBS results and reveal crystallographic structures.

Multilayer coated samples were firstly submitted to helium ion implantation, and NRA analyses have revealed that optimized geometry can accommodate up to 20 at. % of gas without noticeable damage, implanted atoms being probably stored at the Cr/Ta interfaces. Heavy ion irradiation was also performed at room temperature (RT), mimicking nuclear reactor neutron bombardment. Although we detected the growing upon irradiation of mixing layers at the Cr/Ta interfaces, these newly created layers remain many fold thinner than that produced at a single interface, preserving the initial multilayer arrangement.

Currently the study is extended to high temperature irradiation, and preliminary results are encouraging, confirming that the nanometric Cr/Ta multilayer coating can tolerate up to 100 dpa irradiation dose.





RBS spectrum of a Cr/Ta multilayer coated sample after heavy ion irradiation (left) and helium distribution after 2e17 cm^{-2} implantation (right)