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Behaviour of uranium dioxide under irradiation: combined effects of radiation defects induced by ballistic and electronic excitation

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During in-reactor operation, the nuclear fuel is subjected to simultaneous radiation sources induced by the slowing down of fission fragments, the alpha and beta decay, etc. In addition, fission products incorporation induce chemical effects in the matrix. At the atomic scale radiation, damage is produced by both low-energy particles, leading to the collision cascades formation and high-energy particles inducing electronic excitation and ionisation. Due to this radiation damage, a microstructural evolution of the fuel such as cavities, dislocation lines and loops occurs. These defects can induce a swelling and/or a restructuration, which can affect the nuclear fuel integrity. Although ballistic and electronic-induced effects are separately well-established, the synergistic effects between the two slowing-down processes are not well-known. My PhD is aimed to studying this coupled effects and the associated mechanisms. For that purpose, ion irradiation have been performed at the JANNuS-Saclay facilities, where three ion accelerators can be coupled. Mono and dual-beam irradiation will be performed simultaneously on uranium dioxide crystals. Damage build-up kinetics has been in situ characterized by Raman spectroscopy. First results seem to show a possible recovery of the ballistic damage by intense electronic excitations.

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