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Investigation of the Formation Mechanisms of the High Burnup Structure in the Spent Nuclear Fuel – *In Situ* Experimental Simulation with Using Ion Beams

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Uranium dioxide (UO_2) is much-used nuclear fuel over the world especially in light water reactor. It is subjected to significant restructuring processes during its operating life in the reactor core. Although it is well established that uranium dioxide does not become amorphous under irradiation, UO_2 exhibits a defective structure, whose specific microstructure depends on several parameters (e.g. local burnup, local temperature, irradiation conditions, nuclear and electric stopping, and incorporated impurities). In particular, a zone located at the peripheral region of the nuclear fuel pellet (100-200 μm extension) submitted to extreme irradiation conditions, leading to grain subdivision and pore formation, – referred to as the High Burnup Structure (HBS) – focuses attention on the role played by the various parameters either in a separate or in a combined way on the solid destabilization.The main objective of this investigation is to understand the formation mechanisms of the HBS structure and the behavior of a material under irradiation. This goal is achieved experimentally by using a very simplified model - urania single crystals - irradiated with low-energy ions to examine the contributions of ballistic damage and of implanted species to the formation of the HBS structure. Crystals were alternatively (i) implanted at increasing fluence steps with 500-keV Xe or La ions (soluble and insoluble species in UO_2, respectively) at 773 K (the temperature at the periphery of the fuel) and (ii) characterized *in situ* by Rutherford Backscattering Spectrometry in Channeling geometry (RBS/C) and *in situ* Transmission Electron Microscopy (TEM). Two important steps in the disordering kinetics of the solid were established and they were interpreted in terms of the transition from the formation of isolated defects to extended defects at a low dpa number, and due to the aggregation of impurities when their concentration reaches a critical threshold. This second step was solely observed for the insoluble specie.

Biography:

Yara Haddad is graduated from Jordan University of Science and Technology, Jordan, with a bachelor degree in Nuclear Engineering. Later she completed Master degree in nuclear engineering (M2) in the field of nuclear power design from ENSTA, Paris and she is completing her Ph.D. in physics, in particular physics of materials at University Paris-Sud with an expected degree date of December 2017.