Energy Dispersive Neutron Imaging of Nuclear Fuel Pellets

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Growing demand for electric energy requires an expansion of current electrical power production in many countries of the world, involving an increasing demand of nuclear power. Safety and efficiency of nuclear power plants propels research and development in this field to grow to further increase. Neutrons can be used to study a wide range of problems related to these efforts, providing a unique probe ranging from crystal chemistry of nuclear fuels to engineering diffraction on structural materials used in nuclear reactors. Recent advances in neutron detection opened up new capabilities of material characterization using neutron imaging with unparalleled opportunities particularly for nuclear materials, where heavy elements (e.g., uranium) need to be imaged together with light elements (e.g., hydrogen, oxygen). The inherent sorting of the neutrons at a pulsed source by their energy allows examination of samples by selectively setting the contrast on isotopes (via neutron resonances) or crystal structures (via Bragg- edges). The application of state-of-the-art tomographic reconstruction algorithms allows to reconstruct, in 3D, the spatial distribution in cm-sized samples of quantities derived from these effects. None of this is possible with X-ray or reactor nRAD, and at present this technique is only possible at the pulsed neutron sources at LANSCE, SNS (ORNL), ISIS (U.K.), and JPARC (Japan). Here we present the most recent results, leveraged using the time-structure of the LANSCE (Los Alamos Neutron Science Center) neutron beam, presenting a novel energy-dispersive neutron imaging technique applied to nuclear fuel pellets. For the first time, we were able to reconstruct in 3D the tungsten concentration in urania pellets after metallic tungsten was in contact with urania pellets during sintering.