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High-Frequency Acoustic Microscopy Imaging of Pellet/Cladding Interface in Nuclear Fuel Rods

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Abstract : Pressurized Water Reactor (PWR) fuel rods are made of ceramic pellets (e.g. UO2 or (U,Pu) O2) assembled in a zirconium cladding tube. By design, an initial gap exists between these two elements. During irradiation, they both undergo transformations leading progressively to the closure of this gap. A local and non destructive examination of the pellet/cladding interface could constitute a useful help to identify the zones where the two materials are in contact, particularly at high burnups when a strong chemical bonding occurs under nominal operating conditions in PWR fuel rods. The evolution of the pellet/cladding bonding during irradiation is also an area of interest. In this context, the Institute of Electronic and Systems (IES- UMR CNRS 5214), in collaboration with the Alternative Energies and Atomic Energy Commission (CEA), is developing a high frequency acoustic microscope adapted to the control and imaging of the pellet/cladding interface with high resolution. Because the geometrical, chemical and mechanical nature of the contact interface is neither axially nor radially homogeneous, 2D images of this interface need to be acquired via this ultrasonic system with a highly performing processing signal and by means of controlled displacement of the sample rod along both its axis and its circumference. Modeling the multi-layer system (water, cladding, fuel etc.) is necessary in this present study and aims to take into account all the parameters that have an influence on the resolution of the acquired images. The first prototype of this microscope and the first results of the visualization of the inner face of the cladding will be presented in a poster in order to highlight the potentials of the system, whose final objective is to be introduced in the existing bench MEGAFOX dedicated to the non-destructive examination of irradiated fuel rods at LECA-STAR facility in CEA-Cadarache.

Keywords : high-frequency acoustic microscopy, multi-layer model, non-destructive testing, nuclear fuel rod, pellet/cladding interface, signal processing
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