Bi-Axial Deformation of Zr-2.5 Nb Pressure Tube Material

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In the pressurized heavy water CANDU (CANadian Deuterium Uranium) reactor, there are 380 fuel channels, each consisting of a calandria tube and a concentric pressure tube. The latter is the pressure boundary for the primary coolant and holds the fuel bundles. The annulus gap between the pressure tube and calandria tube acts as a thermal insulation reducing heat loss to the moderator water during normal operating conditions. During upset conditions, such as a loss of coolant accident (LOCA), the pressure tube may balloon into contact with the calandria tube and, thus, release the thermal energy into the moderator water, causing the moderator water to boil. The boiling regime on the calandria tube surface affects the progression of the accident. The time it takes the pressure tube to balloon in contact with the calandria tube affects the contact temperature and, thus, the sequence of post-contact events. This will determine whether the event can be controlled before the fuel channel integrity is compromised. In the current study, Digital Image Correlation (DIC) is used to measure the deformation field distribution in order to yield more accurate measurement of bi-axial strain and strain rate. Thermography images are paired with the DIC to obtain temperature and deformation fields simultaneously. The methodology is presented here for a low pressure (3.5 MPa), and low heat up rate (~ 8˚C/s) test. Radial strain is determined from post-test measurements using ultrasonic and laser scanning techniques.