Experimental and crystal plasticity investigation of the toughness of W/Cu joints

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Abstract

The context of the work is to contribute to the lifetime assessment of the so-called monoblocks used as plasma facing components in the ITER nuclear fusion reactor based on experiments and numerical modelling. These monoblocks are made of copper-chromium-zirconium (CuCrZr) cooling ducts which are joined to tungsten (W) using a copper (Cu) interlayer. W/Cu joints must ensure efficient heat exhaustion while preserving the component's structural integrity under extreme environmental conditions. The role of plasticity in the crack resistance across these joints is characterized experimentally, using miniaturized CT and DCB specimens. The interpretation of the fracture tests is assisted by fractography analysis combined with nanoindentation. The analysis of plasticity ahead of the crack tip is represented and simulated using crystal plasticity based finite element modelling (CPFEM). The model assessment is under progress. It focuses on the partitioning of the plastic strain field and lattice rotations in the vicinity of the W/Cu joint. The model aims at predicting the response of W/Cu joints under various operational conditions inside the fusion reactor, including cyclic loading and irradiation.

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