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P3.217 Fracture toughness characterization of Eurofer97 steels in EUROfusion using miniature multi-notch bend bar specimens

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Eurofer97 is one of the leading candidates of reduced activation ferritic martensitic (RAFM) steels for first wall structural materials of early demonstration fusion power plants. During fusion plant operation, intense neutron irradiation damage on first wall materials can cause significant irradiation embrittlement and greatly reduce the fracture toughness of RAFM steels. Therefore, it is critical to characterize the fracture toughness of RAFM steels with high fidelity. This is especially true for testing neutron irradiated specimens which are usually much smaller than standard size specimens due to limited volume of irradiation facilities and low radioactive dose advantage of small size specimens after irradiation. Under the framework of EUROfusion, we are in the process of characterizing fracture toughness properties and irradiation embrittlement behavior of ten Eurofer97 steels with different compositions and thermomechanical treatments. We have developed fracture toughness testing technique using pre-cracked miniature multi-notch bend bar specimens (M4CVN) with a dimension of 45mm (length) x 3.3mm (width) x 1.65mm (thickness) based on the ASTM E1921 Master Curve method. Dedicated experimental setup has been designed and fabricated for testing the M4CVN specimens for both regular laboratories and hot cell facilities at Oak Ridge National Laboratory (ORNL). Fracture toughness results, along with tensile, microhardness, and microstructure results, will be discussed to elucidate the link between materials microstructure and fracture toughness properties for unirradiated conditions. Neutron irradiation for ten Eurofer97 steels at 300℃ for 2.5 dpa (displacement per atom) is currently underway at High Flux Isotope Reactor of ORNL and depending on the test progress, post irradiation examination results may also be presented to study the irradiation embrittlement behavior of Eurofer97 steels.

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