TECHNICAL LECTURE

Influence of neutron irradiation on mechanical length scale bridging in RAFM steel and embrittlement in tungsten grain boundaries

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NDED Seminar Hall

22nd August, 2024
11:00 a.m.

All are invited

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Tea will be served at 10:45 am
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ABSTRACT

Influence of neutron Irradiation on: mechanical length scale bridging in RAFM steel and embrittlement in tungsten grain boundaries

H A R I P R A S A D G O P A L A N
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In the first part of my talk, I will discuss about microindentation to macro tensile mechanical length scale bridging with help of deep learning. Specifically, we propose a long short term memory (LSTM) sequence to sequence deep learning (DL) approach to map high temperature indentation load-displacement curves to tensile data. A customized high temperature indenter generated load-displacement (P-h) curves of Eurofer 97 (European RAFM steel) samples neutron irradiated to 15 dpa at 300 °C. Samples are indented at RT, 250, 300, 350, 400 and 450 °C. Quasi-static tensile tests on the irradiated samples are performed in the same temperature regime. The indentation and tensile experiments were also performed on unirradiated Eurofer 97 samples at room temperature, 250, 300 and 350 °C.

The supervised DL approach, by comparing the input P-h sequence to the output tensile stress-strain curve sequence from the training set, learns the underlying structure to the mechanical property correlation. This is a significant achievement considering that only modest input data is available. In order to make the predictions robust, we initiated a multi-input learning paradigm, wherein one part of the pipeline was LSTM network between sequences, on the other side additional features such as hardness, irradiation temperature, test temperature and brittle-to-ductile transition temperature measured through Charpy impact tests, were concatenated into a neural network. Addition of extra features lead to a remarkable enhancement in the learning outcome. We have demonstrated a new powerful way to facilitate mechanical length scale bridging through deep neural networks. A combination of deep learning, extensive micromechanical testing with a limited macroscale testing opens a new playground for reliable mechanical characterization for fission and fusion materials.

In the second part of my presentation, the role of grain boundaries in irradiation induced embrittlement in tungsten will be discussed. Microscale cantilevers were fabricated through focused ion beam milling for fracture testing. Notched were placed specifically on grain boundaries, which were characterized through EBSD. The influence of grain boundary misorientation and irradiation temperatures on grain boundary fracture will be discussed. Apart from these two main themes, I will share highlight slides (2-3 slides) of some of my work on CNT dispersed alumina, a new analytical grain growth model in nanotube nanocomposites.