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P2.198 Grain scale constitutive modeling and simulation for reduced activation ferritic/martensitic steel

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The constitutive behavior of Reduced Activation Ferritic/Martensitic (RAFM) steel for the potential blanket material of fusion reactor was modeled and implemented into a crystal plasticity finite element method (CPFEM). In the developed constitutive model, the plasticity was formulated by the slip system activation in the body centered cubic single crystal and the stress of polycrystal was homogenized based on the Taylor or full FE schemes. The model takes interactions among dislocations and precipitates into account, which is the main hardening mechanism of tempered martensite structure. Also, the damage accumulation by the decohesion of precipitate-matrix interface and subsequent growth was also phenomenologically included in the model. The proposed model was implemented into the crystal plasticity framework as a user material subroutine and validated by the comparison between simulated and measured flow stress curves for the RAFM steel. The microstructure used for the simulation was obtained from the EBSD data which showed the hierarchical microstructure consisting of laths, blocks and packets in the transformed martensite from prior austenite. Preliminary study showed that the developed constitutive model for the grain scale crystal plasticity FE simulation predicted the stress-strain response and fracture within reasonable accuracy when compared to the experimental data.

Presenter: Dr JEONG, Woojin (Materials Science and Engineering Seoul National University)

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