

## **Elasto-plastic Dislocation-based Constitutive Modeling within Full Scale 3-D Thermo-mechanical FEM Analysis of an ITER-TBM**

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For the near term, researchers must rely on computer simulation tools to study the behavior of fusion components using material models and finite element analysis. The Virtual international Structural Test Assemble (VISTA) is an international project aimed at establishing an effective interface between material modeling and component design activities. The objective is to combine a wide range of models including constitutive and damage laws, finite element models, geometrical configurations and loading conditions, to perform “virtual experiments” over a wide range of conditions, to carry out sensitivity studies and to evaluate a range of potential interactions and failure paths.

Materials modeling provide predictive relations between the microstructure of the material and its macroscopic mechanical properties. A dislocation-based phenomenological equation of the elasto-plastic constitutive behavior for steels as a function of temperature and neutron irradiation damage (dpa) is developed. The model is applied to and calibrated with experimental stress strain data of low activation ferritic steels, such as HT9 and F82H. Model calibration is based on a 3-dimensional (3-D) finite element analysis of a tensile stress bar.

Aside from various material properties the failure paths of a component are highly dependent on geometric features, loading conditions, and interaction between loading and damage. As a first step of developing the VISTA concept it is necessary to develop detailed full-scale 3-D models of entire components in order to capture the effects of 3-D geometric features and to be able to apply realistic boundary conditions. To this end the entire component must be modeled. We present here a dislocation-based material model, which is employed in a detailed full-scale 3-D FEM of the entire EU HCPB TBM. A full thermo-mechanical analysis is performed on the ITER test module using the dislocation-based phenomenological creep model. Realistic boundary conditions could be applied because the entire TBM is modeled. Steady state and transient thermo-mechanical response of the EU HCPB ITER-TBM are reported and compared with results based on purely elastic analysis.