20th European Mechanics of Materials Conference - EMMC20
Florence, Italy | May 27th-29th, 2026
www.emmc20.unifi.it

Coupled Crystal Plasticity and X-FEM Modelling of Tungsten's Brittle to Ductile Transition at the Microscale

Anna Taipale[1], Eralp Demir[2], Chris Hardie[3], Johannes Ast[4], Edmund Tarleton[5]

[1] University of Oxford, United Kingdom. kebl8425@ox.ac.uk
[2] University of Oxford, United Kingdom. eralp.demir@eng.ox.ac.uk
[3] UKAEA, United Kingdom. chris.hardie@ukaea.uk
[4] CEA, France. johannes.ast@cea.fr
[5] University of Oxford, United Kingdom. edmund.tarleton@eng.ox.ac.uk

Paper ID: 599
Symposium S8: Fracture, and damage of materials

Abstract

We have developed a microstructure-sensitive fracture model for single crystal tungsten to predict its fracture behaviour across temperatures in the microscale brittle-to-ductile transition (BDT) regime of tungsten. Understanding the mechanisms behind the BDT is critical for safe operation of future fusion power plants which use tungsten as plasma facing armour. Plastic deformation at the microscale is modelled using OXFORD-UMAT, a publicly available crystal plasticity ABAQUS user subroutine. Fracture is modelled simultaneously using the extended finite element method (X-FEM) which allows efficient simulation of crack propagation without remeshing or prior specification of crack path. Model predictions are validated against single crystal microcantilever fracture experiments which have undergone an EBSD analysis.

Keywords:

Tungsten Crystal Plasticity Fracture Brittle to Ductile Transition X-FEM Microscale Microcantilever Finite Element Modelling