The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

# Microstructurally-Based Statistical Predictions of Failure in Hydrided Zirconium Materials

**T. Hasan[1], L. Capolungo[2] and M.A. Zikry[3]**

[1] North Carolina State University, tshasan@ncsu.edu, [2] Los Alamos National Laboratories, laurent@lanl.gov
[3] North Carolina State University, zikry@ncsu.edu

**Key Words:** *fracture mechanics, dislocation-density crystalline plasticity, statistically-based machine learning failure criteria*

A dislocation-density based multiple slip crystalline plasticity formulation and a microstructurally-based fracture methodology have been used in conjunction with a new statistical framework to develop a representation of failure probabilities for hydrided Zircalloy-4 materials. Using a genetic learning algorithm and Bayes' rule, an extreme value theory (EVT) of fracture was obtained for a stochastic representation of crack nucleation and propagation. This resulting validated model of crack probability can be applied either topographically to generate contours of crack likelihood on a representative material or applied directly to the input parameters to provide a library of fracture probabilities for a broad range of microstructural characteristics and mechanisms. The proposed framework can provide a framework for understanding material failure, and how fundamental material mechanisms can be used to inform predictions at the microstructural scale.