CMM-SolMech 2022 conference

S12 Plasticity, damage and fracture mechanics

List of abstracts

ID 1: *Blast loading on structure using Abaqus and deep neural network* (poster) – T. Park, B. Ahmed, J. Jeon

ID 30: *Phase-field length scale measurement based on the fractography: a case study of Cr-Al2O3 composites* – H. Darban, K. Bochenek, W. Węglewski, M. Basista

ID 48: *Double surface model of the intermittent plastic flow in ductile materials at cryogenic temperatures* – R. Schmidt, B. Skoczeń

ID 79: *Application of unified mechanics theory to constitutive modeling of gigacycle fatigue* (poster) – H. Wei Lee, H. Fakhri, R. Ranade, H. Egner, A. Lipski, M. Piotrowski, S. Mroziński, N. B. Jamal, C. L. Rao

ID 90: *Unified brittle failure criteria* (keynote) – Y. Kwon

ID 91: *Dissipative phenomena accompanying low cycle fatigue of P91 steel* (poster) – W. Egner, H. Egner, S. Mroziński, M. Piotrowski

ID 96: *A domain-decomposition MD-FE coupling method for fracture simulations of amorphous polymers* – W. Zhao, P. Steinmann, S. Pfaller

ID 108: *A mechanically motivated damage model based on the theory of invariant tensor functions* (poster) – C. Findeisen

ID 110: *Prediction of damage growth in EN-AW 2024 aluminum alloy under LCF regime* (poster) – A. Tomczyk, A. Seweryn

ID 125: *Anti-plane bridge cracks interaction in piezoelectric materials with initial fields* – E. Craciun, G. Ghita

ID 126: *A continuum damage mechanics model for static and fatigue degradation of fiber reinforced polymers* (keynote) – Z. M. A. Hamid, C. Findeisen, D. Laveuve, D. Spancken, J. Hohe

ID 140: *Fracture in PMMA notched specimens under torsion* (poster) – E. Bura, A. Seweryn

ID 145: *Gradient damage models for simulation of concrete cracking in L-shape specimen* – A. Wosatko, J. Pamin

ID 148: *Modeling of deformation and fracture of metal-ceramic microcantilever beams in bending* – W. Węglewski, P. Pitchai, K. Bochenek, M. Basista

ID 156: *Theory of yield strength in body-centered-cubic High Entropy Alloys* – F. Maresca, W. Curtin

ID 157: *Fracture simulations of ice with the phase field method* – R. Sondershaus, R. Müller

ID 201: *Micropolar crystal plasticity model with the gradient-enhanced incremental hardening law* – M. Ryś, S. Stupkiewicz, H. Petryk

ID 204: *Experimental and numerical analysis of Lueders bands and PLC effect in AW5083 aluminium alloy* – M. Mucha, L. Rose, B. Wcisło, A. Menzel, J. Pamin

ID 210: *A discussion on the construction of dissipative microstresses in a gradient crystal-plasticity model* – H. Pouriayevali

PHASE-FIELD LENGTH SCALE MEASUREMENT BASED ON THE FRACTOGRAPHY: A CASE STUDY OF CR-AL2O3 COMPOSITES

Hossein Darban[1], Kamil Bochenek[1], Witold Węglewski[1], Michał Basista[1]

[1] Department of Mechanics of Materials, Institute of Fundamental Technological Research, Polish Academy of Sciences, Poland

hdarban@ippt.pan.pl

The phase-field simulation of fracture in heterogeneous materials, such as the metal-ceramic composites, can be conducted in two ways. One way is to distinguish between the constituent phases, and solve the phase-field problem in a heterogeneous domain. While capable of modeling the microscale fracture events, this approach is mostly restricted to small unit cell problems because the simulations need high mesh resolutions for most of the domain since the crack growth path is not known a priori. The second way is to conduct the phase-field model on the homogenized domain with the effective mechanical properties. The approach allows to predict the macroscale fracture properties such as the fracture toughness, but is incapable of capturing microscale fracture mechanisms. A critical issue arises in the determination of the length scale parameter.

To address the issue, we propose to conduct the fractography analysis, define the fracture process zone size, and use that value as the length scale parameter in the phase-field modeling. The technique is tested on Cr-Al2O3 composites fabricated by powder metallurgy at different reinforcement volume fractions and particle sizes. Mode I and mixed-mode I/II fracture tests are conducted on single-edge notched beams in four-point bending mode. The fracture surfaces are analyzed in detail by scanning electron microscopy and the fracture process zone lengths are measured. The phase-field model is then applied to simulate the macroscale fracture in the specimens, which are considered as homogeneous domains with effective elastic properties determined by the rule of mixture.

The numerical models adequately approximate the experimentally measured fracture toughness and the fracture loads of the investigated composites. It is shown that the phase-field model prediction of the crack initiation direction in the mixed-mode loading is in agreement with the results of the experiments and the generalized maximum tangential stress criterion. These outcomes justify using the process zone length as the scale parameter in the phase-field modeling of macroscale fracture in chromium-alumina and similar metal-ceramic composites.