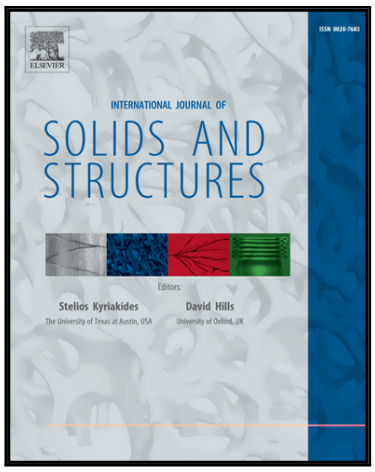

Plastic Anisotropy and Failure in Thin Metal: Material Characterization and Fracture Prediction with an Advanced Constitutive Model and Polar EPS (Effective Plastic Strain) Fracture Diagram for AA 3014-H19

Robert Dick , Jeong Whan Yoon

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Plastic Anisotropy and Failure in Thin Metal: Material Characterization and Fracture Prediction with an Advanced Constitutive Model and Polar EPS (Effective Plastic Strain) Fracture Diagram for AA 3014-H19

Robert Dick[1,2], Jeong Whan Yoon[1,3,*]

[1] *School of Engineering, Faculty of Science, Engineering and Built Environment, Deakin University, Waurn Ponds, VIC 3220, Australia*

[2] *Alcoa Technical Center, 859 White Cloud Road, New Kensington, PA 15068, USA*

[3] *Department of Mechanical Engineering, KAIST, Daejeon 305-701, Korea*

Abstract. Material characterizations for plasticity and fracture have been conducted from uniaxial tensile tests, bi-axial bulge test, and disk compression test for a beverage can AA3104-H19 material. The results from the experimental tests are used to determine material coefficients for the Yld2004-18p model (Barlat et al., 2005). Finite element simulations are developed to evaluate the predicted earing profile. It is shown that the Yld2004-18p model is capable of accurately predicting the complex earing profile. Excellent agreement with the experimental data for eight ears exhibited in AA3014-H19 is achieved using the Yld2004-18p constitutive model. Further mechanical tests are also conducted on the AA3104-H19 to generate fracture data under different stress triaxiality conditions. Tensile tests are performed on the samples with a central hole and notched specimens to achieve tensile and plane-strain conditions. A specially designed torsion test of a double bridge specimen is conducted to generate the points near pure shear conditions. The Nakajima test is also utilized to produce a bi-axial tension condition. The data from the experiments is used to generate the fracture locus in the principal strain space. Mapping from the principal strain space to stress triaxiality space, principal stress space, and Polar Effective Plastic Strain (PEPS) space is accomplished for a general yield function. Finite element modeling is used to validate the fracture diagram in the polar space. A model of a hole expansion during cup drawing demonstrates the robustness of the PEPS fracture theory for a condition with a highly anisotropic material and accurately predicts the direction for onset of failure.