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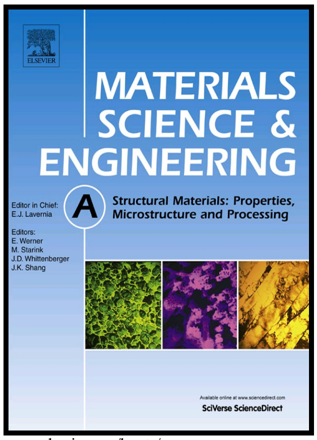

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Prediction of fracture and deep drawing behavior of solution treated Inconel-718 sheets: numerical modeling and experimental validation

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Abstract

In the present work, fracture forming limit diagram (FFLD) of two different solution treated i.e. 970°C (HT970) and 1070°C (HT1070) Inconel-718 sheets were evaluated by carrying out stretch forming experiments. The obtained failure limiting strains were then transformed into effective plastic strain vs. triaxiality locus (ηEPS-FFLD) and major and minor principal stress space ($\sigma-$FFLD). It was observed that the HT1070 material possessed higher ηEPS-FFLD and lower $\sigma-$FFLD indicating improved formability with reduced deformation load. In order to predict the fracture, six different ductile fracture models incorporating anisotropic properties were calibrated with experimental data. Among all the models, Oh model showed comparatively better prediction with an average absolute error of 10.2% and 10.1% for HT970 and HT1070 material respectively. However, the model was not able to capture the fracture limits along complete triaxiality path ($0.33 \le \eta \le 0.66$). Therefore, finite element (FE) analysis of deep drawing and stretch forming processes were performed incorporating experimentally evaluated ηEPS-FFLD and $\sigma-$FFLD. The formability in terms of fracture location, limiting draw ratio, wrinkling evolution, thickness distribution, and limiting dome height were predicted successfully using Hills-48 plasticity theory. Also, the microhardness at critical regions of deformed cups was