Paint-bake Effect on the Plasticity and Fracture of Pre-strained Aluminum 6451 Sheets

Rami Abi Akl, Dirk Mohr

www.elsevier.com/locate/ijmecsci

PII: S0020-7403(17)30021-8
DOI: http://dx.doi.org/10.1016/j.ijmecsci.2017.01.002
Reference: MS3540

To appear in: *International Journal of Mechanical Sciences*

Received date: 5 August 2016
Revised date: 18 December 2016
Accepted date: 4 January 2017

Cite this article as: Rami Abi Akl and Dirk Mohr, Paint-bake Effect on the Plasticity and Fracture of Pre-strained Aluminum 6451 Sheets, *International Journal of Mechanical Sciences* http://dx.doi.org/10.1016/j.ijmecsci.2017.01.002

Paint-bake Effect on the Plasticity and Fracture of Pre-strained Aluminum 6451 Sheets

Rami Abi Akl[1], Dirk Mohr[2]
[1]Impact and Crashworthiness Laboratory, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge MA, USA
[2]Department of Mechanical and Process Engineering, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland

Abstract

In automotive engineering, sheet metal components are subject to a 20-30min heat treatment at 180C during paint baking. This process may significantly alter the mechanical properties of 6000-series aluminum alloys through artificial ageing. Here, a comprehensive experimental program is carried out to characterize the anisotropic plasticity and the fracture initiation in pre-strained artificially-aged aluminum 6451 sheets. It is found that the combination of pre-straining up to 5% strain and heat treatment mainly changes the material's strain hardening behavior and the stress-state sensitivity of its fracture response. The material parameters of the Yld2000-2d plasticity model with combined Swift-Voce hardening are identified for four distinct materials from uniaxial tension and shear experiments. The corresponding Hosford-Coulomb fracture model parameters are determined from smiley shear, V-bending and punch experiments. As an important byproduct of the research, the Yld2000-2d and Hosford-Coulomb models are successfully validated for all four materials through notched and central hole tension experiments. Simple empirical expressions are also provided to estimate the material properties as a function of the pre-strain in engineering practice.

Keywords: Artificial ageing, paint-bake, Yld-2000, stress triaxiality, Lode angle, ductile fracture

1. Introduction