Accepted Manuscript

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PII: S0749-6419(17)30321-2

DOI: 10.1016/j.ijplas.2017.09.004

Reference: INTPLA 2238

To appear in: *International Journal of Plasticity*

Received Date: 6 June 2017

Revised Date: 7 August 2017

Accepted Date: 1 September 2017

Please cite this article as: Holmen, J.K., Frodal, B.H., Hopperstad, O.S., Børvik, T., Strength differential effect in age hardened aluminum alloys, *International Journal of Plasticity* (2017), doi: 10.1016/j.ijplas.2017.09.004.

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Abstract

The strength differential (SD) effect, as reported in literature over the past decades, is a discrepancy between the axial stresses in compression and tension. This study investigates the SD effect in aluminum alloys using both experiments and numerical simulations. We present compressive and tensile tests of four aluminum alloys in several tempers with yield strengths varying from 27 MPa to 373 MPa: a total of thirteen different material configurations. The axial stresses measured in compression tests are significantly higher than corresponding tensile stresses for nearly all material configurations. In our tests, the SD effect generally increases with material strength, indicating that aluminum alloys are pressure sensitive. The physical mechanism responsible for the SD effect was not investigated in this paper, but a plasticity model based on the hypothesis that dislocation motion is affected by hydrostatic pressure, as put forth by several authors, gives an accurate description of the material behavior in compression and tension.

Keywords: Experiments, 6xxx aluminum alloys, SD effect, Pressure sensitivity, Drucker-Prager, Stress triaxiality ratio

1. Introduction

For certain metals, the flow stress in compression has been reported to be higher than the flow stress in tension. This difference in strength between compression and tension is called the strength differential (SD) effect and can be defined as

$$SD = 2\frac{|\sigma_c| - |\sigma_t|}{|\sigma_c| + |\sigma_t|} \tag{1}$$

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