Chair of Metal Forming and Casting
TUM School of Engineering and Design
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Investigation of the deformation capacity of ductile sheet metal materials under non-proportional loading with consideration of the anisotropic damage behaviour

Final Report

Motivation

As part of the project, the influence of uniaxial pre-strains and pre-strains in the plane strain range on the formability and damage development of the two sheet materials AA6016-T4 and DP600 was investigated. It was found that AA6016-T4 is less affected by a change in the direction of loading DP600.

Procedure

Non-proportional expansion paths were created using a modified Marciniak mould. Nakajima and tensile test specimens were then taken from the pre-stretched samples. These samples were then analysed in more detail. Various measuring methods were used, including synchrotron diffraction.

Results and Outlook

The Nakajima tests showed that the formability of the aluminium alloy AA6016-T4 is only influenced to a very small extent by pre-strain. DP600, on the other hand, shows a clear dependency, see Figure 1.

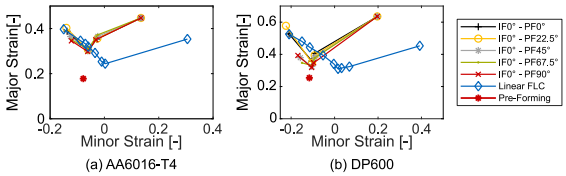

Figure 1. Influence of a uniaxial pre-forming on the formability of (a) AA6016-T4 and (b) DP600.

Closer investigations using synchrotron diffraction showed that a decrease in dislocation density can be observed after the onset of plastic deformation. The dislocation density of DP600 decreases significantly more than that of AA6016 T4, see Figure 2. The cancellation of dislocation structures, which are formed by the pre-strain, leads to plastic instability in the material, which subsequently leads to early failure of the material.

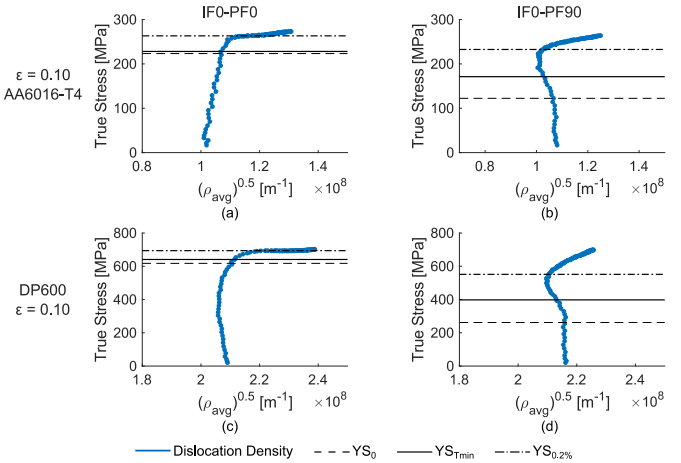

Figure 2. Development of the dislocation density of AA6016-T4 and DP600 (a) & (c) without changing the loading direction and (b) & (d) with changing the loading direction by 90°.

Publications

- 10.1007/978-3-031-06212-4_56
- 10.1007/s12289-024-01823-1
- 10.21741/9781644902479-81

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Partnerships

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