English version below

Institut für Umformtechnik und Leichtbau

Experimentelle und numerische Bewertung der Fließortbestimmung mittels Kreuzzugversuch

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Zusammenfassung

This thesis presents a fundamental investigation of the cruciform test with different sample geometries and on the basis of this an investigation of yield locus shapes for deep drawing grades. The cruciform test has become popular in the last decades in such a way, that researchers published various papers with different designs of specimen and evaluation methods. Thus the lack of a standard geometry and evaluation method has meant so far that correlations of results from different laboratories are almost impossible.

In this thesis, three different specimen designs are compared using FE-Analysis and surface strain measurements via AutoGrid® measurement system. Furthermore, biaxial cruciform tests with these specimen designs are compared with different types of experiments such as the hydraulic bulge test and a plane strain test. Additionally, the specimens are compared with the uniaxial tensile test. The outcome indicates that at least one specimen design provides similar results like the reference experiments.

The behavior of five deep drawing steel grades under biaxial loading are investigated. The identified yield points are compared with yield loci calculated with Hill's 1948 and Barlat's Yld2000-2d criteria. The tested materials reveal a differential work hardening effect changing the shape of the yield loci with ongoing straining. It was observed that for all material except one a saturation state is achieved whereupon the expansion of the yield loci can be described as isotropic. The Yld2000-2d criterion is in much better agreement with the experimental data as Hill48; even though measurements under plane strain loading expose that the exponent should not be defined on basis of lattice structure but rather be optimized.

The effect of the strain rate in biaxial tests is investigated. The results show that higher strain rates lead to yield points at higher stresses and the effect is likewise for all stress-paths. Thus, all yield points have to be identified using same strain rates; otherwise the shape of the yield locus is affected.

The last chapter of this thesis deals with the simulation and the investigation of a deepdrawn body part. The simulation using the Yld2000-2d criterion is in good agreement with the experiment. The outcome of this investigation may contribute some ideas for a calibration of yield locus models to increase the accuracy of these models and thus the accuracy of numerical simulations.

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Experimental and numerical evaluation of yield locus determination by means of cruciform tests

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Abstract

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