The influence of combined sheet metal forming on the increasing formability by experimental and numerical investigations

Yalin Kiliclar*, O. Koray Demir†, Ivaylo N. Vladimirov*, Christian Weddeling†, Stefanie Reeese* and A. Erman Tekkaya†

* Institute of Applied Mechanics (IFAM)
RWTH Aachen University, Germany
Email: yalin.kiliclar@rwth-aachen.de

† Institute of Forming Technology and Lightweight Construction (IUL)
TU Dortmund, Germany
Email: koray.demir@iul.tu-dortmund.de

ABSTRACT

Classical sheet metal forming processes like deep drawing are widely used in the industry. The final shape of the deformed sheet metal depends on several forming factors such as lubrication, punch speed and geometry of the acting tools. A quantity to measure the formability of the workpiece material is the forming limit diagram (FLD) where maximum major and minor strains are compared to their forming limit curve (FLC).

This works aims to increase these FLCs by combining deep drawing with a subsequent electromagnetic high speed forming. The principle is based on the fact that the maximum formability of the material is reached after the quasi-static deep drawing. At this point, the punch is replaced by one which is modified with coil windings in the edge radius region. A high current pulse is induced through to the coils and leads to a high-speed electromagnetic postforming of the sheet. A sharper radius can be observed at the end of the process without material failure which is reflected by a higher FLC.

The process chain is investigated for both the forming of a round cup and for more complex geometries like a cross shaped cup. An efficient viscoplastic material model for large deformations is used for the numerical investigation, coupled with rate dependent Lemaitre type damage formulation. The user material subroutine is implemented via the UMAT interface to the commercial explicit package of LS Dyna.