Finite Element Analysis for Deep Drawing of Tailored Heat Treated Blanks

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Abstract. Aluminum alloys, due to their low density compared to steels, are an important group of materials, in particular for light weight construction of transport vehicles. However, aside from their low specific weight, drawing of car body components made from aluminum alloys is limited by an inferior formability. To enable a modern car body design, it is necessary to enhance the formability of aluminum sheet metal. One basic approach to reach this aim is to adapt the mechanical properties of the blank for the drawing process. The general idea is to soften the deformation zone relative to the force transferring zone, which results in an improved material flow and thus to larger drawing depths. In this paper the process sequence consisting of local induction heat treatment followed by deep drawing of precipitation hardenable aluminum alloy is presented. Using an induction system, it is possible to change the mechanical properties of the 6xxx aluminum blanks in a restricted area by influencing the precipitation structure. Tensile tests characterize the conversion from the stable naturally aged condition T4 to reversible solution heat treated W conditions of AA6016 as function of temperature and time. This effect leads to a reduction of flow stress, which is used to design an material property distribution adapted for the subsequent deep drawing process. A process characterization study provides detailed information concerning induction heating parameters, to improve the deep drawing of cylindrical cups, which results in a decisive increase of the limiting drawing ratio. Accompanying the experimental investigations, a finite element analysis approach is realized as a process design and optimization tool. Following the presented strategy, it is possible to enhance the forming capability of aluminum alloys. This leads to advanced manufacturing processes, which extend the field of applications for aluminum car body parts.