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Abstract

Formation of wavy boundaries at the open end of a drawn cup is referred to as earing. Plastic anisotropy is the main parameter contributing to formation of ears. Therefore, in order to eliminate the undesirable ears in sheet metal parts, it is essential to predict the deformation behavior of sheet metals using advanced anisotropic yield criteria. Accordingly, the objective of this article is that to use BBC2003 yield criterion, to predict earing in deep drawing of cylindrical cups from AA3105 aluminum alloy. First, a new and simple approach is introduced to calculate the eight constants of this yield function. In this approach, only the uniaxial and plane strain tension tests results, were used. Nonlinear governing equations of these constants were derived and solved by means of well-known steepest descend method. In order to investigate performance and accuracy of this method, the calculated constants were utilized to predict normalized uniaxial yield stress, anisotropy parameters and plane stress yield surface. Then, based on this yield criterion and the associated flow rule, a VUMAT subroutine was developed and employed in the commercial finite element software ABAQUS/Explicit dynamics. The simulation of drawing process was conducted for anisotropic AA3105 aluminum alloy sheet. Cup height (earing profile) and thickness distribution were obtained from experiments and corresponding numerical simulations. Comparison of these results demonstrates great potential of BBC2003 yield criterion in accurate prediction of earing.

Keywords: Anisotropic material; finite elements; numerical algorithms; yield condition; BBC2003 yield criterion.