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Earing Minimization with Segmented and Variable Blank Holder Force during Deep Drawing Process for Circular Cup Forming

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Abstract

Aluminum cans are one of the major beverage containers, and 19 billion cans are produced in a year in Japan. But the can body has a production issue called “Earing”, which is caused by the material anisotropy of rolled blank sheet during the deep drawing process. In this study, we have implemented the drawing process simulation of aluminum can bodies by using the LS-DYNA and have tried design optimization to reduce the Earing by the adjustment of the Segmented Blank Holder Force (SBHF) and Variable Blank Holder Force (VBHF)[1]. The SBHF, which is new leading edge technology, is a force when the holder is divided into some subdivisions and is applied different BHFs. The VBHF is a force when the punch stroke is divided into some semi-strokes and the holder is applied with different BHFs in each semi-stroke. In drawing process, we must consider the geometrical defect, so tearing and wrinkling are taken as constraints in the optimization process. The occurrence of tearing is evaluated in minimum thickness, on the other hand the occurrence of wrinkling is evaluated in distance with holder and die. Using the Design Of Experiments (DOE) the response surface by the approximation of second order polynomial has been constructed and the design parameters have been optimized. As a result, we have succeeded in reducing the Earing more than 25 percent compared with the blank holder force applied with constant uniform pressure. Finally, we have developed the BHF control methods to reduce the Earing.

[1] Kitayama, S., Hamano, S., Yamazaki, K., Kubo, T., Nishikawa, H. and Kinoshita H., A closed-loop type algorithm for determination of variable blank holder force trajectory and its application to square cup deep drawing, International Journal of Advanced Manufacturing Technology, Vol. 51, No. 5, (2010), pp. 507-517.