Modeling of size effect on tensile flow stress of sheet metal in microforming

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RESEARCH PAPERS

Modeling of Size Effect on Tensile Flow Stress of Sheet Metal in Microforming

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This investigation considers the size effect on the deformation behavior of simple tension in microforming and thus proposes a simple model of the tensile flow stress of sheet metal. Experimental results reveal that the measure of the flow stress can be represented as a hyperbolic function $\tanh(T/D)$, which is a function of T/D (sheet thickness/grain size). The predicted flow stress agrees very well with the published experiment. Notably, a specimen with smaller grains has lower normalized flow stress for a given T/D. Since the material properties of the macroscale specimen do not pertain to the microscale, a critical condition $(T/D)_c$ that distinguishes the macroscale from the microscale in the tensile flow stress is subsequently proposed, based on the "affected zone" model, the pile-up theory of dislocations, and the Hall–Petch relation. The distribution of the predicted $(T/D)_c$ is similar to the experimental finding that the $(T/D)_c$ decreases as the grain size increases. However, the orientation-dependent factor β is sensitive to $(T/D)_c$. Hence, further study of the orientation-dependent factor β is necessary to obtain a more accurate $(T/D)_c$ and, thus, to evaluate and understand better the tensile flow stress of sheet metal in microforming.

Issue Section: Research Papers

Keywords: deformation, dislocations, forming processes, grain size, sheet materials, sheet metal processing, stress effects, stress-strain relations, size effect, microforming, tensile flow stress

Topics: Flow (Dynamics), Grain size, Stress, Size effect, Sheet metal

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Three different models of flow stress were discussed in this study: the real Point listing of tensile test data, the Swift fitting curve, and Point listing plus Hollomon fitting curve. To investigate the effect of flow stress model on the analysis results, they were examined by conducting hemisphere forming simulations us- ing a commercial CAE code, Pamstamp. Real hemisphere forming of

270MPa mild steel and advanced high strength steels of DP780 and DP980 were also conducted to verify the CAE analysis results and the steel grade effects. 1. INTRODUCTION. With the rapid development of the compu Modeling of flow stress size effect based on variation of dislocation substructure in micro-tension of pure nickel. The significant size effect on nucleation and propagation of crack during tensile deformation of copper foil: Free surface roughening and crystallography study. J. Chen, H. Gao, +6 authors R. Misra. Materials Science. Geometry and grain size effects on the forming limit of sheet metals in micro-scaled plastic deformation. Micro specimen blanked from cold rolled aluminum sheet metal was used in the applied UOM process. Only the upper and lower part of the sample is deformed that gives about 70% of volume. The rest—the middle part—remains undeformed. Fracture strain decreases with decreasing thickness under the uniaxial tensile state. In particular, the fracture strain decreases dramatically from a thickness of 0.3 mm to 0.1 mm. Micro-manufacturing has received good attention globally in terms of its manufacturing methods/processes. One of the most popular micro-manufacturing processes is micro-forming. size/scale effect. A surface model was used to explain the findings. 1. Introduction. Desire for better quality of life, good health and high working efficiency has been one of major drives. to the innovation of many products hence, new products models were invented, for instance netbook Studies had demonstrated that the flow stress of thin sheet-metal decreases compared to that of its bulk. material due to the size effect, and decreases proportionally with miniaturization [17, 18]. Commonly and those for tensile testing have established and confirmed the effect of varying grain size. The least. flow-stress was observed with SS50, which in turn has the larger grain size, this being followed by. CS50 and finally CS100. This is because when a material of greater grain size is deformed Tensile tests are conducted on the copper sheets to study the flow stress of the materials with different grain sizes before carrying out the microscale deep drawing experiments. After the tensile tests, a novel desktop-sized microscale deep drawing system is used to perform the microscale deep drawing process. Size effects on material behavior in microforming. Article. Full-text available. Microforming which exploits the advantages of metal-forming processes has been considered to be a very promising manufacturing technology for microparts. However, the fundamental understandings on microforming have not been well established yet since the extensive findings and know-how of conventional forming cannot be simply transferred to the microscale.