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FORMABILITY OF ZK60A MAGNESIUM ALLOY

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Forging magnesium alloys is challenging due to brittle behavior at room temperature coming from its hexagonal closed pack (HCP) lattice structure. Therefore, warm or hot forming of magnesium alloys is favorable since ductile behavior, resulting in better workability, appears when other slip planes are activated at elevated temperatures [1].

In order to control such initiation of cracking, understanding and prediction of possible cracking and its evolution are necessary. In this regard, it is quite useful to introduce a damage criterion to process design since critical damage value provides a quantitative criterion on fracture occurrence during deformation.

In this study, the formability of ZK60A billets fabricated by semi-continuously casting, subsequent extrusion, and die casting are compared and evaluated. Since determining formability by upsetting and critical damage value is a practically useful methodology, upsetting tests with the three different magnesium alloy billets were conducted at elevated temperatures and two different strain rates.

The specimen bulges as much as compressed due to friction at the contacting interfaces during upsetting, and concentrated deformation at the lateral surface results in surface cracking. In other words, determination of an accurate friction condition should be carefully conducted to obtain a reasonable critical damage value of the material. The effect of friction condition on the critical damage value calculated with Cockcroft-Latham criterion [2] is investigated by numerical analysis and shear friction coefficient for each experimental condition is determined by comparing the results from the upsetting experiment and numerical analysis.

In addition, the differences in critical height reduction depending on the casting methods were investigated based on inherent defects inside such as voids, and variation of the mechanical property at room temperature depending on the locations within the semi-continuously-casted billet was investigated using X-ray tomography.

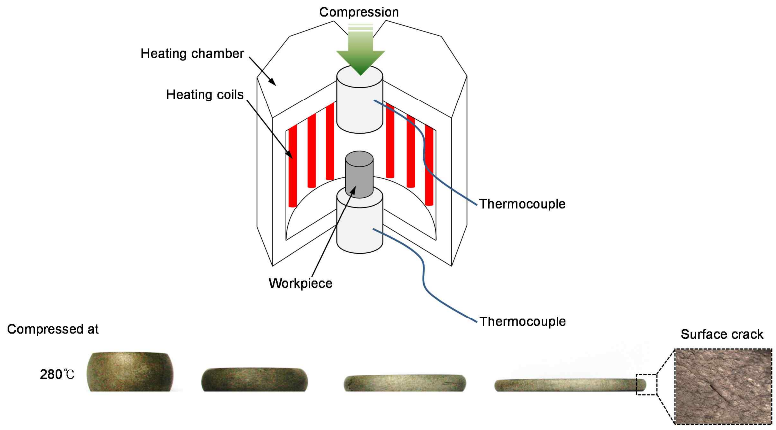

Fig. 1 Schematic description of the upsetting at elevated temperatures.

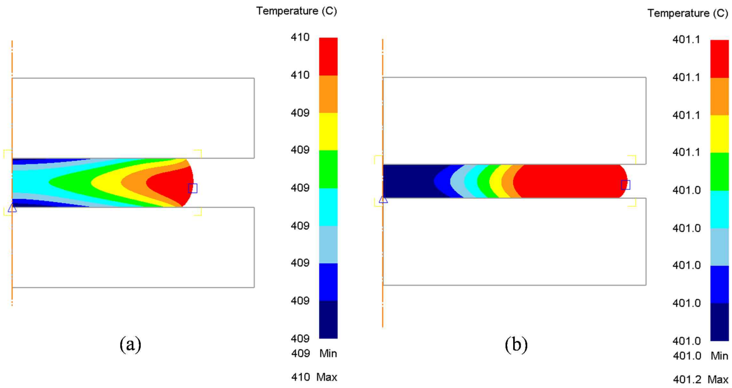

Fig. 2 Numerically obtained temperature distribution and bulged shapes after the upsetting at 400℃ and strain rate (a) 0.01 s^{-1}, and (b) 0.1 s^{-1}.

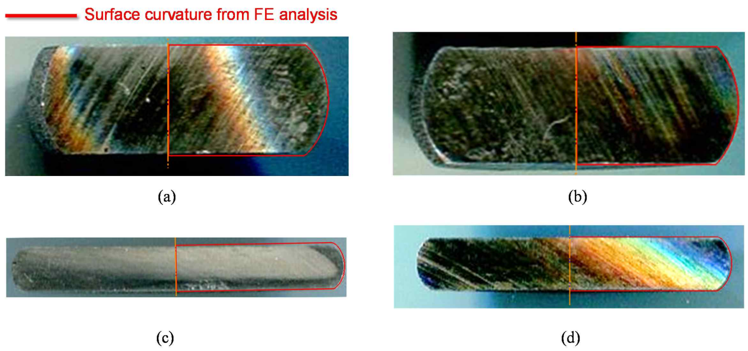

Fig. 3 Comparison of the curvatures obtained from the experiment and simulation: at (a) 280℃ and 0.01 s^{-1}, (b) 280℃ and 0.1 s^{-1}, (c) 400℃ and 0.01 s^{-1}, and (d) 400℃ and 0.1 s^{-1}.

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