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THE ESTABLISHMENT OF THERMAL PROCESSING MAP OF MEDICAL AZ81 MAGNESIUM ALLOY

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Preliminary Note – Prethodno priopćenje

The hot compression deformation of AZ81 magnesium alloy after deformation was carried out on Gleeble-3800 thermal simulator, and the hot deformation characteristics were studied. The maximum true strain is set to 0.7, the deformation temperature is 300 °C, 350 °C, 400 °C and 450 °C, and the deformation rate is 0,01 s^{-1}, 0,1 s^{-1} and 1 s^{-1}. The hot processing map was calculated and drawn, and the microstructure of different compression processes was compared. The results show that the deformation temperature is (400 ± 20)°C, the strain rate is 0,1 s^{-1}, and the crystal is fine and uniform, which is the best hot processing parameters.

Keyword: medical AZ81, magnesium alloy, rheological stress, thermal process diagram, structure

INTRODUCTION

Magnesium alloy has a small density, thermal conductivity, The damping properties and the cutting performance are good, and can be recycled and reused. Magnesium alloys are increasingly valued by the material industry in the face of energy conservation. [1-3] Because magnesium is a six-party structure with a few slip lines and is difficult to plasticized at room temperature, it is especially important to study the shape performance of magnesium [4].

The AZ81 alloy is an alloy made up of a base-up increase of magnesium alloy for AZ61 industrial use, and is made up of conventional heat extrusion and hot rolling technology to fine-size the AZ81 alloy tissue, thereby improving the mechanical performance of the alloy. This paper mainly focuses on medical support, using AZ81 magnesium-alloy deformation as the research object, and examines the plastic of AZ81 magnesium alloy deformation, providing the basis for the determination of the thermal process system and the prediction of the thermal deformation tissue.

MATERIALS AND THEIR METHODS

The alloy used in the experiment is AZ81 wrought magnesium alloy, and its chemical composition is Mg-8,0Al-1,0Zn-0,5Sb (mass fraction/%). The AZ81 magnesium alloy was processed into a cylindrical sample with a height of 150 mm and a diameter of 100 mm by a wire cutting machine, and the hot compression experiment was completed on a Gleeble-3800D thermal simulation machine. The hot compression is first heated to the set temperature at a constant speed of 10°C/s-1), followed by heat preservation for 150 s, and then hot compression is performed. During the period, the set temperature is kept unchanged, and the compression is performed according to the set strain rate. The cooling method uses water quenching, which is beneficial to preserve the microstructure of the magnesium alloy. The deformation temperatures T are 300, 350, 400 and 450 °C, respectively. The strain rates ε are 0,01,0,1 and $1s^{-1}$), respectively. The maximum deformation is 0,7. After hot compression, the samples were cut along the longitudinal section to prepare metallographic samples, and the microstructure after hot deformation was observed by optical microscope.

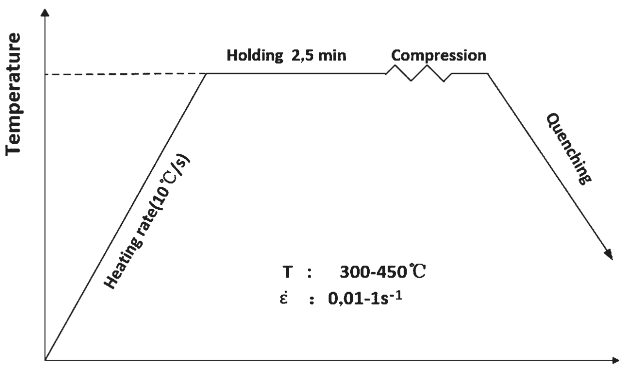

Figure 1 Gleble-3800D Thermal Simulation Experimental Scheme

OPTIMIZATION OF THERMAL PROCESSING PARAMETERS

AZ81 magnesium is now a good fit for medical support materials. However, the process of processing and manufacturing a qualified medical support is not only the characteristic of AZ81 material, but also the ration-

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ality of the process of processing its material. Reasonable process parameters save costs, increase manufacturing efficiency, and reduce scrap rates. In recent years, the process parameters of the thermal process of metal materials have been optimized for thermal process mapping, which not only predicts internal defects in the material during thermal processing, but also optimizes the process parameters to improve the material's tissue performance and obtain optimum molding conditions [5].

The most widely used dynamic material-based model available today, Dynamic Thermal process diagram for Material Modeling (DMM). This type of heat map allows for more precise identification of the optimum process range of alloys, so a DMM based heat map is used.

The principle can be considered as: Assuming equipment, A thermal shut-off system is formed between the mold and the workpiece, which directly links energy dissipation to the thermal process. Based on this theory, the total energy P can be entered into a dissipative G and a dissipative cohal J, which are expressed as:

$$P = \dot{\varepsilon}\sigma = G + J = \int_0^{\dot{\varepsilon}} \sigma d\dot{\varepsilon} + \int_0^{\sigma} \dot{\varepsilon} d\sigma$$

Where the dissipation G is the energy consumed by the material in the event of plastic deformation, and the dissipation coof J is the energy consumed by the evolution of the material tissue during thermal deformation. Together, they form the total energy P. The ratio of G to J is determined by the strain rate sensitivity index (m), which increases with m in metal material and J in metal material decreases with m. When m = l, the metal material is ideal for dissipation conditions and J is at maximum. Metal material during thermal processing, the strain rate sensitivity index m value, expressed as:

$$m = \frac{\partial(\lg \sigma)}{\partial(\lg \dot{\varepsilon})}$$

The power dissipation efficiency factor is introduced. It reflects the proportion of the energy consumed by the microstructure change in P, which is related to m, as shown in the following formula.

$$\eta = \frac{2m}{m+1}$$

The most widely used is Prasad's unstable conviction. The criteria have been successfully applied to a wide range of alloys, including AZ61 magnesium alloys, which are associated with this research material. Therefore, the criteria for determining the stability used in this document are:

$$\zeta(\dot{\varepsilon}) = \frac{\partial\left[\ln\left(\frac{m}{m+1}\right)\right]}{\partial(\ln \dot{\varepsilon})} + m < 0$$

The values under different conditions are drawn into contour lines, that is, the power dissipation diagram, as shown in Figure 2. The figure intuitively shows the stability of microstructure evolution under different deformation conditions. As a part of the optimization tool of thermal processing parameters, the power dissipation diagram provides a simple and intuitive choice of high-power consumption area and high value area for stable organizational structure when selecting the best processing parameters. When the value is high, the main mechanism of microstructure change is dynamic recrystallization, the microstructure is fully refined and the microstructure is evenly distributed.

As can be seen from Figure 2, the distribution of power dissipation values is basically consistent across different strains, and the presence of this phenomenon directly leads to the failure to pass a single power Dissipative diagrams to determine the advantages and disadvantages of material performance Figure 3.

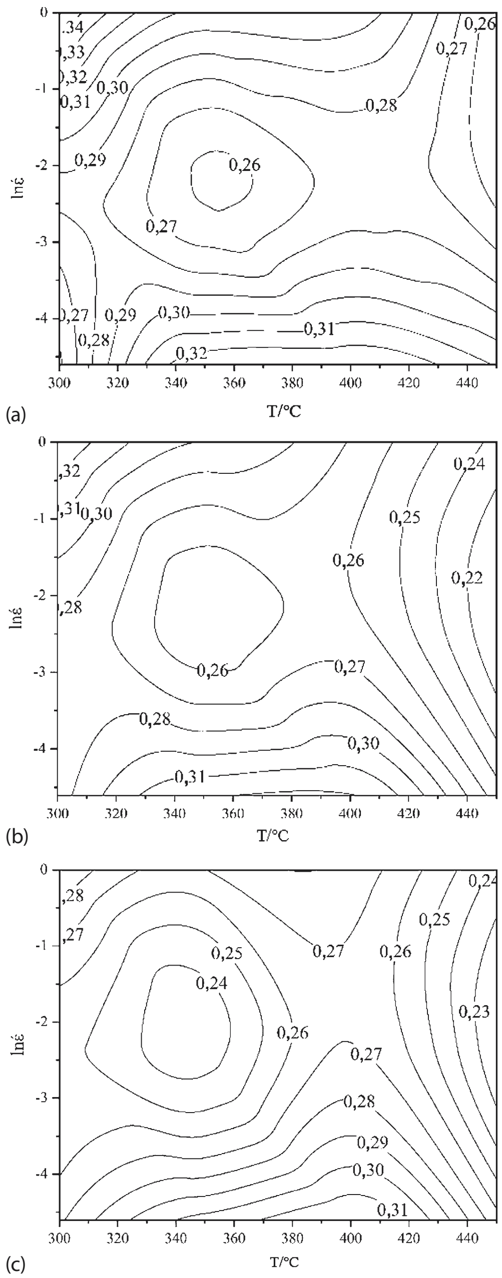

Figure 2 Energy loss graph of AZ81 magnesium alloy at different true strains (a) True strain is 0, 2; (b) True strain is 0, 4; (c) True strain is 0, 6

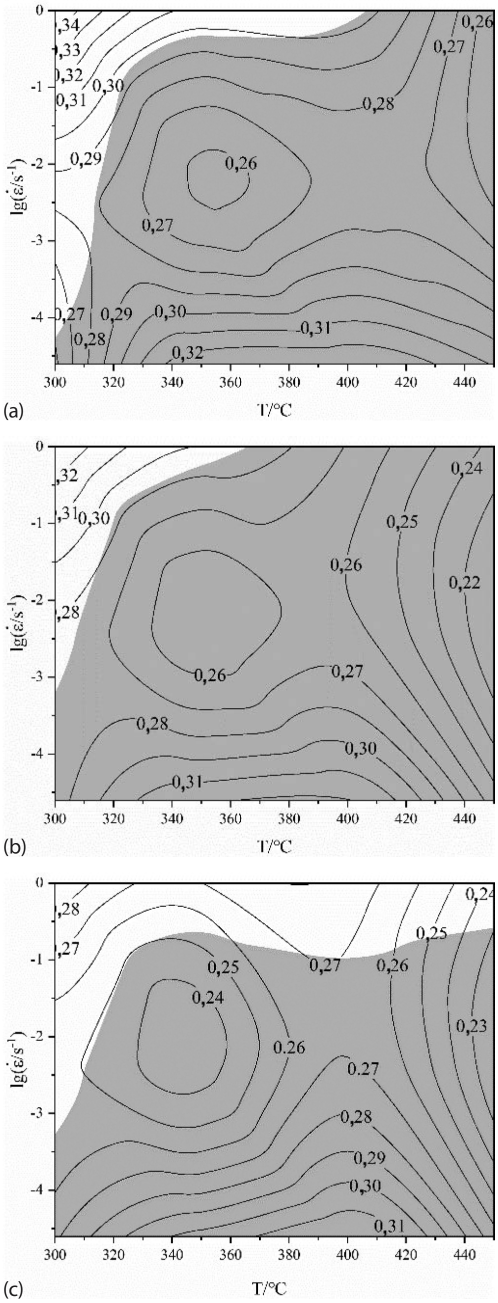

Figure 3 Thermal drawing of AZ81 magnesium alloy(a) True strain is 0, 2; (b) True strain is 0, 4; (c) True strain is 0, 6

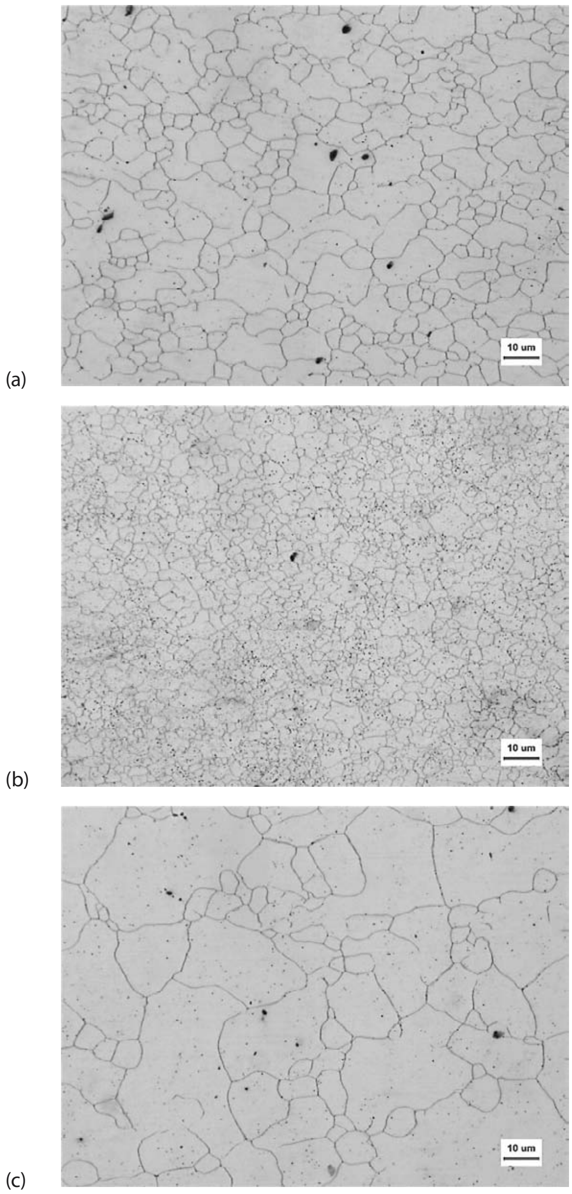

Figure 4 AZ81 magnesium is microscopic in different deformation conditions. (a) 450°C, 0,01s^{-1}; (b) 400°C, 0,1s^{-1}; (c)300°C, 1s^{-1}

The stability factors under different conditions are derived from the instability criterion, and the stability diagram is drawn. The unstable area is filled with color, and the unstable area and the safe area are distinguished. The shaded area with color filling is an unstable area, which is represented by the color depth and the size of the instability factor. The smaller the stability factor, the deeper the color, the higher the probability of loss. For the selection of hot processing parameters, it is necessary to avoid the area with instability risk, that is, the area full of color.

DETERMINATION OF OPTIMAL MACHINING PARAMETERS FOR AZ81 MAGNESIUM

Figure 4 shows the microstructure of AZ81 magnesium alloy with a corresponding variable of 0,7 under different deformation conditions. The development of the processing system should give priority to the dynamic recrystallization zone, because the power dissipation in the dynamic recrystallization zone is high, the processing performance is good, and the organization is easy to control.

Figure 4 (a) shows a gold-phase diagram of sample samples for regions with low values of the requested zone. Temperature is 450 °C, The strain rate is 0,01s^{-1}, and the crystal granules of dynamic recrystallization are shown in the diagram, but the dynamic recrystallization is not performed sufficiently, and the expression Dynamic Recrystallization (DRX) is incomplete, resulting in a serious polycrystalline phenomenon, resulting in uneven material performance and reduced mechanical performance, as indicated in the heat-processing diagram (3(c)) Unstable zone, which should be avoided by heat processing.

Figure 4 (b) shows a gold-phase diagram of the zone sample with the highest value of the requested zone. With a temperature of 400 °C and a strain rate of 0.1 s^{-1}, it can be seen that the compression process also produces a large number of small plasma particles in the plasma, represented by a complete DXR, with uniform tissue distribution, which is the most favorable area for heat processing.

Figure 4 (c) shows a gold-phase diagram of samples tested in stable regions with low values of the requested zone. The temperature is 300 °C and the strain rate is 1s. We can see that the process has been processing with dynamic recrystallization. However, the dynamic recrystallization produces less grain, and the granules are abnormally grown. After processing, the grain in the tissue is large. We should avoid processing this area.

CONCLUSION

Based on the theory of dynamic material modeling, draw a thermal process diagram of the deformed AZ81 magnesium alloy and observe that the deformed AZ81 magnesium alloy is at a temperature of 450 °C, strain rate is 0,01s^{-1}, temperature is 400 °C, strain rate is 0,1 s^{-1}, temperature is 300 °C, and strain rate is 1 s^{-1}, gold phase tissue in 3 areas further proves temperature is (400 ± 20)°C, The zone with strain rate of 0,1 s^{-1} is the best area for heat processing.

Acknowledgments

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Note: The responsible translator for English language is Z.W. Wang - Caofeidian College of Technology, China