Effect of Heat Treatment on the Microstructure and Mechanical Properties of Cast Mg-5Y-3Nd-3Zn-0.6Zr Alloy

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Abstract: The microstructure evolution and mechanical performance of cast,solid solution, and aging Mg-5Y-3Nd-3Zn-0.6Zralloywere systematically investigated by the scanning electron microscope (SEM), X-ray diffractometer (XRD), transmission electron microscope (TEM), differential scanning calorimeter (DSC) and electronic universal testing machine.in this work. The microstructure analyses show that the cast Mg-5Y-3Nd-3Zn-0.6Zr alloy consist of α-Mg, LPSO phase and W phase. After the solid solution of 510 ℃ × 12h,the reticular W phase can be transformed into spherical W phase. The precipitation sequences of the alloy aged at 210℃ is β''(DO19)→β'(BCO) →β(FCC), and the streaks sequences of the alloy is SF → 14H-LPSO. The peak-agingoccurred at 16h due to the high volume fraction of β' phase. The mechanical properties test shows that the tensile strength of cast and solid solution alloys are 196.3MPa and 209.5MPa, the elongation of cast and solid solution alloys are 5.8% and 7.1%.

Keywords: Mg alloy, microstructure, mechanical properties, heat treatment, heat resistant property

1 Introduction

Magnesium alloy is one of the lightest metal structural materials, so the replace of aluminum alloy and steel by magnesium alloy in aircrafts and cars can greatly reduce weight to save fuel. However, the application of magnesium alloy in engine shell, gearbox shell and other high temperature components puts forward higher requirements for the high temperature performance of magnesium alloy.

Alloying is the general method for optimizing the phase composition to enhance the mechanical performance at elevated temperature of magnesium alloys. The Mg-Y-Zn alloy contains LPSO phase has aexcellent mechanical properties because it can hinder the dislocation movement and rise the ductility by kink deformation. The addition of Nd in Mg-Y-Zn alloy can further improve the strength because it can reduce the solid solubility of Y and Zn to enhance the precipitationstrengthening effect. So it is essential to clarify the effect mechanism of Nd content on the microstructure evolution, aging precipitationbehaviour, and mechanical performance of Mg-Y-Zn alloy.

2 Experimental procedure

The Mg-5Y-3Nd-3Zn-0.6Zr alloy was prepared by pure Mg (Mg ≥ 99.9 wt.%), pure Zn (Zn≥99.9 wt.%), Mg-30Y(29.5wt.%Y) master alloy, Mg-30Nd (29.3wt.%Nd) master alloy, and Mg-30Zr (30.8wt.%Zr) master alloy in well-type resistance furnace. The solid solution of the alloy is 510℃ for 12h and the aging treatment was 210℃ for 1-100h.

The metallographic specimens were ground, polished, and etched, and then were observed by SEMand tested by XRD. The specimens with a diameter of 3mm were polished by ion beam and observed by TEM. The mechanical performance of alloy wastested by a universal tensile testing machine, and the diagram of tensile specimenwas showed in Fig. 1.

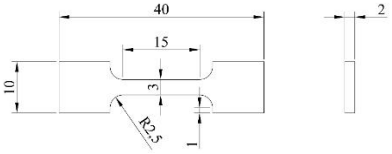

Fig.1 The diagram of tensile specimen

3 Result and discussion

Microstructure of cast WEZK5330 alloy

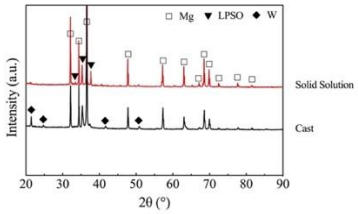

Fig. 2 The XRD of WEZK5330 alloy

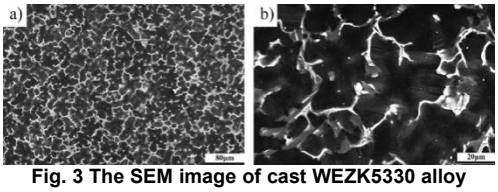

Fig. 3 The SEM image of cast WEZK5330 alloy

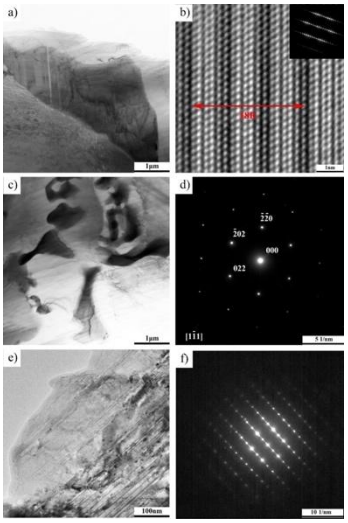

Fig.4The TEM image of cast WEZK5330 alloy

Microstructure of solid solution WEZK5330 alloy

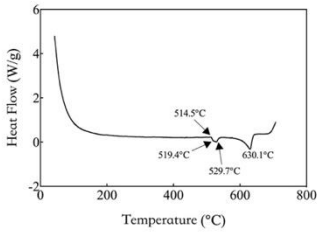

Fig. 5The DSC of cast WEZK5330 alloy

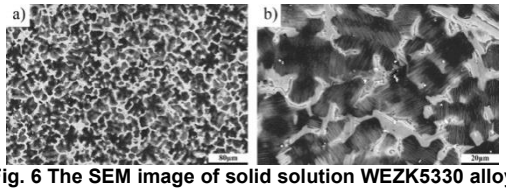

Fig. 6 The SEM image of solid solution WEZK5330 alloy

Microstructure of aging WEZK5330 alloy

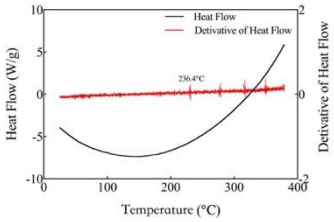

Fig.7The DSC of solid solution WEZK5330 alloy

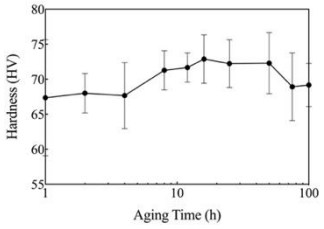

Fig. 8 The aging hardness of WEZK5330 alloy

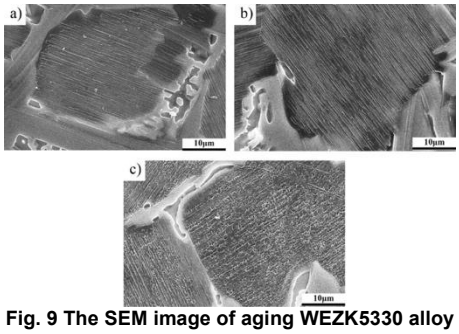

Fig. 9 The SEM image of aging WEZK5330 alloy

Mechanical Properties of WEZK5330 alloy

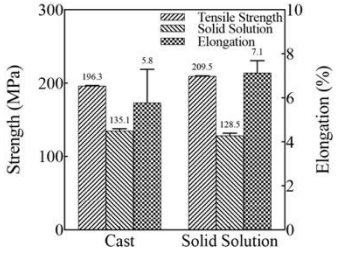

Fig. 10Themechanical propertiesof WEZK5330 alloy

4 Conclusion

1. The cast Mg-5Y-3Nd-3Zn-0.6Zr alloy consist of α-Mg, LPSO phase and W phase.

2. After the solid solution of 510℃ × 12h, the reticular W phase can be transformed into spherical W phase.

3. The precipitation sequences of the alloy aged at 210℃ is β"(DO19)→β'(BCO)→β(FCC)

4. The mechanical properties test shows that the tensile strength of cast and solid solution alloys are 196.3MPa and 209.5MPa, the elongation of cast and solid solution alloys are 5.8% and 7.1%.

References

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