Microstructure and Mechanical Properties of AZ81 Magnesium Alloy

Quan-an Li[1,2,a], Xiaoya Chen[1,*], Qing Zhang[1,2], Jun Chen[1,2], Yao Zhou[1]

[1]School of Materials Science and Engineering, Henan University of Science and Technology, Luoyang 471023, China

[2]Collaborative Innovation Center of Nonferrous Metals, Henan Province, Luoyang 471023, China

[a]q-ali@163.com *email: chenxiaoya2010@163.com

Keywords: AZ81 Magnesium Alloy; Microstructure; Mechanical Properties

Abstract. The microstructure and mechanical properties of AZ81 magnesium alloy have been studied by micro-analysis and tensile tests. The results showed that the alloy mainly consists of α-Mg matrix, $Mg_{17}Al_{12}$. The tensile strength of AZ81 magnesium alloy is measured, The best tensile strength is 258MPa at 20℃.

Introduction

In today's world, the energy crisis and environmental pollution are increasingly serious, which makes people pursuit of lightweight material. As the lightest metal structure material, magnesium alloy has become a research focus. Moreover due to the small density, good thermal conductivity and the characteristics of the electromagnetic interference resistance, magnesium alloy is more widely application in 3C products[1-5].

The biggest application is casting of magnesium alloy. In addition to the necessary strength at room temperature, a considerable part requires enough high temperature strength. And the most widely used is Mg-Al alloys that are die casting magnesium alloys. AZ81 magnesium alloy is one of the most widely used in industrial application of magnesium alloy[6-10]. The experiment is on the basis of previous studies, the microstructure and mechanical properties of AZ81 magnesium alloy have been further studied.

Experimental

The raw materials for experiment are pure magnesium(99.95%), industrial pure Al (99.9%), Zn. Magnesium alloy is smelt in an induction furnace, using 1vol.% SF_6+99vol.% CO_2 gas mixture for smelting protection. solid solution process is cared out at 420℃ for 12h, and then quenched in warm water. Aging process is perfored at 200℃ for 16h, and then cooled in air. Mechanics performance test is made on AG-I 250KN precision universal experimental machine, stretching rate is 1 mm/min. At 20 ℃, 100℃ and 150℃, the tensile strength and elongation of the AZ81 magnesium alloy is measured, the tensile sample is shown in Fig. 1. Use D8ADVANCE type X-ray diffractometer to analyze the phases on the alloy, The microstructure of the alloy is analyzed by optical microscopy .Use JMS-5610LV scanning electron microscope to observe the tensile fracture morphology.

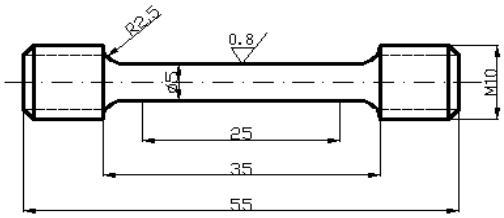

Fig.1 Tensile sample

Results and analysis

The phases of as-cast AZ81 magnesium alloy are analyzed, and the X-ray diffraction patterns of the AZ81 magnesium alloy is shown in Fig. 2. It can be seen that the alloy consists of α-Mg matrix, $Mg_{17}Al_{12}$. In addition, some peaks of Zn contented phase are not observed since the addition of Zn is little.

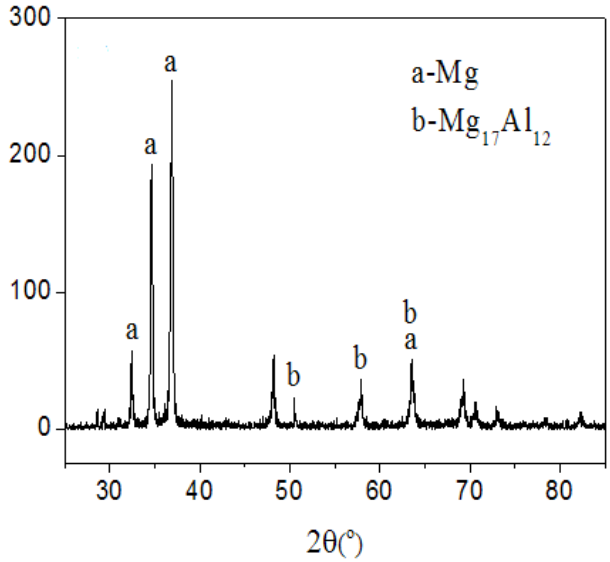

Fig.2 X-ray diffraction patterns of the as-cast AZ81 alloy

Fig. 3 shows the microstructure of AZ81 magnesium alloy. The microstructure of as-cast AZ81 alloy is shown in Fig. 3(a), It can been seen from Fig. 3(a) that the alloy is mainly composed of dendritic shaped α-Mg matrix and gray divorced eutectic β-$Mg_{17}Al_{12}$[11] phase which distributed in the grain boundary. Fig. 3(b) shows the microstructure solid solution and aging AZ81 alloy, it can be seen that block-shaped β-$Mg_{17}Al_{12}$ phase distributes on the grain boundary.

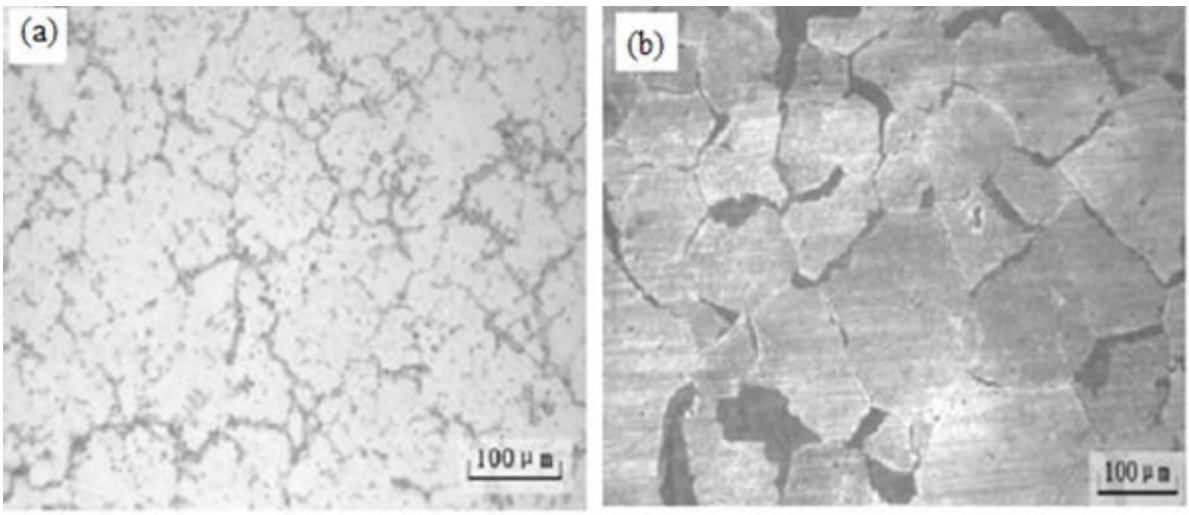

Fig.3 The microstructure of AZ81 magnesium alloy.
(a) as-cast AZ81 ; (b) solid solution and aging AZ81

It can be seen from table 1, that from room temperature (20 ℃) to high temperature (175℃), the tensile strength of the alloy decreases, and the peak appears at 20℃. Mechanical properties of the alloy are the best at room temperature. The mechanical properties of the alloy under the high temperature remain to be improved.

Table.1 The mechanical properties of aging alloy

Temperature	Tensile Strength [MPa]	Elongation [%]
20 ℃	258	7.8
150℃	186	10.7
175℃	162	12.2

The SEM fractographies of tensile fracture surface for aging AZ81 magnesium alloy at room temperature is shown in Fig. 4. Fracture has a small tear edges, and is mainly composed of a lot of big size cleavage planes and the local tongue shape pattern, it has obvious characteristic of cleavage fracture. Morphology has apparent shear plane, it may be due to much and massive the second phase($Mg_{17}Al_{12}$), the microporous is formed at second phase, and the microporous is connected via cut way, it eventually formed the shear plane.

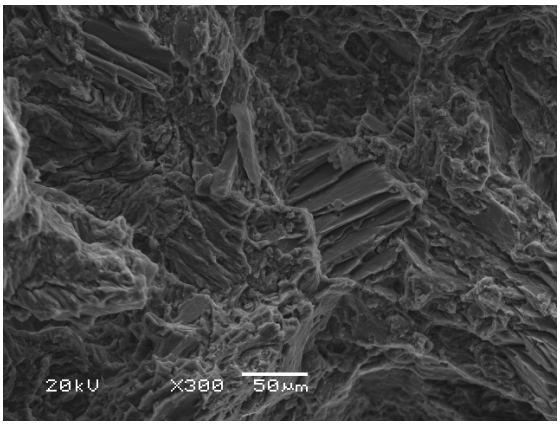

Fig.4 SEM fractographies of tensile fracture surface for aging AZ81 magnesium alloy at room temperature

Conclusions

1) The microstructure of AZ81 magnesium alloy is mainly composed of α-Mg matrix, β-$Mg_{17}Al_{12}$.
2) Mechanical properties of AZ81 magnesium alloy at room temperature are best, Tensile strength is 258Mpa.

Acknowledgement

The project is supported by the National Natural Science Foundation of China (No. 51171059), Basic and Frontier Technologies Research Plan of Henan Province (No. 102300410018) and Program for Innovative Research Team (in Science and Technology) in University of Henan Province (No. 2012IRTSTHN008).

References

[1] J Zhang, F.Q Yuang, H Huang. Mechanical Properties of as-Cast and as-Extruded Mg-Zn-Al-Re Magnesium Alloys at Room Temperature and Elevated Tremperatures[J]. Rare Metal Materials and Engineering, 2013, 42(3): 593-597.

[2] C Lin, X.G LI. Initial corrosion behaviors of AZ91 magnesium alloy in the presence of SO2[J]. Journal of University of Science and Technology Beijing, 2004, 11(5): 433-441.

[3] K Ishikawa, H Watanaba, T Mukai. High strain rate deformation behavior of an AZ91

magnesium alloy at elevated temperatures[J]. Materials Letters, 2005, 59: 1511-1515.

[4] B Akyuz. Influence of Al content on machinability of AZ series Mg alloys[J]. Transactions of Nonferrous Metals Society of China, 2013, 23(8): 2243−2249.

[5] X.Y Fang, D.Q Yi, B Wang, et al. Hot compression deformation behavior of the Mg-Al-Y-Zn magnesium alloy[J]. Rare Metals, 2008, 27(2): 121-126.

[6] B L Mordike, T Ebert. Magnesium: properties-applications-potential[J]. Materials Science and Engineering A, 2001, 302(1): 37-45.

[7] L.J Yang, Y.H Wei, L.F Hou. Microstructure evolution of thixomolding AZ91D magnesium alloy during heat treatment[J]. Journal of Materials Science. 2010, 45(13): 3626-3634.

[8] B Akyuz. Influence of Al content on machinability of AZ series Mg alloys[J]. Transactions of Nonferrous Metals Society of China, 2013, 23(8): 2243−2249.

[9] J.C Xie, Q.A Li, J.H Li, et al. Influence of Ca on mechanical properties of AZ81 Mg alloy[J]. Light Metals, 2007, (12): 58-62.

[10] K.J Li, Q.A Li, X.Q Wang. Effects of Gadolinium on AZ81 Magnesium Alloy Microstructure[J]. 2010, 62(1): 10-13.

[11] T Liu, X.Y Teng, G.R Zhou, et al. Effects of Y and Er Addition on Microstructure and Mechanical Properties of As-Cast AZ91 Alloy[J]. Rare Metal Materials and Engineering, 2012, 41(11): 1940-1944.