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Mechanical properties of the model casting magnesium alloy AZ 91*

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Selected mechanical properties of the model casting magnesium alloy AZ91 used for automobile wheels are investigated. The results of tensile test, impact test, hardness and fatigue test are presented in this paper. These results, with using SEM fracture analysis, are completed.

1. INTRODUCTION

Magnesium alloys has been used for a wide variety of applications, namely from the reason of their low density and high strength–to–weight ratio. Due to its attractive properties, magnesium alloys has been successfully used in various structural applications. Low inertia, which results from its low density, is advantageous in rapidly moving parts, for example automobile wheels and other automobile parts. The similar situation is in the aeronautical market and air–frame application. Trends in magnesium alloys progress for the automotive market were analyzed recently by Magers [1]. Selection of magnesium alloy components in production motorcars and trucks are given in table 1 (after [2]). The widely spectrum of magnesium alloy products are available with a large range of strengths and ductilities.

As shown in Table 1, AZ91 is often used magnesium alloy in production of motorcars and trucks. This alloy in Czech Republic is developed by ČKD Motory a.s.Hradec Králové. From this reason presented paper is devoted to the study of selected mechanical properties and SEM fracture analysis of magnesium alloy AZ91.

2. EXPERIMENTAL PROCEDURES AND RESULTS

For the experimental study of selected mechanical properties the model magnesium alloy AZ91 (produced by ČKD Motory a.s.Hradec Králové) was used. This model alloy was cast in the shape of plates and rods. Plate dimensions were 200x100x15 mm and the rod diameter was 12 mm.

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Table 1
Selection of magnesium alloy components in production motor cars and (after [2])

Company	Part	Model	Alloy
Ford	Clutch housing, oil pan, steering column	Ranger	AZ91HP AZ91B
	Four-wheel-drive transfer case housing	Aerostar 1994	AZ91D
	Manual transmission case housing	Bronco	AZ91D
General Motors	Valve cover, air cleaner, clutch housing(manual)	Corvette	AZ91HP
	Induction cover	North Star V-8 1992	AZ91D
	Clutch pedal, brake pedal, steering column brackets	„W“ Oldsmobile, Pontiac, Buick	AZ91D
Chrysler	Drive brackets, oil pan	Jeep 1993	
	Steering column brackets	LH midsize 1993	
	Drive brackets, oil pan	Viper	
Daimler-Benz	Seat frames	500 SL	AM20/50
Alfa-Romeo	Miscellaneous components (45Kg)	GTV	AZ91B
Porsche AG	Miscellaneous components (53 kg)	911	
	Wheels (7.44 kg each)	944 Turbo	AZ91D

There were used two states of these alloys for next investigation:
1. Initial casting alloy (casting into sand form) – signed A.
2. Casting alloy with application of solution heat treatment T4– signed B.

Conditions of this heat treatment were following:

preheating 375 ^{o}C / 3 hour + 415 ^{o}C / 20 hour

The structure and results of basic mechanical properties of studied magnesium alloy AZ91 were described in paper [3].

Tensile test:

The samples for tensile test were made from rod shape alloy.

The results of tensile test, using INOVA TSM 50 tensile machine, were following:

A: Yield point: 98 MPa, Tensile strength: 180 MPa and percentage elongation 6 %.
B: Yield point: 135 MPa, Tensile strength: 271 MPa and percentage elongation 11 %.

Impact test:

The samples for impact test- Charpy V-notch were made from plate shape alloy.

The results of impact test- Charpy V-notch, were following:

A: Impact strength KV= 2 J
B: Impact strength KV= 6,5 J

The fracture surface of impact test sample is showed in Figure 1 and 2. These fracture surfaces are very similar from the reason of dendritic segregation and binding defect namely in case of alloy A.

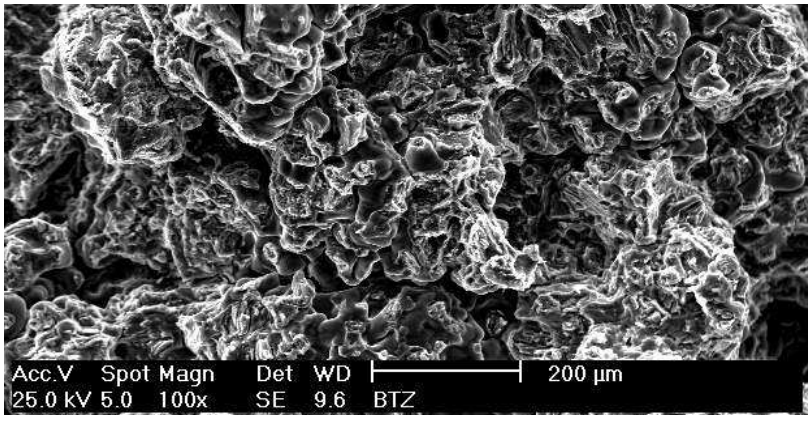

Figure 1. The fracture surface of impact test sample of alloy A

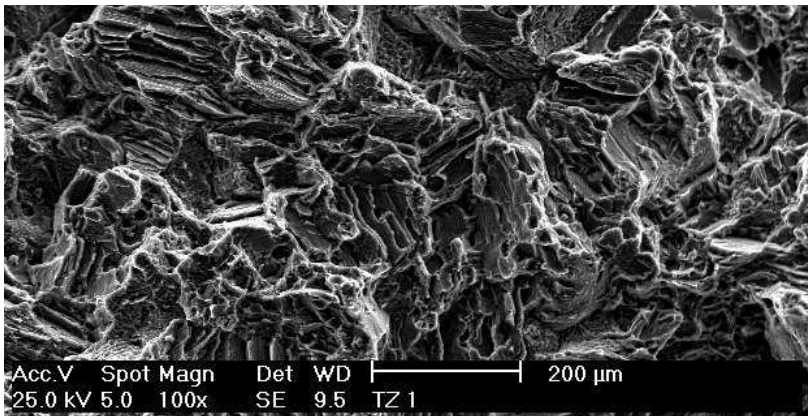

Figure 2. The fracture surface of impact test sample of alloy B

Hardness:

Measurements of hardness were made on the polish surface of the plate A and B. From the reason of the dependence of the hardness on method used and loading conditions, the Brinell, Vickers and Rockwell were used. For each method 100 measurements and statistical evaluation were made. At the next text the average values are used.

The results of hardness tests were following:

A: 80 HV5, 70 HV10, 61 HV30, 68 HBS 2,5/31,25, 64 HRF

B: 75 HV5, 67 HV10, 60 HV30, 64 HBS 2,5/31,25, 59 HRF

This results show the dependence of hardness on method used for magnesium alloy AZ91 and for its comparison can be used. More details presented in paper [4].

Fatigue:

The samples for fatigue test were made from rod shape alloy A. The length of samples was 22 mm and diameter 10 mm. Fatigue tests were performed on rotation beam testing machine at a frequency 2000 Hz. Stress-cycles to failure curve is shown in Figure 3.

The fatigue lifetime of AZ91 cast alloy shows a large scatter from the reason of presence of the pores with agreement fatigue fracture surface showed in Figure 4. This fact due a lower value stress fatigue limit at 5.10^6 cycles, of course.

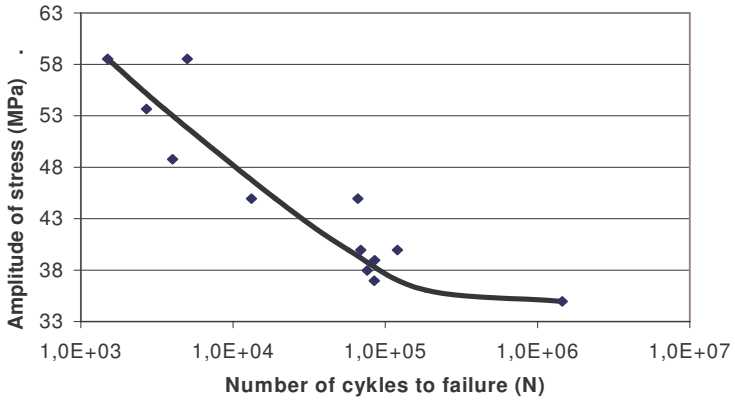

Figure 3. Fatigue curve of AZ91 cast alloy A

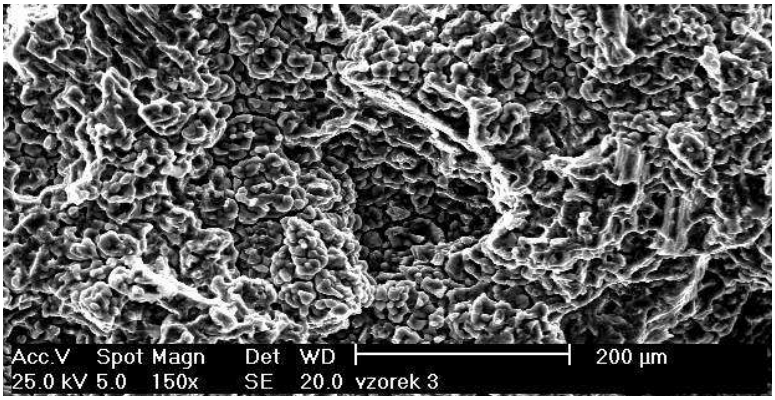

Figure 4. The fracture surface of fatigue test sample of AZ91 cast alloy A

3. CONCLUSIONS

Mechanical properties of model magnesium AZ91 cast alloy in initial and application next solution heat treatment (T4) state were tested. The results show the possibility of heat treatment for higher mechanical property achievement. The fatigue test results show the negative influence of the pore on fatigue properties of alloy AZ91. The hardness test shows a dependence of the hardness values on method of measurement. These results for comparison between different methods can be used

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