EVALUATION OF INTERNAL DAMPING ON MAGNESIUM ALLOY DEPENDING ON THE TEMPERATURE USING BY MATHEMATICAL METHODS

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1. Introduction

Effect of gradual storage of mechanical energy in the material results in a change of mechanical and physical characteristics, which can cause degradation of material properties such as: reduction of the machine tools accuracy, initiation of fatigue cracks, generation of noise and vibration in the working environment, changes of material properties, reduction of corrosion resistance, degradation of regulatory devices and sensors, eventually damage of entire device. Measurement of the internal friction allows monitoring the ongoing structural changes and various mechanisms [1]. Analyze of vibrations is important tool for calculation eigen frequencies of the systems and prediction reaction from material to excitation vibrations [2].

As experimental material for study was used a magnesium alloy AZ91 which was manufactured by squeezes casting method and was delivered without heat treatment.

2. Experimental

In experimental measurement was used a resonance method, using by the experimental equipment from Department of Materials Engineering, from University of Žilina. This method is based on continuous excitation of oscillations of the test bar, and the entire apparatus vibrates at a frequency which is close to the resonance.

Ultrasonic resonance system can measure the only at a single resonant frequency. Before the measurement is necessary to adjust the specimen so the resonance frequency of ultrasonic horn with mounted specimen is the same as resonance frequency of the ultrasonic horn by itself.

For the measurement of the decay test specimen was designed so that the resonance frequency with resonance frequency mechanical part. Starting resonance frequency for all measurements was close to f = 20.4 kHz.

In Figure 1 can be seen, that our measured waveform can also be divided into two periods. First interval of temperature from 50 ° C to 200 ° C and the second temperature interval from 200 ° C to 400 ° C, what was the end of the measurement.

During the measurement occurred local maxims of quality factor in a narrow temperature interval. Similar material behavior was also studied in work [3] and the presence of these maxims is still not clear and there is still a discussion about the reason of their creation. According to previous studies [3, 4] the presence of local maxims depends on frequency, temperature and the deformation amplitude.

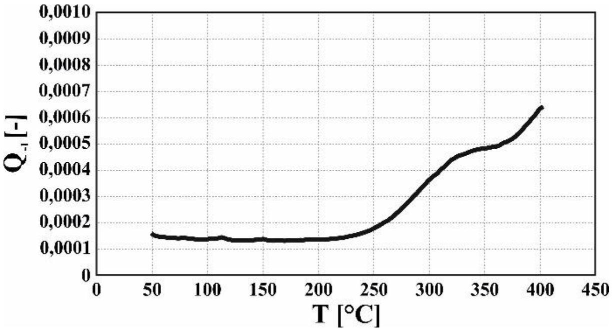

Fig. 1. Temperature depended on internal damping for magnesium alloy.

3. Processing of measured values by mathematical methods

Measurement of the internal damping consists of a large number of measured values of the internal damping depending of temperature. Measuring data contains noisy data, which cannot be presented without necessary adaptations and without mathematical and physical understanding of the basis of measured data.

The mathematical processing of measured values of the magnesium alloy was used approximation by the least squares method. By numerical experimentation we got the most suitable shapes of functions for the approximation of the measured data. For the measured spectrum of internal damping depending on the temperature (Fig. 1) we looked for a universal linear model. In our case the universal model is a polynomial third degree in the form:

$$y(t) \sim \sum_{i=0}^{3} c_i x^i \quad (1)$$

whose parameters are: c_0 = 1.304e-004; c_1 = 5.863e-007; c_2 = -7.283e-009; c_3 = 2.251e-011.

From second interval of procedure of the internal damping of a material was derived non-linear exponential model in the form:

$$y(t) \sim c_0 \exp(c_1 t + c_2 t^2 + c_3 t^3) \quad (2)$$

and represents a relationship which can be linearized by the natural logarithm:

$$lny \sim lnc_0(c_1 t + c_2 t^2 + c_3 t^3) \quad (3)$$

Approximation results are shown in Figure 2. The mutual subtracting of regression curves was obtained individual process of the internal damping, which represents the interaction of additive elements with atoms of the parent phase (Fig. 3).

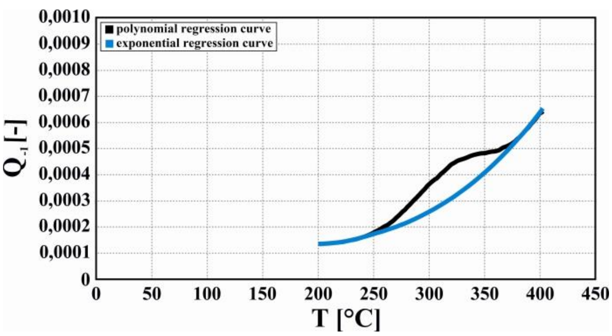

Fig. 2. Regression of the temperature measurement by polynomial and exponential regression curve for magnesium alloy.

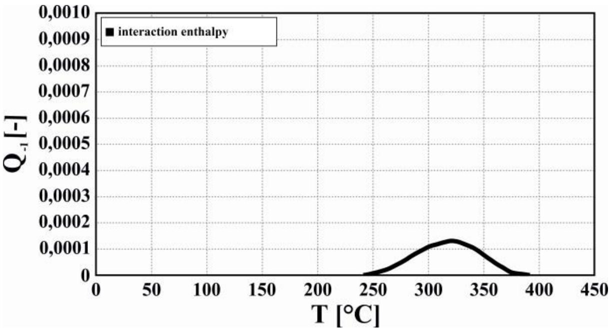

Fig. 3. The separation of the influence of the second mechanism from course of internal damping depending of temperature for magnesium alloy.

4. Conclusions

Based on experimental results from internal damping measurement of magnesium alloy can be stated:
- the internal damping increases with increasing of temperature,
- by increasing the temperature is a lot of energy released by movement of dislocations and the ability of a damping increases in magnesium alloy,
- it can be assumed that the area obtained from peak represents energy used for dissolution of the discontinuous precipitate,
- from curves can be detected the beginning and the end of dissolution and from area can be determined a ratio amount of precipitate in the structure.

Acknowledgements

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