DEPENDENCE OF INTERNAL DAMPING ON TEMPERATURE IN AUSTENITIC STAINLESS STEELS

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1. Introduction

Austenitic stainless steels are ternary alloys of Fe-Cr-Ni. Their microstructure is austenitic at room temperature. These steels exhibit a unique combination of strength and ductility. Austenitic stainless steels are used in applications, where are needed high strength, good formability and good corrosion resistance [1].

Impact of gradual storage of mechanical energy in the material produces a change of mechanical and physical characteristics. It can cause degradation of material properties. These properties are e.g. 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 damping allows monitoring of the ongoing structural changes and various mechanisms [2,3].

2. Experimental material

There were used three types of austenitic stainless steels- AISI 304, Cr-Ni-Mo low-carbon steel AISI 316L and Cr-Ni-Mo steel stabilized with Ti AISI 316Ti. Dimensions of each sample are visible in Fig. 1.

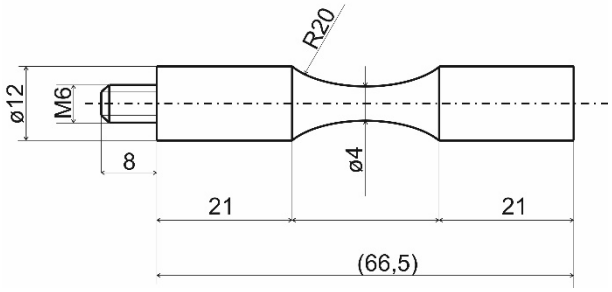

Fig. 1. Experimental sample

3. Experimental procedure

The internal damping was measured three times at each sample on the experimental equipment used at Department of Materials Engineering, University of Žilina, that consists of mechanical and electronic parts (Fig. 2.). First measurement was carried out on the samples in initial state, second measurement on the samples after recrystallization- the samples were heat treated at temperature 800 °C for 15 minutes before measurement. Before third measurement the samples were cooled to -70 °C for 20 minutes and then they were deformed by impact deformation. Temperature dependence of internal damping of materials was observed in interval of temperatures from 25 °C to 400 °C, and back. Heating rate was 1°C/ 1 min.

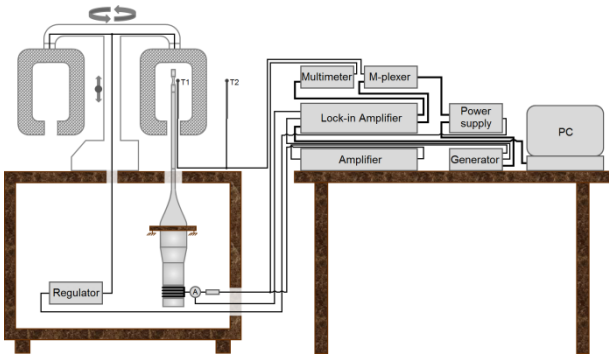

Fig. 2. Device for measurement of internal damping

4. Experimental results

The results for samples in initial state showed one-way memory effect of austenitic stainless steels. The peaks created at temperature about 100 °C have not been created during the way back to lower temperatures (Fig. 3.). Decrease of internal damping with increasing temperature is caused by phase transformation. Material with higher content of deformation twins has got higher peak of internal damping.

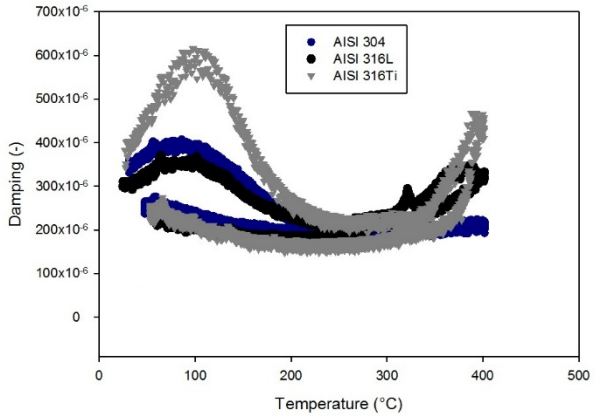

Fig. 3. Internal damping of samples in initial state

Recrystallization annealing (800 °C/15 min) was used for removing of hardening after cold forming. Results in Fig. 4. show substantial change in comparison with graphs for initial state. Highest change of values was observed in AISI 316Ti, curve of AISI 304 was lower and covered by curve of AISI 316L. Decrease of internal damping in all of the samples was caused by structural changes in experimental samples during recrystallization.

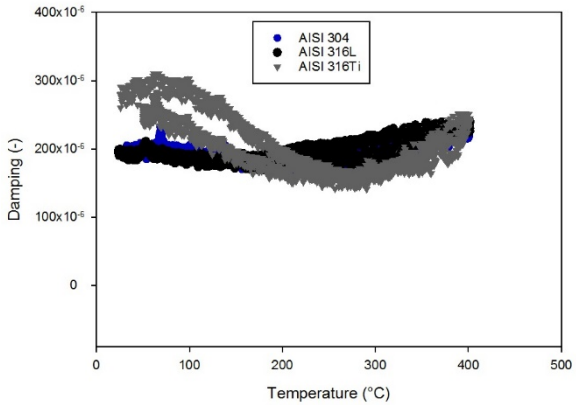

Fig. 4. Measurement after recrystallization

Before third measurement, it was necessary to create new deformation twins in experimental samples. For deformation twinning are needed low temperatures and high speeds of deformation, so the samples were cooled to -70 °C for 20 minutes and then they were deformed by impact deformation. Results in Fig. 5. show, that the curves of internal damping returned to similar values as they were before recrystallization. There was proved memory effect of austenitic stainless steels.

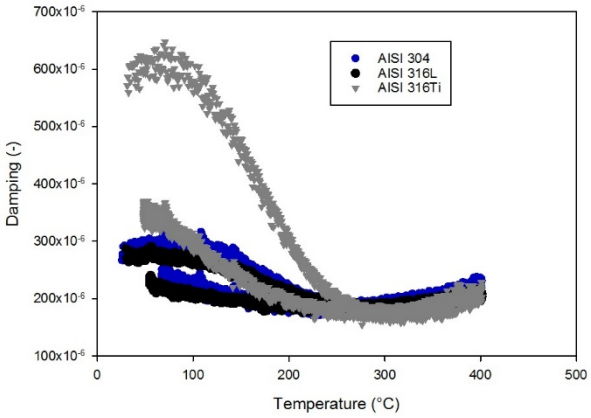

Fig. 5. Measurement after cooling and impact deformation

5. Conclusion

- The internal damping increased with increasing temperature in interval of temperatures higher than 300 °C.
- Austenitic stainless steels showed one-way memory effect.
- Memory effect was verified by experiment with heat treatment and following impact deformation, where new deformation twins were created.

Acknowledgements

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References

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