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INVESTIGATION OF MAGNETIC SUSCEPTIBILITY IN AMORPHOUS BINARY ZrNi AND ZrCu SYSTEMS

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ABSTRACT
The investigation of magnetic susceptibility in binary amorphous Zr35Ni65, Zr40Ni60, Zr35Cu65 and Zr40Cu60 systems was reported in this paper.
The alloys and amorphous ribbons by melt spinning method were produced in the Laboratory for Pyisics of Metals at the Faculty of Sciences, Dept. Physics, Sarajevo.
The tests were conducted in temperature range from 80K to 250K by investigation the temperature dependence on the magnetic susceptibility. For this investigation was used a special sensitive method for measuring ac magnetic susceptibility which enabled a simultaneous measurement of the real and the imaginary component of the susceptibility.
The research is fundamental, i.e. belongs to physics of the solid state.
The obtained results are graphically presented.
Keywords: Amorphous Metallic Alloys, ac Susceptibility, Paramagnetism, Phase Transition

1. INTRODUCTION
The alloys for the production amorphous systems were made into a vacuum electrical-arc furnace in atmospheric argon. The composition of the alloys is:

- Zr35Ni65 (Zr: 35 at.%; Ni: 65 at.%),
- Zr40Ni60 (Zr: 40 at.%; Ni: 60 at.%),
- Zr35Cu65 (Zr: 35 at.%; Cu: 65 at.%),
- Zr40Cu60 (Zr: 40 at.%; Cu: 60 at.%).

Melt-spinning method has been used to obtain amorphous metal systems in the form of metal ribbons.
The magnetic susceptibility is the complex variable, because it is a response of the system on the external magnetic field and has the time shift. This was the reason why we decided to use the induction method, "ac technique " to measure the magnetic susceptibility [1].
The real component of the magnetic susceptibility is connected with the dispersion effects, while the imaginary component of the susceptibility describes the energy changes in the system. If the magnetic system is placed in a spiral, then the real component of the magnetic susceptibility directly affects the inductivity of the spiral, while the imaginary component affects its Ohm resistance.

2. EXPERIMENTAL INVESTIGATIONS

The susceptometer [1] used for measurement of the temperature dependence on the ac magnetic susceptibility.

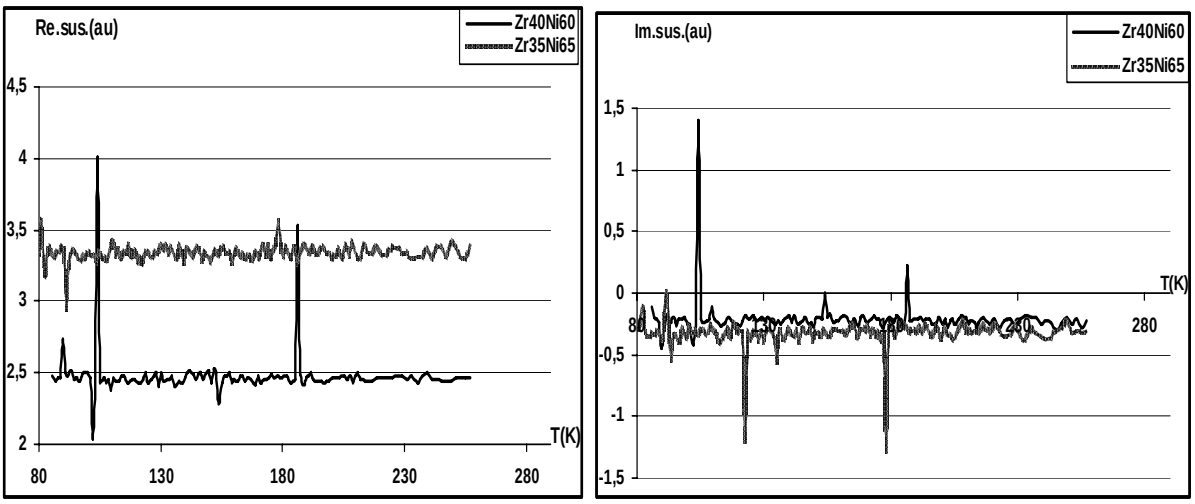
From the relation $V^{sample} = i\mu_0 S\omega N_S H_0 \frac{dM}{dH} e^{i\omega t}$ (μV) one can see that the voltage on the sample is proportional to the susceptibility.

In this paper, ac magnetic susceptibility is numerically expressed in relative units, since for the purpose of relaxation process monitoring, it is sufficient to know the value proportional to the ac magnetic susceptibility.Voltage on the sample [1] is proportional to the susceptibility.

The experiment [1] was completely computer controlled. The data were collected at determined time intervals, stored in the computer for subsequent use and presented graphically.

3. RESULTS AND CONCLUSIONS

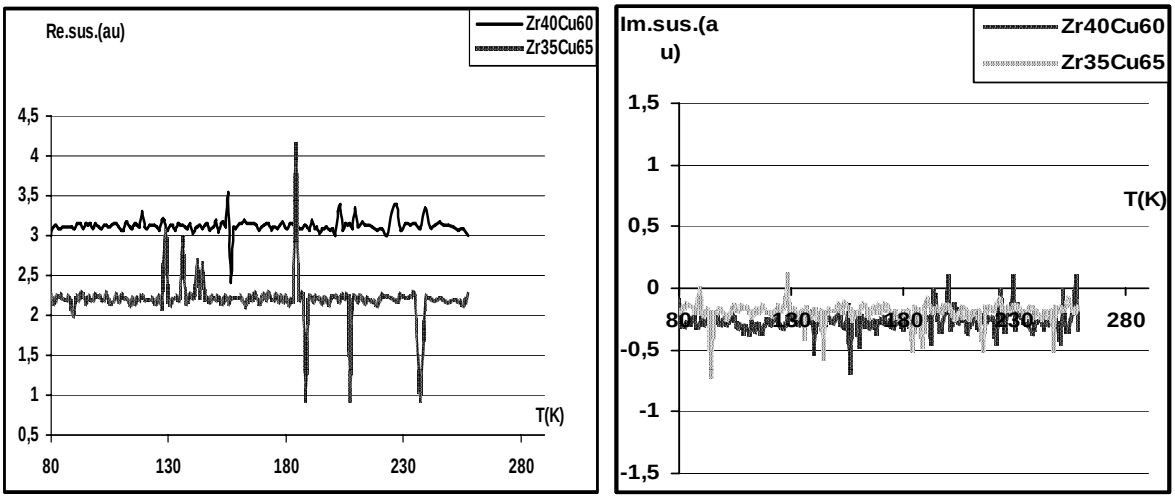
Based on the analysis of the obtained results for the dependence of the magnetic susceptibility on the temperature of samples Zr35Ni65, Zr40Ni60, Zr35Cu65, Zr40Cu60 the following conclusions can be drawn:



a) *b)*

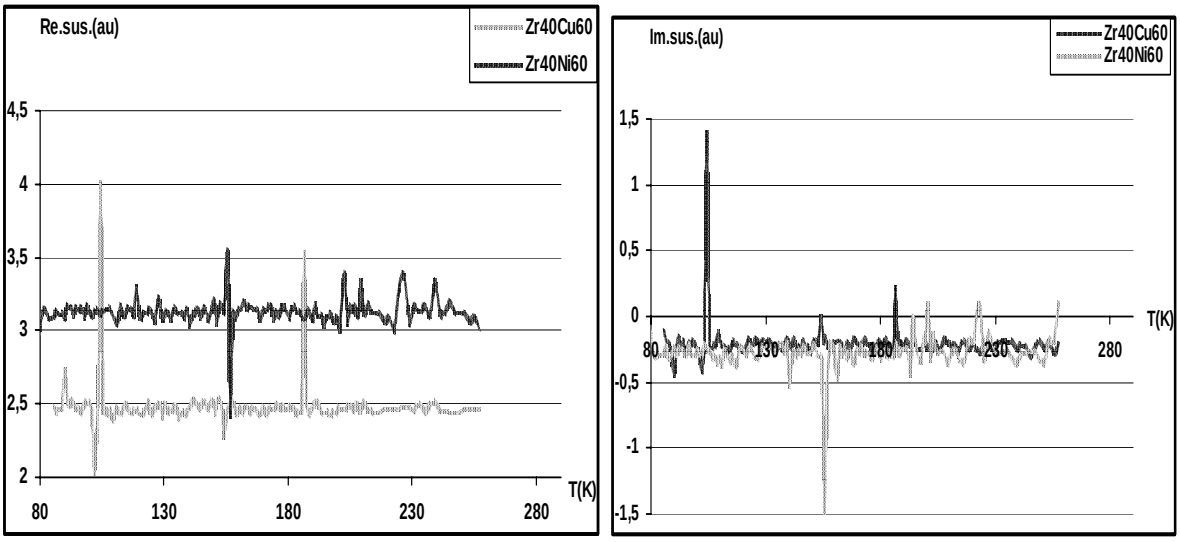
Figure 1. Real and imaginary component of magnetic susceptibility of the amorphous metal system as a function of temperature

1. The obtained alloys and samples were paramagnetics in temperature range from 80K to room temperature. Zr is paramagnetic, Ni is feromagnetic and Cu is diamagnetic.
2. Zr35Ni65 alloy has higher magnetic susceptibility than Zr40Ni60 alloy, (Fig.1 a)).
3. Value of the imaginary component of the magnetic susceptibility (the stabilization of energy) of Zr35Ni65 and Zr40Ni60 alloys was almost identical (Fig.1 b).
4. Zr40Cu60 alloy has higher magnetic susceptibility than Zr35Cu65 alloy (Fig.2 a),
5. Value of the imaginary component of the magnetic susceptibility (the stabilization of energy) of the Zr40Cu60 and Zr35Cu65 alloys was almost identical (Fig.2 b)),
6. Zr40Ni60 alloy has higher magnetic susceptibility than Zr40Cu60 alloy (Fig.3 a),
7. Value of the imaginary component of the magnetic susceptibility (the stabilization of energy) of Zr40Ni60 and Zr40Cu60 alloys was almost identical (Fig.3 b),
8. Zr35Ni65 alloy has higher magnetic susceptibility than Zr35Cu65 (Fig.3 c), and
9. Value of the imaginary component of the magnetic susceptibility (the stabilization of energy) of the Zr35Ni65 and Zr35Cu65 alloys was almost identical (Fig.3 d).

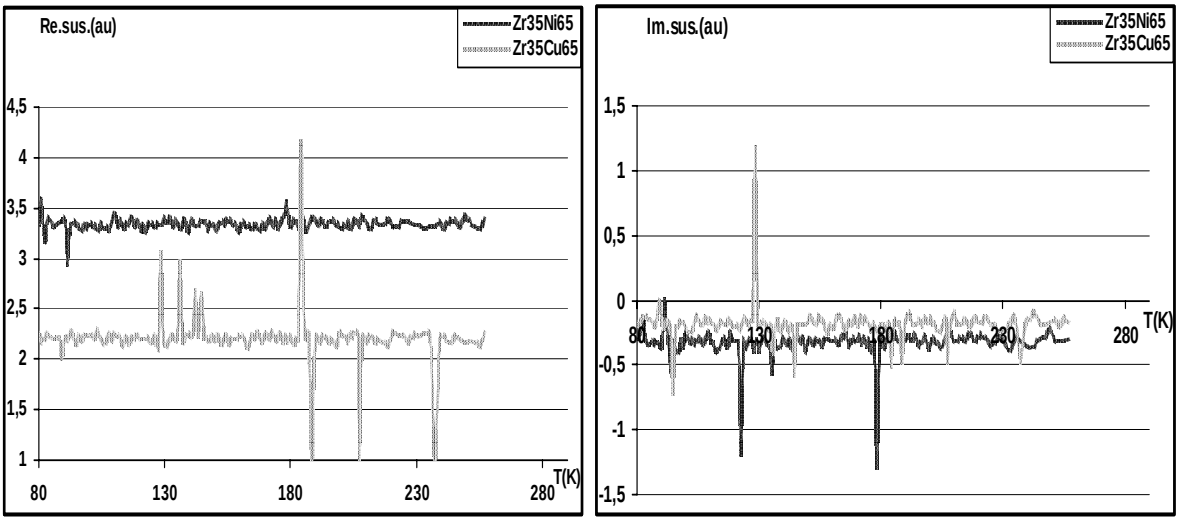


a) *b)*

Figure 2. Real and imaginary component of magnetic susceptibility of the amorphous metal system as a function of temperature



a) *b)*



c) *d)*

Figure 3. Real and imaginary component of magnetic susceptibility of the amorphous metal system as a function of temperature

4. REFERENCES:

[1] S.Bikić, I.Gazdić, M.Tais, S.Sulejmanović, N.Bajrović and T.Mihać, " Ivestigation of Magnetic Susceptibility in an Amorphous $Fe_{43,2}Ni_{23,2}Co_{13,6}B_{20}$ System ", Materials Science Forum Vols.453 454(2004)pp.381-386, online at http://www.scientific.net, 2004 Trans Tech Publications, Switzerland.

[2] E.Girt, S.Bikić, G.Knežević, R.Baltić, T.Mihać i R.Simeunović, "The Measurements of Magnetic Susceptibility in Samples with Early Metastable States ", Macedonian Academy of Science and Arts, Proceedings, XII Yugoslav Symosium of Physics of Condesend Matter, 121(1992).

[3] S. Bikić, I. Gazdić, M. Tais, S. Sulejmanović, N.Bajrovićand and T. Mihać, „The very low temperature relaxation in amorphous system FeNiCoB", Proceedings, 9th International Research/expert Conference, Trends in the development of machinery and associated technology TMT 2005, held at Antalya, Turkey 26-30 September 2005., 1287-1290 (2005).

[4] A.Forgl, R.Reisser and H. Kronmüller, "Investigation of magnetic properties in amorphous FeZr alloys", Proceedings of the Symposium on Magnetic properties of amorphous metals, held at Benalmádena, Spain May 25-29, 1987, 344-346 (1987).