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# INVESTIGATION OF ELECTRICAL RESISTANCE IN AMORPHOUS AND RELAXED BINARY ZrNi, ZrCu SYSTEMS

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**ABSTRACT**
*In this paper the investigation of electrical resistance in binary amorphous Zr40Ni60, Zr35Ni65 and Zr40Cu60, Zr35Cu65 systems is reported.*
*That was the test of the theoretical results of the quantum theory electrical resistance of amorphous systems.*
*The tests were conducted in temperature range from 85K to 280K by investigation the temperature dependence of the electrical resistance. A special sensitive method for measuring electrical resistance was used for this investigation.*
*The research is fundamental, i.e. belongs to physics of the solid state and physics of metals.*
*The obtained results are presented graphically.*
**Keywords:** Amorphous Metallic Alloys, Electrical Resistance, Phase Transition

## 1. INTRODUCTION

The quantum theory predicts that the electrical resistance of amorphous metallic systems decreases with increasing of temperature because the dispersions effects in these systems are higher than in an arranged systems [3]. The amorphous system is gradually arranged by increasing temperature and the dispersion effects are decreased in the system likewise the electrical resistance. The absolute value of resistance should decrease with relaxing of system.
It is known that the electrical resistance increases with increasing temperature in the crystalline metallic systems. A behavior of the electrical resistance will show if the system is transformed in a crystalline state depending on relaxation degree.

## 2. EXPERIMENTAL RESULTS

The alloys 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.%) were produced in a vacuum electrical-arc furnace in atmospheric argon in the Laboratory for Physics of Metals at Faculty of Sciences, Dept. Physics, Sarajevo [1]. Amorphous ribbons were produced from that alloys

by melt-spinning method [2]. A dependence of the electrical resistance on temperature was tested by very sensitive methods, Figure 1.

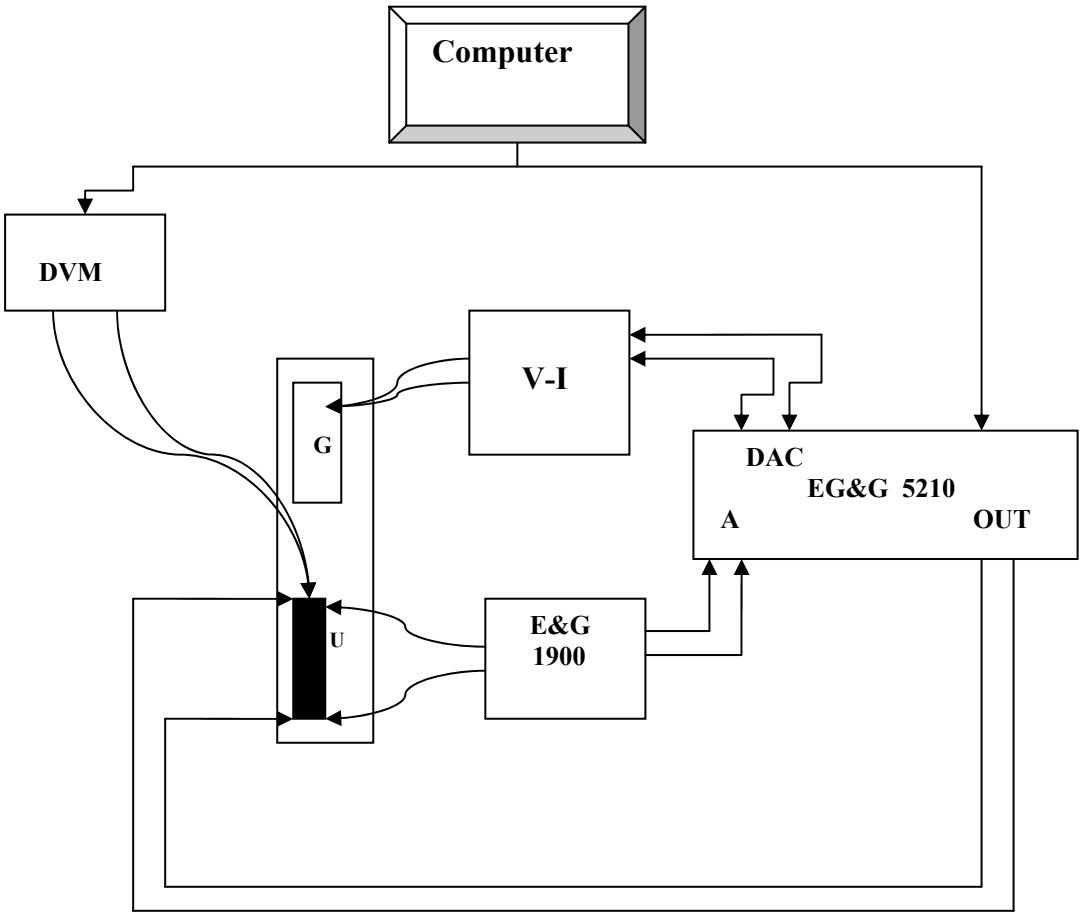
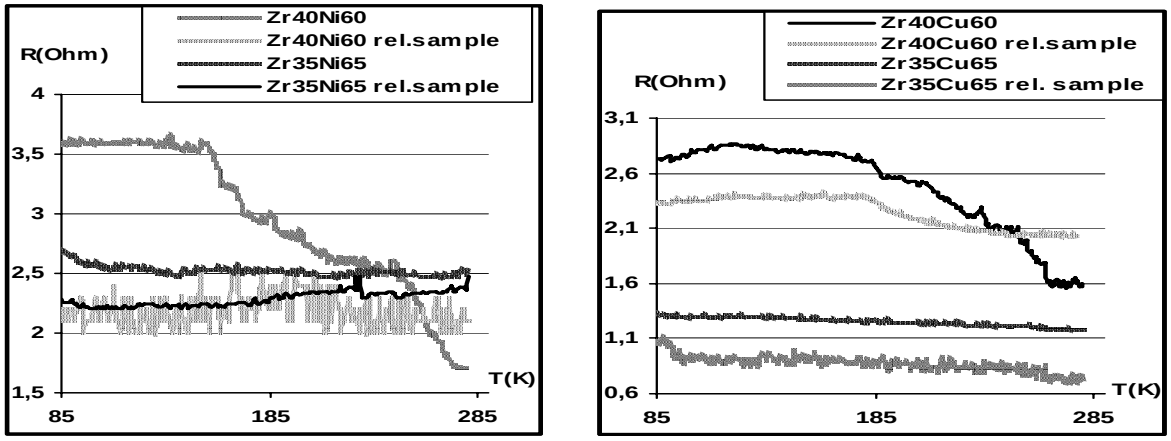



*Figure 1. Schema of system for measuring of resistance depending of temperature: EG&G 5210 - the phase sensitive detector (lock-in amplifier), DVM-Keithley (instrument for measuring very low stress-temperature), V-I - potentiometer and EG&G 1900-transformer, G - heater, U -sample.*

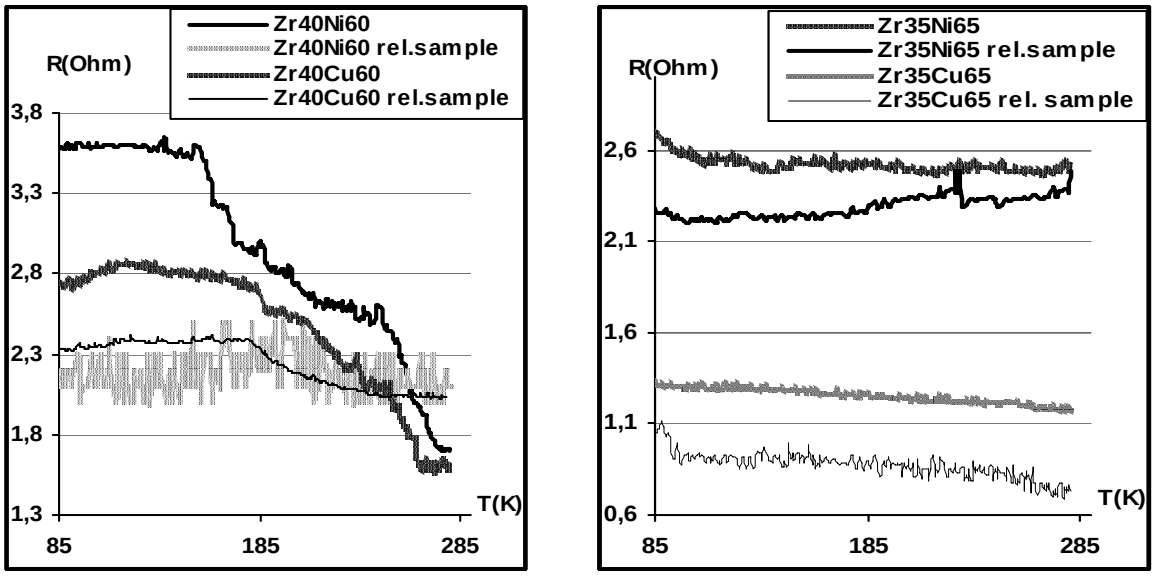
## 3. RESULTS AND CONCLUSIONS

On the base of the analysis of the graphical presented results the following conclusions can be drawn:



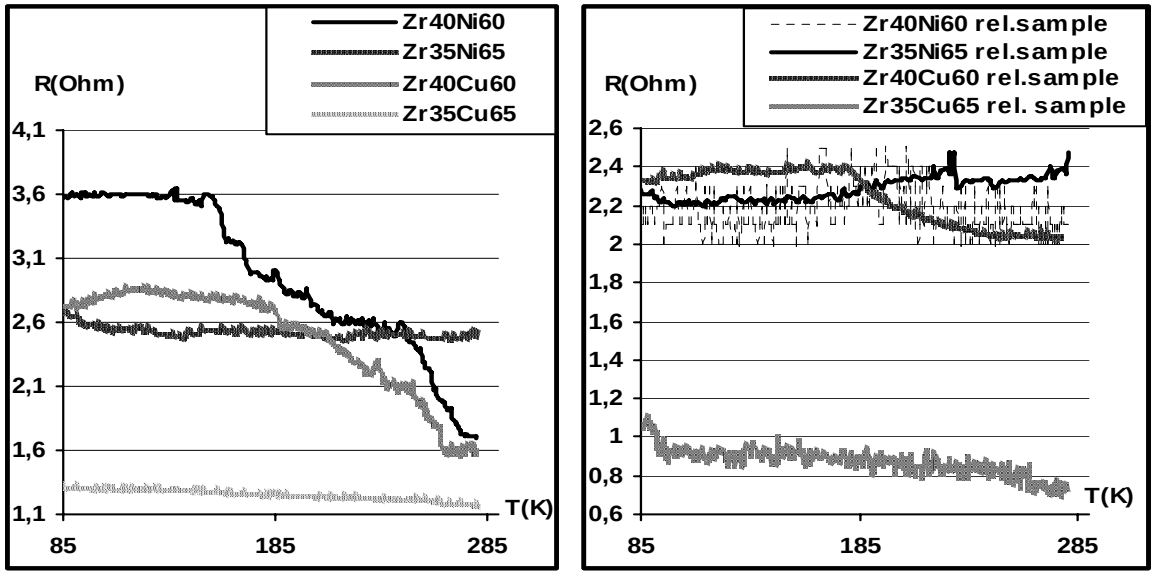

*a)* *b)*

*Figure 2. Electrical resistance in amorphous and relaxed systems as a function of temperature (rel.-relaxed)*




*a)* *b)*

*Figure 3. Electrical resistance in amorphous and relaxed systems as a function of temperature (rel.-relaxed)*




*a)* *b)*

*Figure 4. Electrical resistance in amorphous and relaxed systems as a function of temperature (rel.relaxed)*

1. The electrical resistance of Zr40Ni60, Zr35Ni65, Zr40Cu60 and Zr35Cu65 alloys are decreased with increasing temperature of the system in according with the theoretical results Figure 2 a), b)
2. For all systems after the relaxing process, the electrical resistance value is decreased in regarding to it before the relaxing process, Figure 2 a), b) and 3 a), b).
3. The electrical resistance of Zr40Ni60 amorphous system is higher than of Zr40Cu60 alloy, Figure 3 a).
4. The systems Zr40Ni60 and Zr40Cu60 are amorphous after the relaxation process. The electrical resistance is decreased in the temperature interval from 180 K to 280 K,

Figure 3 a).

5. The electrical resistance of the relaxed system Zr40Ni60 is lower than the electrical resistance of the relaxed system Zr40Cu60 in the temperature interval from 180 K to 280 K, Figure 3 a).
6. The system Zr35Cu65 is amorphous after the relaxation process Figure 3 b).
7. It is supposed that the system Zr35Ni65 is partially crystallized because the electrical resistance of the relaxed system is decreased in the temperature interval from 85 K to 185 K. After that, the electrical resistance increases in the temperature interval from 185 K to 280 K, Figure 3 b).
8. The electrical resistance of amorphous as well as relaxed Zr35Cu65 sample is lowest in the temperature interval from 85 K to 280 K, Figure 4 a), b).

## 4. REFERENCES


[1] I.Gazdić, S.Bikić, S.Sulejmanović, N.Bajrović i M.Tais, »Metastabile states of amorphousalloys«, Proceedings, 9th International Research/expert Conference, Trends in the development of machinery and associated technology TMT 2006, held at Barcelona-Lloret de Mar, Spain 11-15 September 2006. 1239-1242, (2006).

[2] S.Sulejmanović, I.Gazdić, S.Bikić, N.Barović, M.Tais, S.Mijović i T.Mihać, » Modificirana melt spinning metoda za proizvodnju amorfnih traka sa znatnim stepenom reproducibilnosti« Sveske Akademije nauka i umjetnosti BiH, (prihvaćeno za štampu 2003).

[3] K.V. Rao," Electrical transport properties",in Buteworths monographs in materials, ed.by F.E.Luborsky, Buteworths monographs in materials, Butterworth & Co (Publishers) Ltd, London, 401-429(1983).