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METASTABILE STATES OF AMORPHUOS ALLOYS

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ABSTRACT
This paper performed investigation of existence of the meta-stabile states in samples of amorphous alloys $Fe_{43,2}Ni_{23,2}Co_{13,6}B_{20}$ *using calorimetric method. The amorphous samples are attained through ultra-fast calcinations in cooled, rotating cylinder- shaped in strips. As a suitable parameter, which could indicate an existence of meta-stabile states, an electrical resistance was chosen, or more specifically, the change in the value of electric resistance with temperature increase. Since this parameter is in direct correlation with the degree of the system's orderliness, investigating the change in the electrical resistance within a certain temperature interval led to the conclusion that the structure of the amorphous samples goes through the process of relaxation. The investigated temperature interval was between the liquid nitrogen temperature and the room temperature.*
Keywords: amorphous alloys, electrical resistance, metastabile states.

1. INTRODUCTION
Examined specimens were in the shape of a thin strip which was obtained by tempering on a fastly rotating cylinder-so called chill block melt spinning method (CBMS) . It is known that samples which are obtained in such a way are unstable and that they contain a lot of free bulk in themselves. Also, there is as indication that the newly formed sample has a significant surplus of free volume than at room temperature [1]. This means that the sample is to a high degree relaxed at room temperaure, that is, an intensive relaxataion process had been going on inside it [2]. This idea of the existance of an intensive low temperature relaxation process which goes on since the formation of sample until room temperature, gives new possibilities in additional research of amorphous strips [3]. In o rder to notice the changes in the structure of amorphous strips which occur from the temperature of liquid nitrogen up to the room temperature, starting point could be to get some energy to the system and to follow the system's reaction with emphasis on precise and continuous measuring of temperature.The system in this case is our alloy obtained by our own method and the energy is AC (alternating) current whose voltage is 1 V and whose power is 1mA. System's reaction is in fact the decrease in the voltage on the amorphous sample from which we can afterwards find the electrical resistance at low temperatures, and on the basis of electrical resistance w can determine are there any early metastabile states in samples of amorphouse alloys.

2. EXPERIMENTAL RESULTS

Device for production of amorphous strips was manufactured at the Faculty of Natural Sciences in Sarajevo by the authors of this paper. Certain parts of this device are shown on figures 1 and 2. It should be emphasized that the device is run by a computer and that it takes just a few seconds to produce amorphous strips. Obtained samples, which are under examination, are thin strips whose width is 2 to 2,5 mm and whose length is 20 to 25 mm. During the production, the strips are directly put into liquid nitrogen. It is especially important that the strip from the process of production until finishing measuring electrical resistance must not be at any time taken out of the liquid nitrogen.

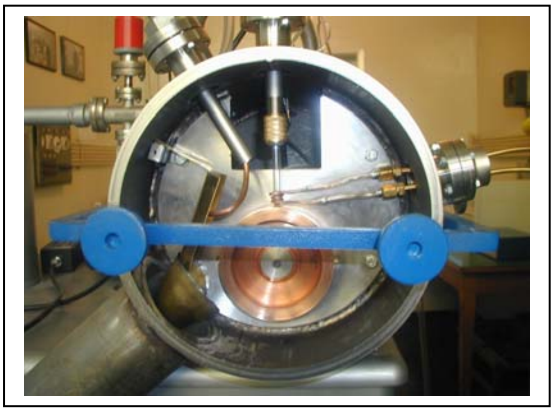


Figure 1. part of the device for production of amorphous strips

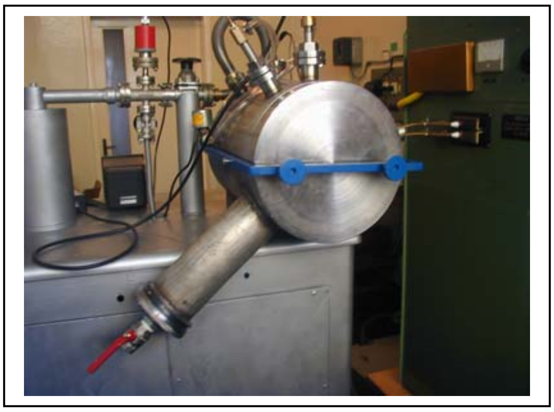


Figure 2. Same part of the device but closed and under vacuum

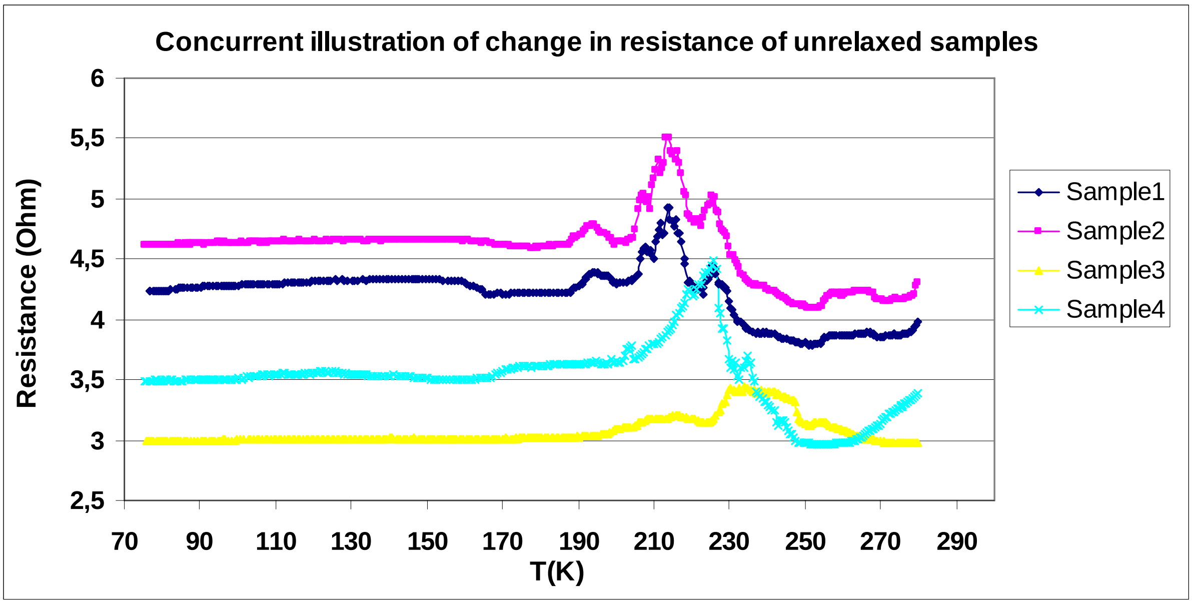
All samples do not come from the same process of production which means that their different shapes do not have the same initial resistance. Decrease in the voltage is measured on the sample in the temperature interval from 75K to 290K. In order to get more precise results we must take into consideration resistance of conductors in electrical current. Because of that, and because of different initial resistance values, we need to show relative change of electrical resistance in the following relation:

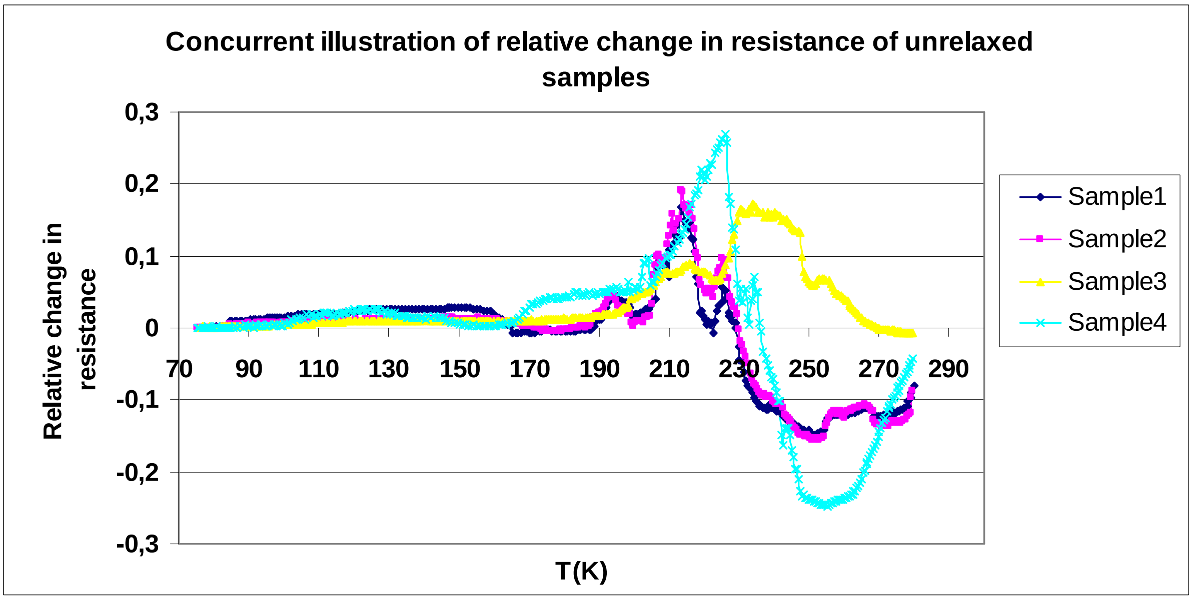
$$\delta = \frac{R(T) - R(1)}{R(T) - R(c)} \qquad (1)$$

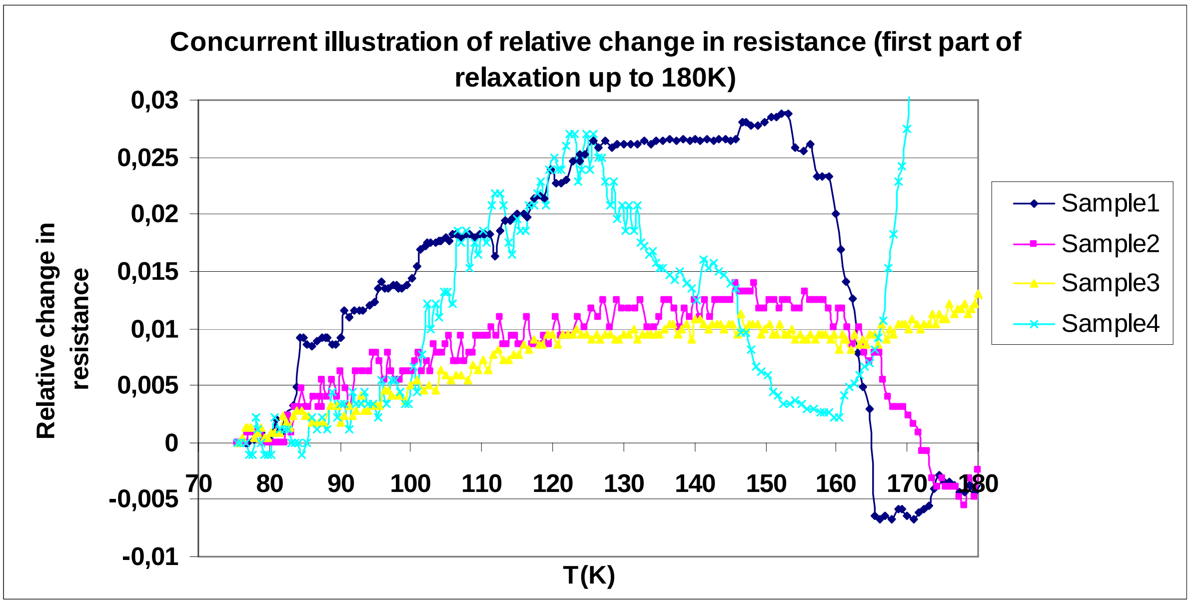
where : R(T) is the resistance of the sample at temperature T , R(1) is the resistance of the sample at temperature of liquid nitrogen,that is, first measured resistance, and R(c) is the resistance of the conductor which connects the measuring system and whose value is 0,8 Ω.

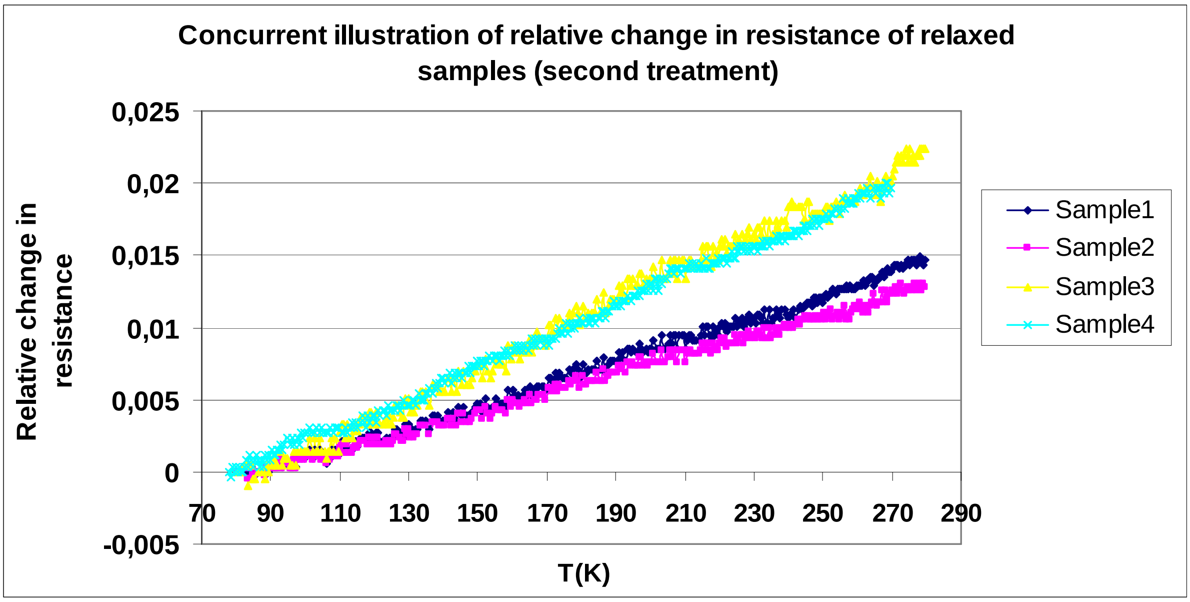
Four samples were treated and they are designated on the chart as samples 1 to 4.
After that, the same samples were treated again under same conditions in the temperature interval from 75K to 290K(second treatment).
In order to draw conclusions, a chart had to be made on which concrete changes were presented graphically.Such changes are:

1. Concurrent illustration of change in resistance of unrelaxed samples,
2. Concurrent illustration of relative change in resistance of unrelaxed samples,
3. Concurrent illustration of relative change in resistance(first part of relaxation up to 180 K),
4. Concurrent illustration of relative change in resistance of relaxed samples(second treatment).


Concurrent illustration of change in resistance of unrelaxed samples
Resistance (Ohm)
6
5,5
5
4,5
4
3,5
3
2,5
70
90
110
130
150
170
190
210
230
250
270
290
T(K)
Sample1
Sample2
Sample3
Sample4


Concurrent illustration of relative change in resistance of unrelaxed samples
Relative change in resistance
0,3
0,2
0,1
0
-0,1
-0,2
-0,3
70
90
110
130
150
170
190
210
230
250
270
290
T(K)
Sample1
Sample2
Sample3
Sample4


Concurrent illustration of relative change in resistance (first part of relaxation up to 180K)
Relative change in resistance
0,03
0,025
0,02
0,015
0,01
0,005
0
-0,005
-0,01
70
80
90
100
110
120
130
140
150
160
170
180
T(K)
Sample1
Sample2
Sample3
Sample4



3. CONCLUSION

From graphic illsutration of change in electrical resistance and from relative change of electrical resistance of all tested unrelaxed samples (1-4) depending on temperature, we can see that the process of relaxation consists of two parts. First part starts at the temperature of liquid nitrogen and ends at the temperature of 180 K. Temperature in the second part of the process goes from 180 K to room temperature. The fact that proves that this is really a process of relaxation in both stages is the existance of two declines in electrical resistance values. In the first part this change electrical resistance is smaller while in the second partit is much bigger. Significantly smaller change in electrical resistance values at low temperatures can be explained by saying that activation energy in this area is not enough to transform the system into a permanently stable state. After second treatment, under same conditions, it can be concluded that metastabile states dissappear.

4. REFERENCES

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