INVESTIGATION OF $Cu_{60}Zr_{40}$ METALLIC GLASS BY THERMAL DILATATION METHOD

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The $Cu_{60}Zr_{40}$ metallic glass samples were investigated by thermal dilatation method. The experimental set up of own construction enabled investigation with different heating rates (in the range 0.3K/s - 1.0K/s). From the obtained curves we made conclusions about the phase transition temperature. The activation energy of this phase transition was evaluated. Also the length change during partial heating treatment was observed.

Introduction

The contraction of amorphous samples during heating is due to the transition from the disordered structure. The length change as a temperature function is shown on fig. 1; after the peak the sample begin to transform into crystalline phase. The result of the phase transformation is the contraction of the sample. The first part of the curves contains information of free volume change due to the applied tensile stress on the samples.

Experimental

The investigated samples were 22 mm long, 2.1 mm wide and about 7 μm thick. The length change during thermal dilatation experiments was measured by use of constant heating rates in the range from 1.0 K/s to 0.3 K/s. The experimental set up /1/ contained a digital nanovoltmeter (Keithley M-180) and a chart recorder, so the numerical values as well as the curves were obtained. Fig.1 shows the normalised numerical values for heating rates 1.0 K/s, 0.5 K/s and 0.3 K/s. After each thermal treatment the samples were cooled. This process is shown on fig.2, where the full line shows the increase of the temperature. The numbers 1, 2 and 3 are marking the heating process to 460K, 609K and 860K, respectively. The temperature was controled by an Artronix set, connected with a furnace of low heat capacity.

Discussion

As given in fig.1 , the maxima and minimum of the curves are shifting towards higher temperatures at greater heating rates. The same dependance was found by investigation of $Fe_{40}Ni_{40}B_{20}$ samples /2/. From the obtained curves it was possible to evaluate the activation energy for crystallisation and the crystallisation temperature. Due to the theory of the annealing curve analysis /3/, the activation energy can be evaluated from the relation:

$$\ln \left(\frac{\alpha_2 T_1^2}{\alpha_1 T_2^2} \right) = \frac{E}{k} \left(\frac{1}{T_1} - \frac{1}{T_2} \right) ,$$

where α_1, α_2 are heating rates, E is the activation energy and k Boltzmann constant. The obtained value for activation energy was 400 kJ/mole.

The temperature at which the crystallisation occurs was in the range from 781K to 798K.

The parts of the curves obtained by partial heating treatment are forming, as shown on fig. 2, the characteristic dilatation curve. The maxima of this curve corresponds to 742K, which could be taken as the minimal transition temperature.

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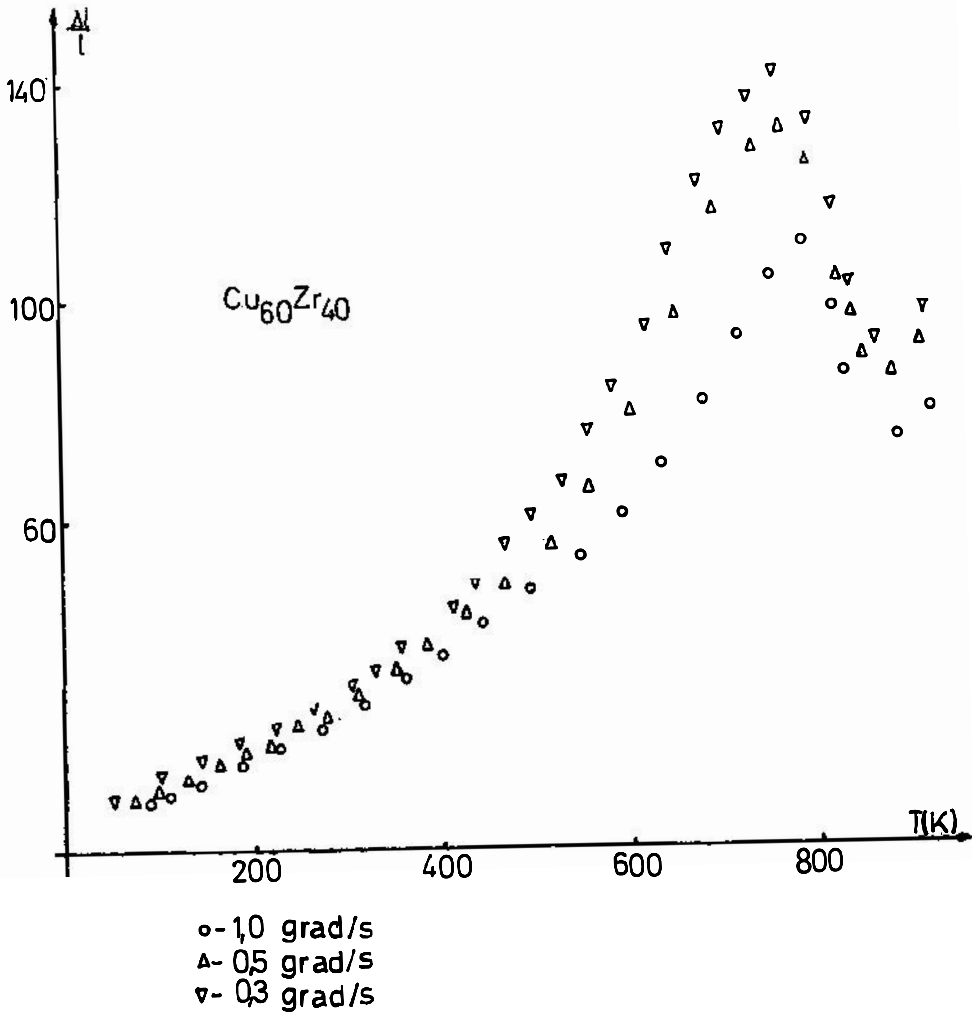

Fig.1 The length change of $Cu_{60}Zr_{40}$ sample as a temperature function

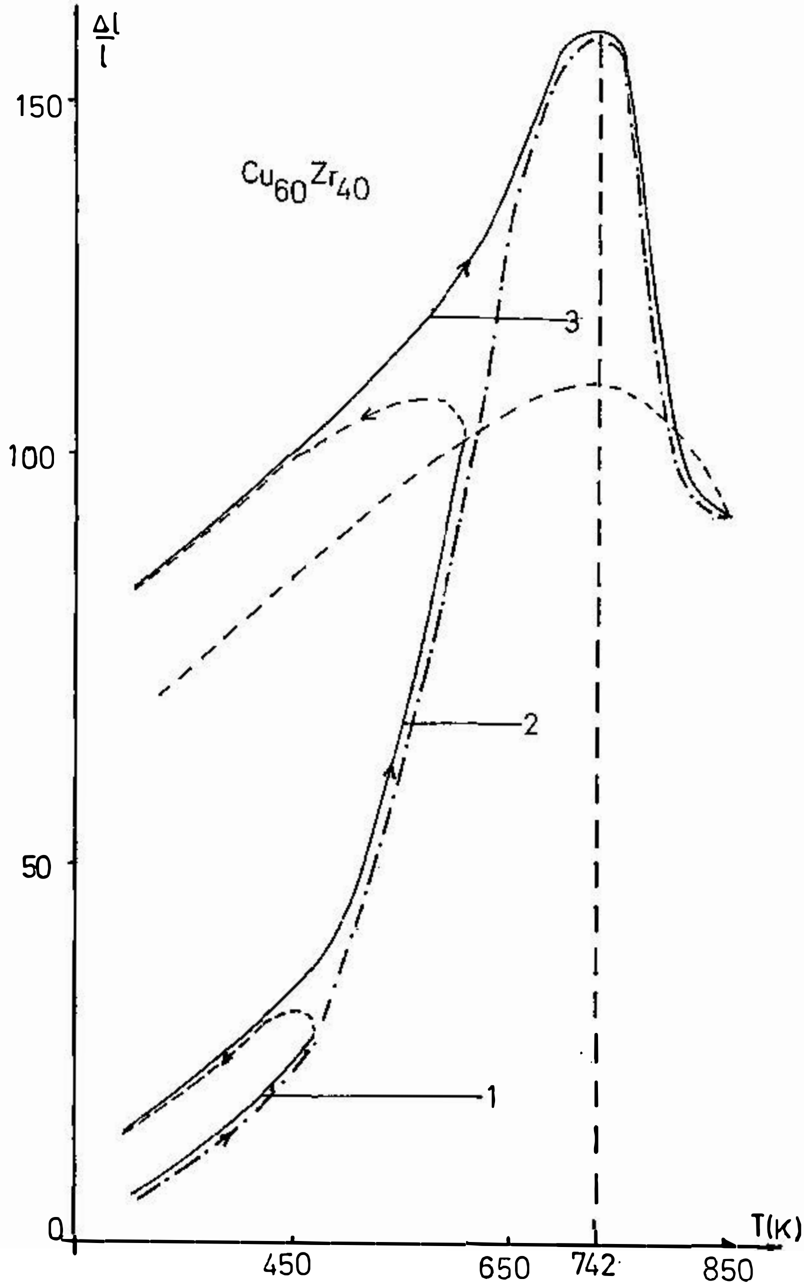

Fig.2 The relative length change during partial heating of the sample.The curves 1, 2 and 3 show the annealing to the temperature 460K, 609K and 860K ,respectively.