Thermochimica Acta, 93 (1985) 661-664
Elsevier Science Publishers B.V., Amsterdam

THE DECRYPTONATION THERMAL ANALYSES OF METALLIC GLASS $Fe_{40}Ni_{40}B_{20}$

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ABSTRACT

The $Fe_{40}Ni_{40}B_{20}$ metallic glass was investigated by DkTA in the as - guenched state as well as isothermaly annealed at 350 °C for times between 1 and 24 days.

INTRODUCTION

Due to rapid quenching the structure of metallic glasses is strongly disordered and, as in all glasses, it is metastable with respect to the corresponding equilibrium crystalline phases as well as to amorphous state. Under the influence of temperature and time the structure transforms to a more stable state with lower free energy by means of changes of internal arrangement of its structural units. These changes are reflected in a characteristic way on several physical and thermophysical properties which can thus be used for investigation of kinetics and mechanism of the structural changes.

According to the annealing temperatures two types of structural rearrangements take place in metallic glasses.

At temperatures below the glass - transition temperature T_g changes in local arrangement of atoms take place; the material, however, still remains amorphous. Such so - - called structural relaxations can substantially alter certain properties of metallic glasses, above all magnetic and mechanical ones [1 to 3] .

At temperatures above T_g crystallization takes place.

The crystallization thus determines the limiting operational temperature of metallic glasses.

In order to study these processes methods of DTA, DSC and magnetic measurement methods were elaborated.

In our work we present the application of decryptonation thermal analysis for investigation of structural changes of metallic glasses.

EXPERIMENTAL

Samples of $Fe_{40}Ni_{40}B_{20}$ metallic glass were in form of thin ribbons with dimensions 1,5 x 0,7 cm. Prior to experiment the were degreased with trichlorethylene and the surface layer was removed by immersing the samples in 10% solution of HNO_3. The samples were then subjected to gradual implantation of ^{85}Kr by ion bombardment using a high--frequency transformer. The average specific activity was 15.10^3 $imp.min^{-1}$.

Using the DkTA apparatus shown on Fig. 1 [4,5] the temperature dependence of relased radioactive krypton was obtained.

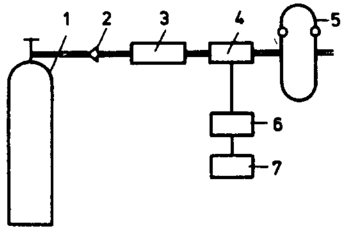

Fig. 1. The diagram of device for DkTA (1 - pressure tank, 2- reduction valve, 3 - dekryptonation chamber, 4 - flow-type GM-tube, 5 - flow meter, 6 - rate-meter, 7 - plotter)

Fig. 2 represents the typical DkTA curve of $Fe_{40}Ni_{40}B_{20}$ glass.There are two pronouced peaks on the curve. The first one appears at temperature 215 °C, the second at 450 °C.

We assume the first peak to be due to relaxation while the second peak corresponds to the crystallization.

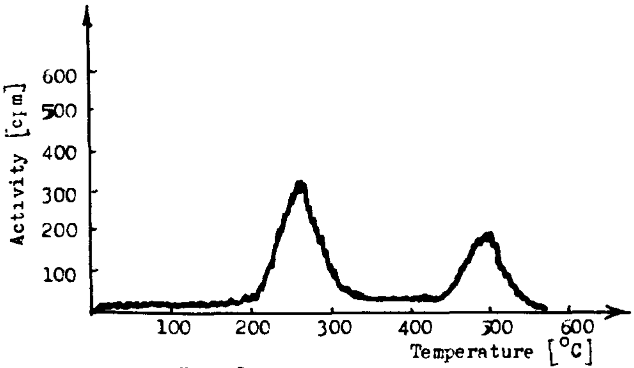

Fig. 2

DkTA curve of metallic glass $Fe_{40}Ni_{40}B_{20}$

In order to make sure about the relaxation being responsible for the appearance of the first peak, we isothermaly annealed the samples prior to krypton implantation at temperatures 180, 250 and 350 °C for times between 1 and 24 hours. The samples were then krypton-implanted and their DkTA curves were taken. Figs. 3 and 4 show the DkTA curves of metallic glasses annealed for 1 and 24 hours at 350 °C respectively.

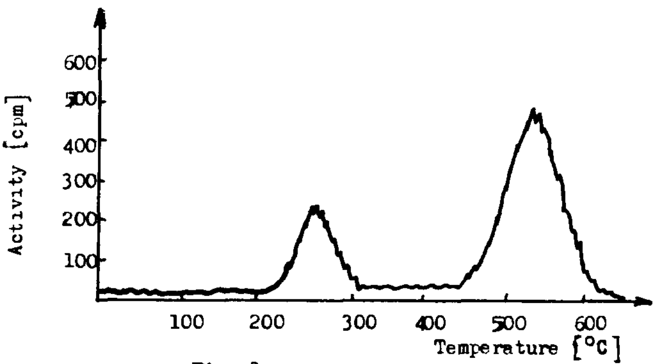

Fig. 3

DkTA curve of metallic glass after one hour annealing at temperature 350 °C

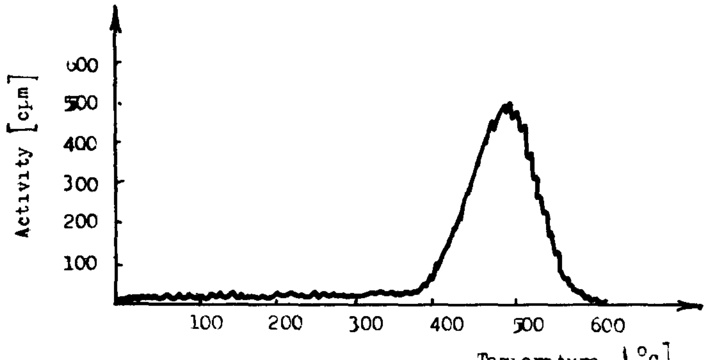

Fig. 4

DKTA curve of metallic glass after 24 hours annealing at temperature 350 °C

With increasing annealing time the first peak markedly decreases and finally disappears after crystallization of the sample. The permanence of the second peak even after long-time annealing is explained by the fact that the metastable orthorombic boride Fe_3B precrystalized to a stable $Fe_2B + \alpha$ phase [6] . Electron microscopic observations proved that after low-temperature annealing the structure still remains amorphous.

CONCLUSIONS

These first experiments are of informative character and the physical interpretation requires further investigation. In case of proving the method to be physically advantageous, it will represent a usefull tool for studying relaxation processes.

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