RHEOLOGICAL PROPERTIES OF AMORPHOUS AND NANOCRYSTALLINE METALLICALLOYS UNDER TRANSIENT CREEP

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Abstract – The laws of the various strains of amorphous and nanocrystalline metallic alloys under transient creep. Found that the deformation of amorphous alloys and nanokristallichevkih in transient creep stepwise. It is noted that below the crystallization temperature deformation proceeds heterogeneously above homogeneously. Morphological features of the condition of surfaces and fracture surfaces of samples at various stages of creep.

I. INTRODUCTION

Metallic glasses (MG) in many references are similar to ordinary glasses and liquid metals [1]. One of the amazing properties of amorphous alloys is their ability to plastic flow. In an amorphous solid there isn't translational symmetry, and, consequently, the dislocation in the classical understanding of the nature of the defect. [2] Thus the amorphous solid must be completely brittle. But in MG plastic, deformation occurs yet. Plastic deformation in the amorphous alloys can occur homogeneously or non-homogeneous. The evolution of the structure of metallic glasses is the most important problem of the physics of strongly disordered systems. The actual problem of physics of disordered media is the study of plastic flow of MG as well as increasing the number of research methods of their mechanical properties.

In this regard, the goal of this paper is to study of deformation and fracture of various amorphous and nanocrystalline metallic alloys under transient creep.

II. INSTRUCTION FOR AUTHORS

Studies had been using tapes of amorphous Co-based systems: Co-Fe-Mn-Si-Cr-B-Ni (AMAG-170-179 AMAG, AMAG-180), Co-Fe-Mn-Si-B-Cr (AMAG-183 AMAG-186) and ribbon of the nanocrystalline iron-based alloy Fe-Cu-Nb-Si-B (AMAG-200) obtained by spin-ningovaniya. The objects of study were the samples measuring 55×3,5×0,02 mm.There was created and developed a method of installation of the experiment to test for creep. A sample was helded between two jaws, one of which is fixedly connected to the upper part of the installation, the lower jig in turn was attached to the sample and remained in a free state in the specimen by creating initial mechanical stress-tions ~13,5 MPa. Then the sample was placed in an oven. During the experiments, the heating of the samples was determined pyrometer Testo 845. The heating rate was 0,65 °C/s. Elongation of the specimens were fixed on a digital video camera. Then the pro-plagued scan video frame by frame, which is determined on the basis of the change in length of the sample during the experiment.

There were built dependences of relative samples' deformation from time.

Prior to the crystallization temperature according to the observed long stops corresponding to a certain amount of deformation. After the temperature of crystallization of the dependence varies. Stops of deformation become less long-inflammatory, and the number of deformation jumps at a fast rate increases.

It is established that the destruction of the samples Co-based alloys occurs when the strain reaches 25% and a temperature ~600-700 °C. It is noted that in the Co-based alloys below the crystallization temperature deformation occurs hetero-genetic above homogeneously.

Studies of amorphous structural state at different stages of the heating carried out on the fracture surfaces of the samples. For this purpose, samples after heating to a temperature of Position recovered and destroyed by bending. Fig. 2 shows the morphology of the fracture surface of the alloy samples AMAG-186. It was established that the samples at a heating temperature of more than 400 °C, there is a pronounced grain structure. With increasing temperature, the heating of the sample size increases crystals. When heated to 400 °C is about the size of 100 nm while heating to 500 °C and 600 °C ~ 250 nm and ~500 nm, respectively. Similar changes are confirmed by X-ray structure analysis.

The diffraction patterns instead of "halo", typical for amorphous structures there is a series of diffraction peaks.

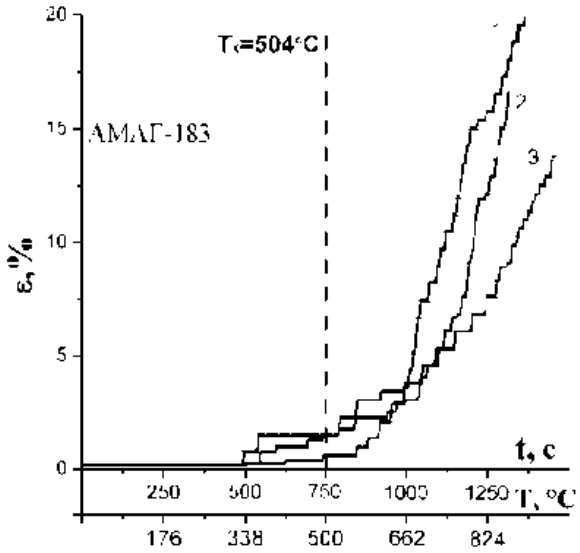

Figure 1 – Dependence of the strain (ε, %) of the time (t, c) for the alloy specimens AMAG-183 (1, 2, 3 - various samples of the same alloy) T_c - crystallization temperature

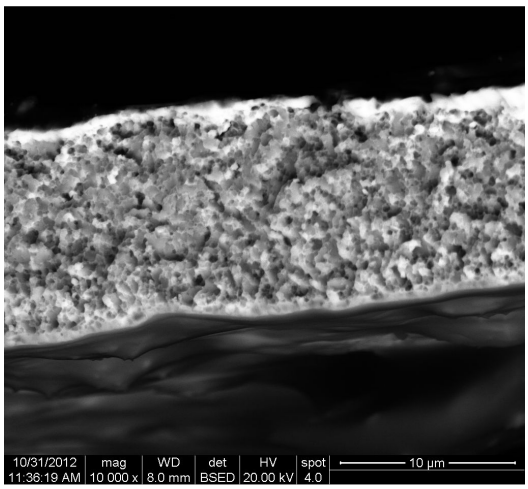

Figure 2 – Grain structure on the fracture surface of the sample alloy AMAG-186 were heated 600 °C

It is found that the destruction of the samples is viscous at temperatures above 600 °C. It was also noted that the crystal grain textured along the axis of tension. In the destruction of the sample thickness in the formation of sink marks is reduced to 5% from the initial condition, and corresponds to approximately 1 micron.

Formation of steps on the dependence on ε-t connected with the fact that when the crystals separate shear bands locked to them and deformation not develops. This corresponds to a long time-recurrent periods in which the development of the deformation occurs. As the temperature increases the number of crystals and the number of shear bands. Above the deformation temperature crystallization becomes homogeneous and its background blocking strips deformation becomes significantly less time. Creep goes into steady state throughput of the abrupt flow.

Fig. 3 shows the dependence of the strain versus time for alloy AMAG-200. Deformation has a stepwise character.

Samples of the alloy AMAG-200 under specified conditions of the experiment are not destroyed, the relative de-formation samples is 15%.

Fig. 4 shows the morphological peculiarities of the surface of the alloy samples AMAG-186 under-vergnutyh heat 400 °C.

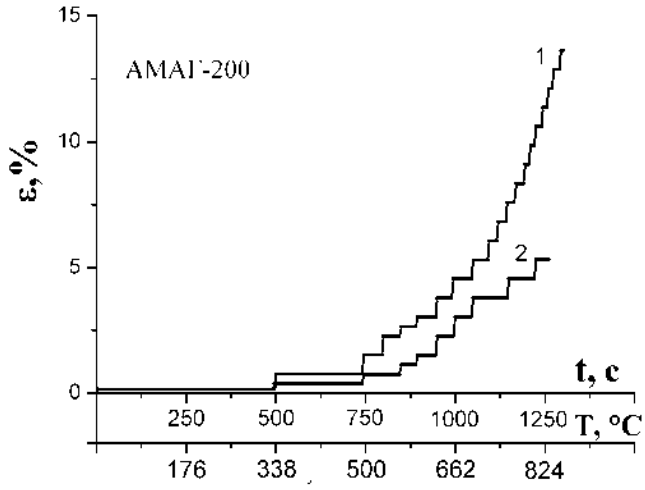

Figure 3 – Dependence of the strain (ε, %) of the time (t, c) for the alloy specimens AMAG-200 (1, 2 – different samples of the same alloy)

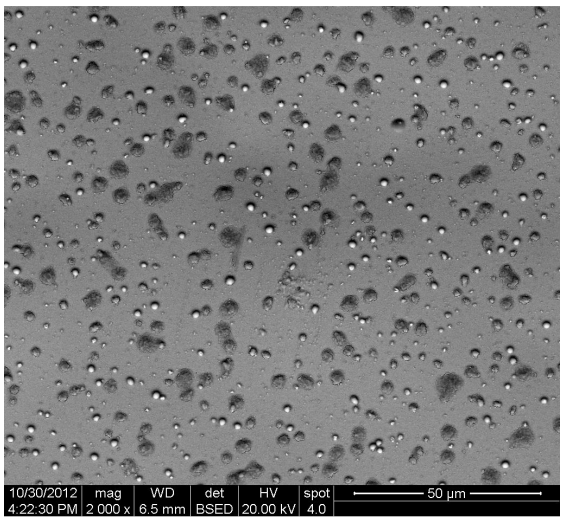

Figure 4 – The formation of oxide particles on the surface of the alloy samples AMAG-186 were heated 400 °C

It can be seen that heating the samples leads to the appearance of the different surface structures, the size of which increases with increasing heating temperature. The element composition is established that they are the oxides of the various components of the alloy. On the surfaces of the alloy AMAG-200 depending on the heating temperature, the appearance of different colors occurs ran-STI.

III. Conclusion

Thus, it is experimentally found that the deformation of amorphous and nanocrystalline alloys in transient creep stepwise. It is noted that the amorphous alloys appear first deformation jumps to the crystallization temperature. As the temperature decreases the time between adjacent irregular, and the magnitude of the deformation jump remains almost constant.

Acknowledgments

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