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STRUCTURE CHANGE IN THE $Al_{88}Ni_2Y_{10}$ METAL GLASS AT THERMAL TREATMENT AND DEFORMATION

Structure change of the $Al_{88}Ni_2Y_{10}$ metal glass at heating and plastic deformation by rolling was studied. It was found that the first stage of crystallization occurring by the primary reaction is followed by the changes in amorphous phase that result in formation of amorphous regions with different types of short range order and the composition that is characterized by different radius of the first coordination spheres. When the first stage of crystallization has been finished, the structure consists of aluminium nanocrystals and inhomogeneous amorphous phase.

In the case of plastic deformation, formation of nanocrystals occurs even at room temperature. The increase in the part of nanocrystal phase in the course of deformation is insignificant; at isothermal annealing at 150°C, the part of nanocrystal phase increases significantly when the anneal lasts ~ 100 h, after that, this parameter is changed slightly. The formed nanostructure is quite stable and retains for 500 hours at the temperature of 150°C.

Size distributions of aluminium nanocrystals have been drawn for varied duration of the isothermal anneal. It was demonstrated that size distribution became narrower when anneal duration increased, whereas the average size of nanocrystals increased insignificantly (from 6 to 8 nm). Basing on the analysis of size distributions of nanocrystals, and their changes related to the anneal duration, we concluded that nucleation of nanocrystals obeys heterogeneous mechanism.

When the anneal temperature increases, formation of previously unknown metastable crystal phase occurs. The structure of the new phase can be described by the orthorhombic lattice with the parameters a = 4.88 Å, b = 5.52 Å, c = 10.25 Å.

Keywords: amorphous alloys, crystallization, nanocrystals, transmitting electron microscopy, roentgenography

Fig. 1. X-ray diffraction pattern of the initial amorphous alloy (*а*) and that of the alloy after the end of the first crystallization stage (*б*)

Fig. 2. The region of the X-ray diffraction pattern corresponding to the area of the first diffusion halo: *1* – experimental curve; *2* – total envelope curve; *3*, *4* – reflections from aluminum nanocrystals; *5*, *6* – reflections from the amorphous phase

Fig. 3. X-ray diffraction pattern of the sample after deformation by 10%

Fig. 4. X-ray diffraction patterns of the sample after anneal at 150°C for 1 (*1*), 4 (*2*), 16 (*3*), 330 (*4*) and 500 (*5*) h

Fig. 5. X-ray diffraction patterns of the sample after the anneal for 1 h at 150°C (*1*), 200°C (*2*) and 280°C (*3*)

Fig. 6. X-ray diffraction patterns of the sample after the anneal at 285°C for 1 h

Fig. 7. Size distributions of aluminum nanocrystals after isothermal anneal at 150°C for 1 (*а*), 4 (*б*) and 121 h (*в*)

Fig. 8. The average size of aluminum crystals vs the duration of isothermal anneal at 150°C