Influence of intensive plastic deformation under pressure upon synthesis of Zr-Zn alloys from elemental powders

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Nowadays the methods of intensive plastic deformation under pressure are extensively applied to receive body materials with new functional properties. One of such technologies is the synthesis of alloys from elemental powders using intensive plastic deformation by torsion in Bridgman anvils [1-3]. One of the advantages of this method is that it allows to obtain new materials from powders of metals that have very different melting temperatures. So the primary purpose of the present research was to study the microstructure and phase constitution of Zr-Zn alloys produced from powders of pure metals by mechanical alloying under high pressure.

To carry out the research there were prepared elemental powder mixes of zirconium and zinc with the content of zinc from 5 to 50 at.%. The received mixes were subjected to mechanical alloying in Bridgman anvils under pressure of 3-8 GPa at room temperature. X-ray diffraction analysis and transmission electron microscopy were used to study the phase state and structure.

Mechanically alloyed alloys have been studied depending on the pressure, the content of zinc and the number of revolutions. It is established that the structure of the alloy depends on the pressure, the content of the alloying metal in the alloy and the degree of plastic deformation. This study has revealed that the investigated alloys have nanodispersed and amorphous structure. It is established that the size of nanograins depends on the alloying metal content in the alloy and the degree of plastic deformation.

The formation of a high-pressure phase (ω-phase) was observed in all synthesized alloys (Figure 1a, b). X-ray pattern shows that solubility of zinc in α-phase of zirconium increases slightly and is 1 at.%. Regions with an amorphous structure are observed in alloys at the zinc content > 10 at.%. However, the number of amorphous regions significantly depends on the zinc content in the alloy. Almost complete amorphization was confirmed by the X-ray pattern and selected area electron diffraction pattern of the Zr-40 at.% Zn and the Zr-50 at.% Zn alloys (Figure 1c). It was found that intermetallic particles ZrZn of plate-shape are formed in the alloy Zr-20 at.% Zn after aging at 500 °C for 15 minutes.

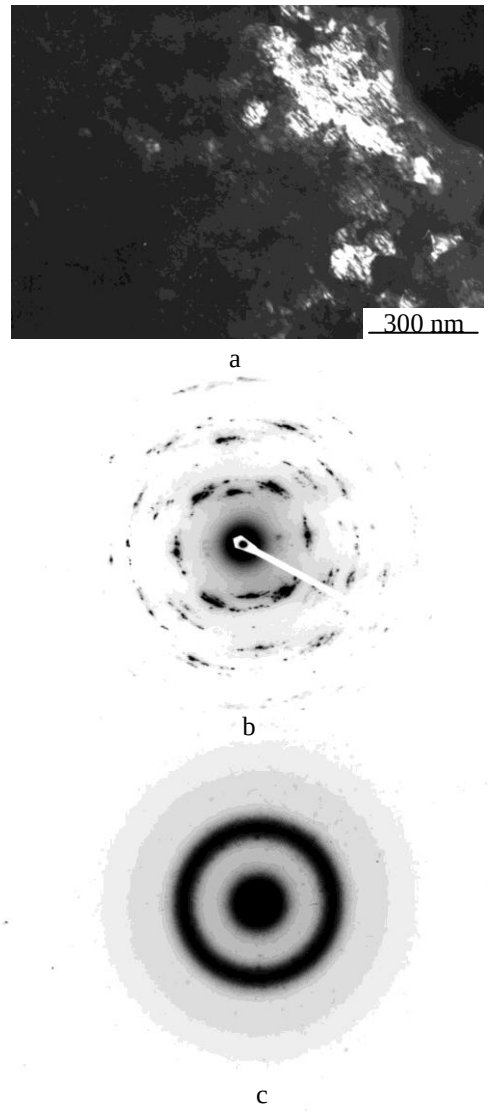

Figure 1. Microstructure of Zr-Zn alloys synthesized at 5GPa, n=5: a-Zr-5 at.% Zn, darkfield image taking in the reflection of the ω-phase; b-SAED of the ω-phase; c-Zr- 50 at.% Zn, SAED.

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