THE SOLID SOLUTIONS IN THE Zr-Zn-Ni SYSTEM AT 600°C

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INTRODUCTION

The development of new materials requires systematic investigations of the interactions between the components in ternary and multicomponent systems, their phase diagrams, the composition and crystal structures of the compounds obtained. In this respect it is interesting to study the variation of the interactions of the components in Zr-Zn-M systems (where: M = d- element (Fe, Co, Ni).
The interaction of zirconium with zinc and nickel over the whole range of concentrations has not yet been studied. We report the results of the investigations of the solid solutions in the Zr-Zn-Ni system at 600°C.

EXPERIMENTAL

The alloys were prepared by sintering of powders of metals in quartz ampoules under vacuum at 600°C for 240 h with the following arc melting in argon. Then they were annealed in quartz ampoules under vacuum at 600°C for 240 h. The purity of the starting metals was better than 99.9%. The powder diffraction patterns were obtained by using the diffractometer DRON-2 (FeK_α-radiation). The lattice parameters and crystal structure refinement were calculated by means of LATCON and RIETWELD ANALYSES programs [1].

RESULTS AND DISCUSSION

The interaction of the components in the binary systems Zr-Zn, Zr-Ni and Ni-Zn characterized by the mutual solubility of the components in the solid state and large homogeneity regions of existence of the binary compounds. So significant region of solubility Zn in Ni (to 28 at.%) observed in Ni-Zn binary system.
The reason of the forming limited solid solutions based in a binary compounds is a similarity of the electron structure of this elements.
Limited solid solutions of the base binary compounds of $ZrNi_5$, Zr_7Ni_{10}, ZrNi, Zr_2Ni and Zr_2Zn were observed. The existence regions for these solid solutions were determined by the change of lattice parameters.

The change of the lattice parameters according to contents of the zinc and nickel in the solid solutions present in Table and Figures 1-5.
From Figures it is visible that at replacement of atoms Ni the atoms Zn observe increase of the lattice parameters and on the contrary, reduction of the lattice parameters at replacement of atoms Zn by atoms Ni in solid solution based on Zr_2Zn binary compound. It is explained to that radius of atom of Zn is more than radius of atom of Ni.
At research of the solid solution based on Zr_7Ni_{10} binary compound (fig. 3) we notice deformation which results in reduction of the lattice parameter *a*. However, volume of an elementary cell is increased.
Our investigation revealed the existence $Zr_9Ni_{11-x}Zn_x$ (were x=1) compound (structure type $Pt_{11}Zr_9$, space group I4/m, a= 0.9896 nm, c= 0.663 nm, V= 0.6496 nm^3). It can be consider as the rest of the solid solution based on Zr_9Ni_{11} binary compound which exists at 900°C.

Table. Lattice parameters for the solid solutions in Zr-Zn-Ni system at 600°C

Composition	Space group	Lattice parameters			Volume
		a, nm	b,nm	c,nm	
$ZrNi_5$	$F\bar{4}3m$	0.6702			0.3010
$Zr_{20}Ni_{75}Zn_5$		0.6725			0.3041
$Zr_{20}Ni_{70}Zn_{10}$		0.6739			0.3060
$Zr_{20}Ni_{65}Zn_{15}$		0.6757			0.3085
$Zr_{20}Ni_{60}Zn_{20}$		0.6771			0.3103
Zr_7Ni_{10}	Aba2	0.9211	0.9156	1.2386	1.0443
$Zr_{40}Ni_{55}Zn_5$		0.9151	0.9254	1.2393	1.0495
$Zr_{40}Ni_{50}Zn_{10}$		0.9110	0.9360	1.2400	1.0580
ZrNi	Cmcm	0.3268	0.9937	0.4101	0.1331
$Zr_{50}Ni_{45}Zn_5$		0.3287	1.0032	0.4103	0.1353
$Zr_{50}Ni_{40}Zn_{10}$		0.3296	1.0231	0.4106	0.1385
Zr_2Ni	I4/mcm	0.6483	0.6483	0.5267	0.2214
$Zr_{65}Ni_{30}Zn_5$		0.6488	0.6488	0.5271	0.2219
$Zr_{65}Ni_{25}Zn_{10}$		0.6493	0.6493	0.5276	0.2224
Zr_2Zn	$Fd\bar{3}m$	0.3303	0.3303	1.126	0.1228
$Zr_{65}Ni_5Zn_{30}$		0.3300	0.3301	1.1203	0.1220
$Zr_{65}Ni_{10}Zn_{25}$		5	0.3299	1.117	0.1216
		0.3299			

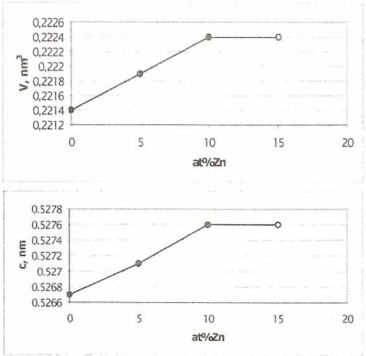


Figure 1. Change of lattice parameters for the solid solutions based on Zr_2Ni binary compound

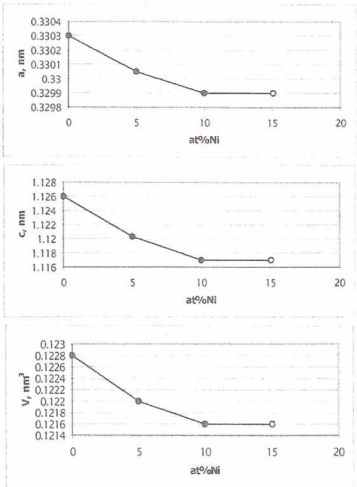


Figure 2. Change of lattice parameters for the solid solutions based on Zr_2Zn binary compound

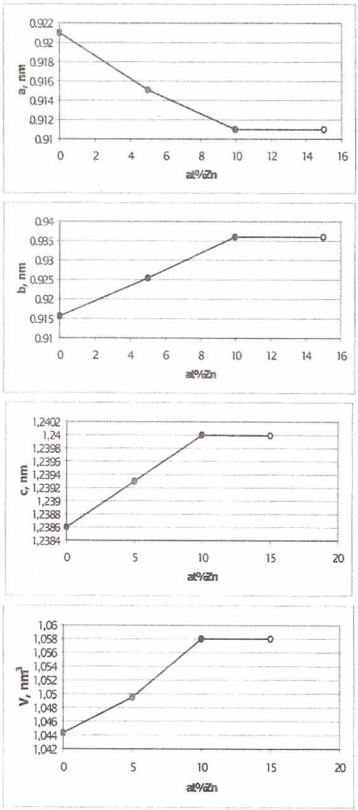


Figure 3. Change of lattice parameters for the solid solutions based on Zr_7Zn_{10} binary compound

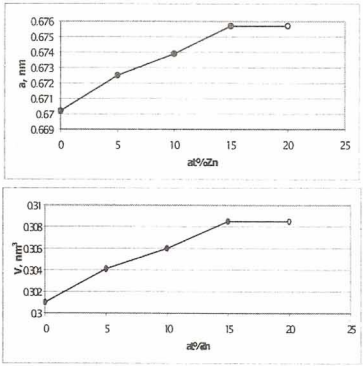
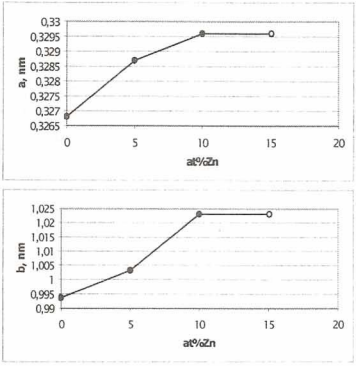


Figure 4. Change of lattice parameters for the solid solutions based on $ZrZn_5$ binary compound



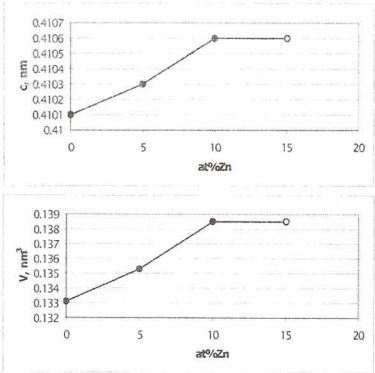


Figure 5 Change of lattice parameters for the solid solution based on ZrNi binary compound

REFERENCES

Wiles D.B.,Sakthivel A. and Young R.A., Program DBW3.2S for Rietveld Analysis of X-ray and Neutron Powder Diffraction Patterns, Atlanta, Georgia, Institute of Technology. 1988, 11p.