INVESTIGATION OF THE INTERACTION BETWEEN THE COMPONENTS IN THE Ti – Cu – Zn (670K) AND Fe – Zn – Ge (570 K) SYSTEMS

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The isotermal section of the Ti – Cu – Zn system at 670 K and Fe – Zn – Ge system at 570 K was investigated by X-ray phase analysis. Five ternary compounds were obtained in the Ti – Cu – Zn system. Crystal structures were determined for the $TiCu_2Zn$ – $AuCu_3$ structure type (space group $Pm\bar{3}m$, a=0.3671(3) nm); $Ti_6(CuZn)_{23}$ – Th_6Mn_{23} structure type (space group $Fm\bar{3}m$, a=1.1991(6) nm); $TiCuZn_2$ – $MnCu_2Al$ structure type (space group $Fm\bar{3}m$, a=0.6036(1) nm).

INTRODUCTION

The interaction of titanium with copper and zinc over the whole range of concentrations has yet been studied. The binary systems at the boundaries of the Ti–Cu–Zn ternary system have been widely studied including the phase diagrams over the whole concentration regions. The Ti–Cu, Ti–Zn and Cu–Zn binary systems have been accepted as given in [1]. Crystallographic parameters for the compounds existing in these system were taken from [2] and are given in Table 1.

Table 1. Crystallographic parameters of the compounds in the Ti–Cu, Ti–Zn and Cu–Zn binary systems

Compound		Structure type	Space group	Lattice parameters, nm	
			a	b	c
CuTi	AuCu	P4/mmm	0.4440	-	0.2856
CuTi *	CuTi	P4/nmm	0.3107	-	0.5919
$CuTi_2$ *	CFe_3W	Fd3m	1.124	-	-
$CuTi_2$	$MoSi_2$	I4/mmm	0.29438	-	1.07861
$CuTi_3$	AuCu	P4/mmm	0.4158	-	0.3594
Cu_2Ti *	Au_2V	Amm2	0.4363	0.7977	0.4478
Cu_3Ti *	Cu_3Ti	$Cmc2_1$	0.2572	0.4503	0.4313
Cu_3Ti	Cu_3Ti	Pmmn	0.5162	0.4347	0.4531
Cu_3Ti_2	Al_3Os_2	I4/mmm	0.3140	-	1.3962
Cu_3Ti_2 *	Cu_3Ti_2	P4/nmm	0.313	-	1.395
Cu_4Ti *	Au_4Zr	Pnma	0.4525	0.4341	1.2953
Cu_4Ti	$MoNi_4$	I4/m	0.584	-	0.362
Cu_4Ti_3	Cu_4Ti_3	I4/mmm	0.3126	-	1.9964
TiZn	ClCs	Pm3m	0.3143	-	-
$TiZn_{15}$	$TiZn_{15}$	Cmcm	0.7720	1.1449	1.1755
$TiZn_2$	$MgZn_2$	$P6_3/mmc$	0.5064	-	0.8210
$TiZn_3$	$AuCu_3$	Pm3m	0.39322	-	-
Ti_2Zn	$MoSi_2$	I4/mmm	0.3036	-	1.0678
$TiZn_5$			the structure is not determinate		
$TiZn_{10}$					
CuZn (β)	CsCl	Pm3m	0.29539	-	-
CuZn (β) *	W	Im3m	0.29967	-	-
Cu_5Zn_8 (γ)	Cu_5Zn_8	I43m	0.8869	-	-
$CuZn_4$(ξ)	Mg	$P6_3/mmc$	0.27418	-	0.42939

* these compounds were not observed at 670 K

Crystallographic parameters for the compounds in the Fe – Zn, Fe – Ge and Zn – Ge binary systems are given in Table 2.

Table 2. The crystallographic data of compounds of the Ti–Cu–Zn system

Compound	Structure type	Space group	Lattice parameters, nm
			A
$TiCu_2Zn$	$AuCu_3$	$Pm\bar{3}m$	0.3671(3)
$Ti_6(CuZn)_{23}$	Th_6Mn_{23}	$Fm\bar{3}m$	1.1991(6)
$TiCuZn_2$	$MnCu_2Al$	$Fm\bar{3}m$	0.6036(1)
$Ti_{50}Cu_{20}Zn_{30}$		the structure is not determinate	
$Ti_{10}Cu_{10}Zn_{80}$			

EXPERIMENTAL DETAILS

Isothermal section of the phase diagram of Ti – Cu – Zn system have been constructed by X-ray phase analysis of 60 alloys prepared by arc melting in argon atmosphere (with Ti as a getter). Homogenization was carried out in evaquated quartz ampoules at 670 K for 600 hours and quenched in cold water. The purity of starting materials was better than 99,9%. Powder patterns of alloys were obtained using powder diffractometer DRON-2.0 (FeK_α-radiation). Lattice parameters were calculated using LATCON.

RESULTS AND DISCUSSION

The isothermal section of the phase diagram of the Ti – Cu – Zn system at 670 K has been studied by investigating 60 ternary alloys and has been built (Fig.1) using the data of X-ray phase analyses.

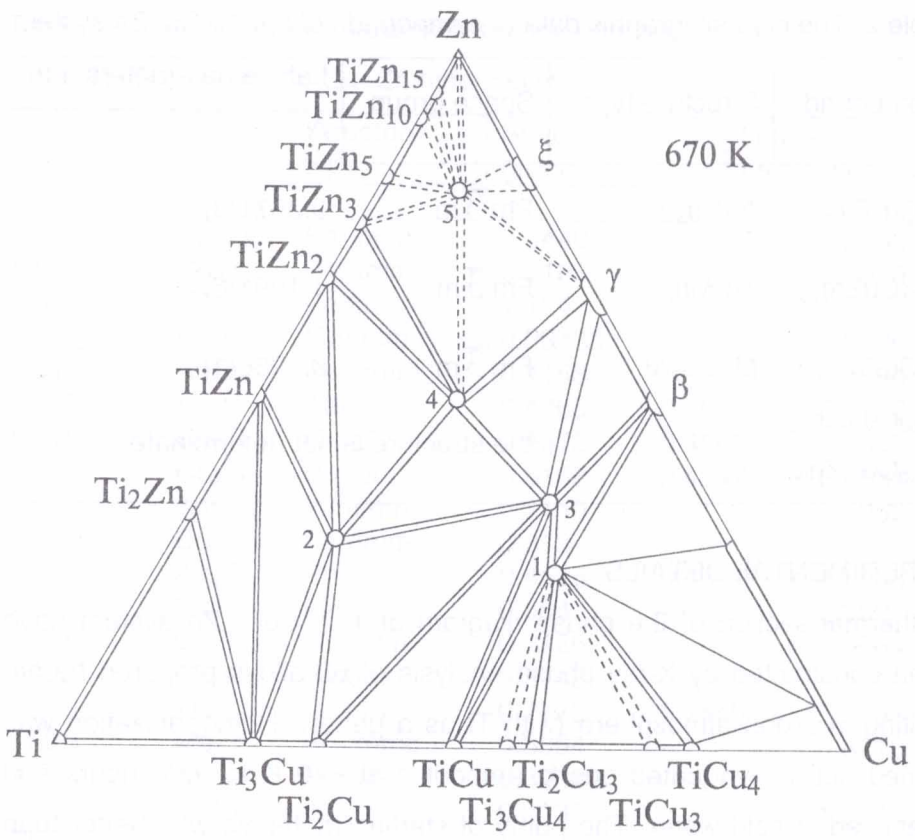

Fig.1 Isothermal section of the phase diagram of the Ti – Cu – Zn system at 670 K $TiCu_2Zn$, $Ti_{50}Cu_{20}Zn_{30}$, $Ti_6(CuZn)_{23}$, $TiCuZn_2$, $Ti_{10}Cu_{10}Zn_{80}$

Phase relation is characterised by the formation of five ternary compounds. The crystal structure of three of these new compounds has been determined using X-ray powder diffraction data. The characteristics of these compounds are given in Table 2.

Solubility of the third component in binary compounds was not observed. $TiCu_2Zn$ ($AuCu_3$ structure type) compound has been determined by X-ray powder diffraction data. An isostructural compound exists in Ni – Cu – Zn system: $NiCu_2Zn$, a=0.36357 nm [2]. $TiCuZn_2$ ($MnCu_2Al$ structure type) compound is characterised by ordered situating of atoms. An isostructural compounds exists in Au – Cu – Zn and Ag – Au – Zn systems: $AuCuZn_2$,

a=0.61273 nm; $AgAuZn_2$, a=0.62943 nm [2]. $Ti_6(CuZn)_{23}$ (Th_6Mn_{23} structure type) compound is characterised by unordered situating of copper and zinc atoms on right point-system. An isostructural compounds exists in Hf – Cu – Zn: $Hf_6Cu_7Zn_{16}$ – a=1.201 nm [2].

The limited solid solution on the base of $Fe_{13}Ge_8$ binary compound for the Fe – Zn – Ge ternary system at 570 K was investigated. $Fe_{13}Ge_8$ binary compound dissolves up ~10 at. % Zn. The lattice cell change from a=0.7976, c=0.4993 nm (for the $Fe_{13}Ge_8$) to a=0.7969, c=0.4988 nm.

REFERENCES

1. Massalski T.B., Binary Alloys Phase Diagrams, American Society for Metals, V. 1-2, 2223 (1986)
2. P.Villars, L.D.Calvert, Person's Handbook of Crystallography Data for Intermetallic Phases, American Society for Metals, V. 1-3, 3258 (1983)