INTERACTION OF THE COMPONENTS IN THE La-Co-Zn TERNARY SYSTEM AT 470K

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ABSTRACT

The isothermal section of the La-Co-Zn system at 470K has been investigated by X-ray phase analysis. Existence of some binary compounds has been confirmed. Seven ternary compounds and solid solutions, basing on the binary phases, have been obtained at 470K. Crystal structures have been determined for the $LaCo_{5-x}Zn_x$ ($AuBe_5$ structure type), $La_2Co_2Zn_{15}$ ($Ce_2Al_2Co_{15}$ structure type), $La_2Co_5Zn_2$ ($Ce_2Ni_5Zn_2$ structure type), $LaCo_2Zn$ (YRh_2Si structure type) and $La_3Co_{1-x}Zn_x$ ($AuCu_3$ structure type) ternary compounds. For the binary compounds $LaCo_5$ DSC measurement has been carried out.

INTRODUCTION

Interaction of lanthanum with cobalt and zinc over the whole concentration range has not been studied yet. It has been studied, considering the existence of some ternary compounds. Three ternary phases $LaCoZn_{12}$ ($BaCd_{11}$ structure type), $LaCo_6Zn_7$ (Th_2Zn_{17} structure type) and $LaCo_9Zn_4$ ($NaZn_{13}$ structure type) have been investigated by X-ray powder analysis [1].

The binary systems La-Co, La-Zn and Co-Zn have been accepted as given in [2]. Crystallographic characteristics for the binary compounds of the La-Co, La-Zn, Co-Zn systems according to [3] are listed in Table 1.

Table 1. Crystallographic parameters for the binary compounds of the La-Co, La-Zn and Co-Zn systems.

Compound	Type	Space group	a, nm	b, nm	c, nm
LaZn	CsCl	$Pm\bar{3}m$	0.376		
$LaZn_2$	$CeCu_2$	*Imma*	0.4689	0.7638	0.7593
$LaZn_4$	$LaZn_4$	*Cmcm*	0.633	1.029	0.611
$LaZn_5$	$CaCu_5$	*P6/mmm*	0.5416		0.4217
La_3Zn_{22}	Pu_3Zn_{22}	$I4_1/amd$	0.897		2.148
La_2Zn_{17}	Th_2Zn_{17}	$R\bar{3}m$	0.9131		1.3334
$LaZn_{11}$	$BaCd_{11}$	$I4_1/amd$	1.0686		0.6881
$LaZn_{13}$	$NaZn_{13}$	$Fm\bar{3}c$	1.206		
$LaCo_{13}$	$NaZn_{13}$	$Fm\bar{3}m$	1.133		
$LaCo_5$	$CaCu_5$	*P6/mmm*	0.5117		0.3975
La_2Co_7 (LT)	Ce_2Ni_7	$P6_3/mmc$	0.5109		2.4523
La_2Co_7 (HT)	Co_7Er_2	$R\bar{3}m$	0.5109		3.6701
La_2Co_3	La_2Ni_3	*Cmca*	0.4886	1.034	0.7811
$LaCo_2$	Cu_2Mg	$Fd\bar{3}m$	0.7449		
LaCo			0.5981		
La_6Co_5			0.4890		0.4312
La_4Co_3			0.6063		0.9775
La_3Co	Fe_3C	*Pnma*	0.7277	1.0020	0.6575
$Co_{13}Zn_7$	Cu	$Fm\bar{3}m$	0.3620		
β	W	$Im\bar{3}m$	...	...	...
CoZn	βMn	$P4_132$	0.6319		
Co_5Zn_{21}	Al_4Cu_9	$P\bar{4}3m$	0.8926		
γ_1	...	...	...	...	...
δ	...	...	...	...	...
$CoZn_{13}$	$CoZn_{13}$	*C2/m*	1.3306	0.7535 β=126.78°	0.4992

In this paper we present our results on the isothermal section of the La-Co-Zn system at 470K and data on the new ternary compounds and solid solution.

EXPERIMENTAL

Isothermal section of the phase diagram of La-Co-Zn system has been constructed by X-ray phase analysis of 108 alloys prepared by arc melting in argon. The alloys were annealed in quartz ampoules under vacuum at 470K for 1500 h. The purity of the starting metals was better than 99.9%. Powder patterns of alloys were obtained by powder diffractometer DRON-4 (FeK_α-radiation, 0.02° step scanning, 8-10 sec./one point speed of scanning). Lattice parameters and crystal structure refinement were calculated by of LATCON and RIETWELD ANALYSES programs [4].

RESULTS AND DISCUSSION

The phase diagram of the La-Co-Zn ternary system at 470K is shown in Fig.1.

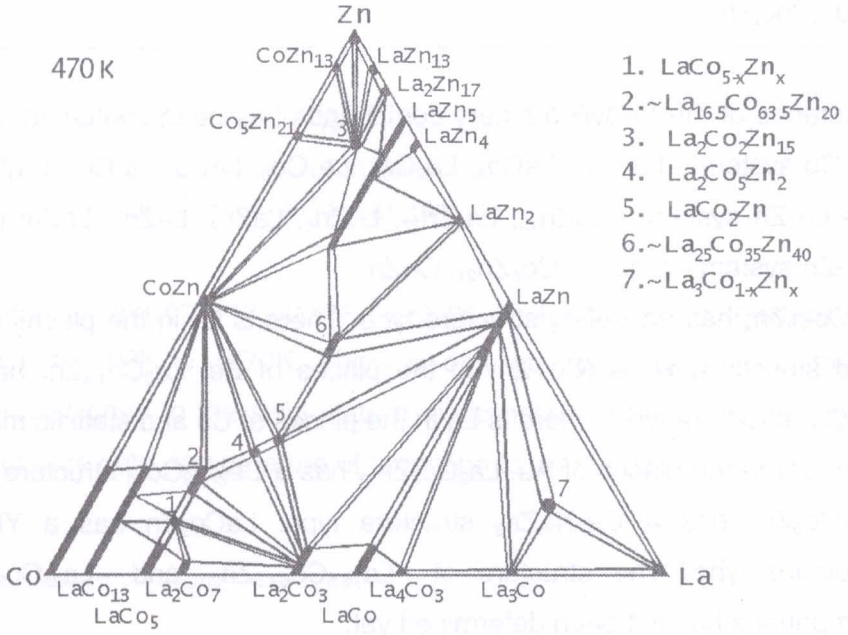

Figure. 1. Isothermal section of the La-Co-Zn system at 470K.

There are seven ternary compounds in this system their crystallographic characteristics are listed in Table 2.

Table 2. Crystallographic parameters of the La-Co-Zn system.

Compound	Structure type		Space group	Lattice parameters, nm	
			A	b	c
$LaCo_{5-x}Zn_x$	$AuBe_5$	$F\bar{4}3m$	0.7115(2)		
$La_2Co_2Zn_{15}$	$Ce_2Al_2Co_{15}$	$R\bar{3}m$	0.9080(1)		1.3316(4)
$La_2Co_5Zn_2$	$Ce_2Ni_5Zn_2$	$R\bar{3}m$	0.5055(2)		3.6325(7)
$LaCo_2Zn$	YRh_2Si	$P6_3/mmc$	0.5023(1)		1.6371(2)
La_3Co_{1-x},Zn_x	$AuCu_3$	$Pm\bar{3}m$	0.5305(3)		
$\sim La_{16.5}Co_{63.5}Zn_{20}$			Structures are not determinate		
$\sim La_{25}Co_{35}Zn_{40}$					

Existence of the following binary compounds has been confirmed: in the La-Co system – $LaCo_{13}$, $LaCo_5$, La_2Co_7, La_2Co_3, LaCo, La_4Co_3, La_3Co; in the La-Zn system – $LaZn_{13}$, La_2Zn_{17}, $LaZn_5$, $LaZn_4$, $LaZn_2$, LaZn; in the Co-Zn system – $CoZn_{13}$, Co_5Zn_{21}, CoZn.

$LaCo_{5-x}Zn_x$ has an $AuBe_5$ structure type. There is La in the places of Au and statistic mixture (Co+Zn) in the places of Be. $La_3Co_{1-x}Zn_x$ has an $AuCu_3$ structure type. There is La in the places of Cu and statistic mixture (Co+Zn) in the places of Au. $La_2Co_2Zn_{15}$ has a $Ce_2Al_2Co_{15}$ structure type. $La_2Co_5Zn_2$ has a $Ce_2Ni_5Zn_2$ structure type. $LaCo_2Zn$ has a YRh_2Si structure type. The structure of $\sim La_{16.5}Co_{63.5}Zn_{20}$ and $\sim La_{25}Co_{35}Zn_{40}$ compounds has not been determined yet.

The formation of the solid solutions on the basis of the binary compounds in the La-Co and La-Zn systems is characteristic of the investigated ternary systems. The solubility of Co in La-Zn is about 10 at.%. The

solubility of Zn in $LaCo_5$, La_2Co_3, LaCo is about 5 at.%. The largest solubility of Zn is equal about 20 at.% in $LaCo_{13}$.

In the case of the binary compound $LaCo_5$ DSC measurement has been carried out (Fig. 2.).

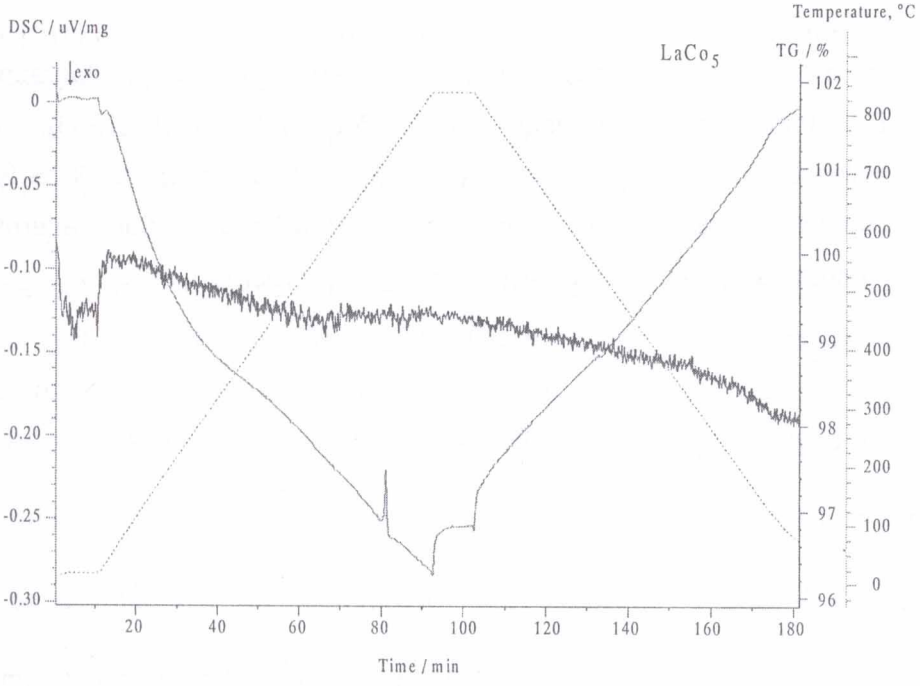

Figure 2. DSC diagram of $LaCo_5$ sample.

The heating and cooling curves have been studied in the temperature range from 290K to 1270K. There is only one peak present on these curves, assigned to the solid state transformation at 999K. According to the literature data, temperature of formation for the $LaCo_5$ is ~1363K.

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