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COMMUNICATION

Phase Diagram of Y–Rh–Ga System at 870 K

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Binary systems at the boundaries of the ternary Y–Rh–Ga system have been studied widely including the phase diagrams over the whole concentration regions for systems Y–Ga and Y–Rh [1–3]. The corresponding crystallographic data are summarized in Table 1. The Y–Rh–Ga system has been studied previously only with respect to the formation of compounds with specific compositions and structures: $Y_2Rh_3Ga_9$ ($Y_2Co_3Ga_9$-type) [4] and YRhGa (TiNiSi-type) [5].

In this communication we present the results of investigation of the isothermal section of Y–Rh–Ga system at 870 K in the range 0–0.50 at.% Rh and new ternary intermetallic compounds. Isothermal section of Y–Rh–Ga phase diagrams has been built by X-ray phase analysis of 97 alloys prepared by arc melting in argon (with Ti as a getter). High purity metals (yttrium, 99.76 mass %; rhodium, 99.95 mass % and gallium, 99.99 mass %) were used for these preparation of the alloys. During arc melting, the weight losses were less than 1% of the total mass of the ingots. The alloys were annealed in quartz ampoules under vacuum at 870 K for 720 h. Phase analysis was carried out using X-ray powder diffraction patterns obtained by Debye method (camera RKD-57.3, CrK-radiation) and powder diffractometer DRON-2.0 (FeK_α-radiation, with Silicon standard). Lattice constants were determined from the powder patterns (diffractometer DRON-3.0, CuK_α-radiation). For the crystal structure determination diffraction data were collected using a θ–2θ scan technique with steps of 0.05 ° 2θ and exposition time 10–20 sec. at every point (diffractometers DRON-4M, CuK_α-radiation and HZG-4a, CoK_α-radiation). The intensity and position of each reflection were determined precisely by the PROFAN profile from the CSD program package [6]. The isothermal section of the phase diagram of the Y–Rh–Ga ternary system at 870 K in the range 0–0.50 at.% Rh is shown in Fig. 1. Ten ternary compounds were found in Y–Rh–Ga system. Previously we reported the crystal structure of $Y_3Rh_3Ga_8$ [7], $Y(Rh_{0.20}Ga_{0.80})_3$ [8], $YRh_{0.38}Ga_{1.62}$ [9] and $Y_3(Rh_{0.60}Ga_{0.40})_2$ [10] compounds. Crystallographic parameters of these ternary compounds are presented in Table 2. The system is characterized by the existence of numerous compounds with narrow homogeneous regions. The YRh phase dissolves up to 15 at.% gallium. All other binary compounds dissolve less than 2 at.% of the third component.

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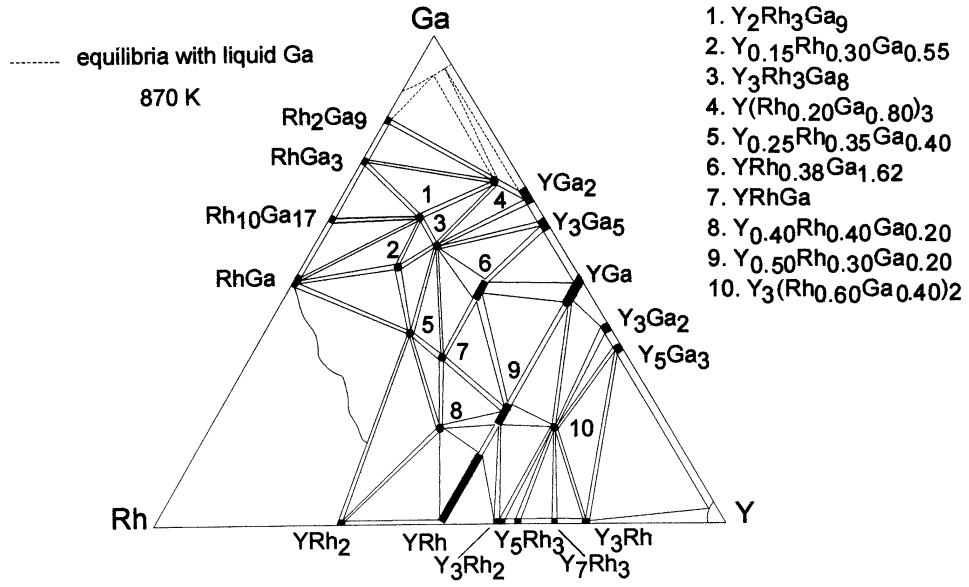

Figure 1. Isothermal section of the Y–Rh–Ga system at 870 K at the range 0–0.50 at.% Rh.

Table 1. Crystallographic data of the binary intermetallic phases in Y–Rh–Ga system, existing at 870 K.

Compound	Structure type	Space group	Lattice parameters, nm			Ref.
			a	b	c	
YGa_2	AlB_2	P6/mmm	0.4217	–	0.4111	[2]
Y_3Ga_5	Tm_3Ga_5	Pnma	1.145	0.9674	0.6098	[2]
YGa	α-ITl	Cmcm	0.42963	1.0876	0.40738	[2]
Y_3Ga_2	Gd_3Ga_2	I4/mmc	1.162	–	1.486	[2]
Y_5Ga_3	Mn_5Si_3	$P6_3/mmc$	0.8576	–	0.6415	[2]
YRh_5	$CaCu_5$	P6/mmm	0.5141	–	0.4294	[3]
YRh_3	$CeNi_3$	$P6_3/mmc$	0.5230	–	1.738	[3]
YRh_2	$MgCu_2$	Fd3m	0.7498	–	–	[2]
YRh	CsCl	Pm3m	0.3430	–	–	[3]
Y_3Rh_2	Y_3Rh_2	I4/mcm	1.1232	–	2.516	[3]
Y_7Rh_3	Th_7Fe_3		0.9775	–	0.6190	[3]
Y_5Rh_3	Mn_5Si_3	$P6_3/mmc$	0.8161	–	0.6398	[3]
Y_3Rh	Fe_3C	Pnma	0.7138	0.9438	0.6319	[2]
Rh_2Ga_9	Co_2Al_9	$P2_1/c$	0.6448	0.6405	0.8829	[2]
				β = 96.85°		
$RhGa_3$	IrIn3	P4n2	0.648	–	0.654	[2]
$Rh_{10}Ga_{17}$	$Rh_{10}Ga_{17}$	P4c2	0.5813	–	4.746	[2]
RhGa	CsCl	Pm3m	0.3010	–	–	[2]

Table 2. Crystallographic data of the ternary intermetallic phases in Y–Rh–Ga system.

Compound	Structure type	Space group	Lattice parameters, nm			Ref.
			a	b	c	
$Y_2Rh_3Ga_9$	$Y_2Co_3Ga_9$	Cmcm	1.2965(1)	0.75269(8)	0.9479(1)	[4]
$Y_{0.15}Rh_{0.30}Ga_{0.55}$			the structure is not determined			
$Y_3Rh_3Ga_8$	La_3Al_{11}	Immm	0.4316(3)	0.9705(6)	1.2715(7)	[7]
$Y(Rh_{0.20}Ga_{0.80})_3$	$AuCu_3$	Pm3m	0.4281(1)	–	–	[8]
$Y_{0.25}Rh_{0.35}Ga_{0.40}$			the structure is not determined			
$YRh_{0.38}Ga_{1.62}$	KHg_2	Imma	0.43887(2)	0.70076(3)	0.76682(3)	[9]
YRhGa	TiNiSi	Pnma	0.6801(5)	0.4290(1)	0.7737(3)	[5]
$Y_{0.40}Rh_{0.40}Ga_{0.20}$			the structure is not determined			
$Y_{0.50}Rh_{0.30}Ga_{0.20}$			the structure is not determined			
$Y_3(Rh_{0.60}Ga_{0.40})_2$	Y_3Rh_2	I4/mcm	1.15438(8)	–	2.4991(2)	[10]

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