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## Letter

## Phase equilibria in the Dy-V-Si system at 1200 K

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## Abstract

Phase equilibria in the Dy–V–Si system were investigated by X-ray powder diffraction and metallographic analysis. The isothermal cross-section at 1200 K was obtained. It is obvious that the AlB<sub>2</sub>-type (space group P6/mmm, no. 191) DyV<sub>0.1</sub>Si<sub>1.9</sub> compound [a=0.3817(1) nm, c=0.4114(1) nm] belongs to the extended region of an AlB<sub>2</sub>-type DySi<sub>1.56</sub>-based solid solution. © 2002 Elsevier Science B.V. All rights reserved.

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The interaction between the components in the Dy–Si, V–Si and Dy–V binary systems have been studied in Refs. [1-4]. However, phase equilibria in the Dy–Si and Dy–V

systems were not obtained. No binary compounds were detected in the Dy–V system (Table 1).

The alloys (Fig. 1) were made in an electric arc furnace



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Table 1

Crystallographic data of compounds in the Dy–V–Si system The reliability factors are  $R_{\rm F} = 100 \cdot (\Sigma_{\rm k} |(I_{\rm k}^{\rm obs})^{1/2} - (I_{\rm k}^{\rm cal})^{1/2}|)/\Sigma_{\rm k} |(I_{\rm k}^{\rm obs})^{1/2}|)/\Sigma_{\rm k} |(I_{\rm k}^{\rm obs})^{1/2}|)/\Sigma_{\rm k} |(I_{\rm k}^{\rm obs})^{1/2}|)/\Sigma_{\rm k} |(I_{\rm k}^{\rm obs})^{1/2}|$  ( $I_{\rm k}^{\rm obs})^{1/2}|$ )% ( $I_{\rm k}^{\rm obs}$  is the integrated intensity evaluated from summation of contribution of the *k*th peaks to net observed intensity,  $I_{\rm k}^{\rm cal}$  is the integrated intensity calculated from refined structural parameters)

No.	Compound	Space group	Strucyure type	a (nm)	b (nm)	c (nm)	$R_{\rm F}$ (%)	Refs.
1	Si <sup>a</sup> Si <sup>a</sup>	Fd3m Fd3m	C C	0.54307 0.5418(4)			3.3	[1,2] This work <sup>b</sup>
2	$V^a \ V^a$	Im3m Im3m	W W	0.30240 0.3022(4)			7.2	[1,2] This work⁵
3	Dy (LT1) Dy (LT2) <sup>a</sup> Dy (LT2) <sup>a</sup> Dy (HT)	Cmcm P6 <sub>3</sub> /mmc P6 <sub>3</sub> /mmc Im3m	Mg Mg W	0.3595 0.35903 0.3589(5) 0.398	0.6183	0.5677 0.56475 0.5640(9)	6.5	[1,2] [1,2] This work <sup>b</sup> [1,2]
4	$V_3Si^a$ $V_3Si^a$	Pm3n Pm3n	Cr₃Si Cr₃Si	0.47249 0.4735(3)			6.5	[2,4] This work <sup>b</sup>
5	$\begin{array}{c}V_5Si_3^a\\V_5Si_3^a\end{array}$	I4/mcm I4/mcm	$W_5Si_3$ $W_5Si_3$	0.9429 0.9413(3)		0.4756 0.4748(2)	3.6	[2,4] This work <sup>b</sup>
6	V <sub>6</sub> Si <sub>5</sub>	Ibam	Ti <sub>6</sub> Ge <sub>5</sub>	1.5966	0.7501	0.4858		[2,4]
7	$\frac{\text{VSi}_2^{\text{a}}}{\text{VSi}_2^{\text{a}}}$	P6 <sub>2</sub> 22 P6 <sub>2</sub> 22	$CrSi_2$ $CrSi_2$	0.4571 0.4565(3)		0.6372 0.6366(3)		[2,4] This work <sup>ь</sup>
8	$Dy_5Si_3^a$ $Dy_5Si_3^a$	$P6_3/mcm$ $P6_3/mcm$	$Mn_5Si_3$ $Mn_5Si_3$	0.837 0.8350(6)		0.626 0.6230(3)	1.7	[2,3] This work <sup>b</sup>
9	${\operatorname{Dy}}_5{\operatorname{Si}}_4^a$ ${\operatorname{Dy}}_5{\operatorname{Si}}_4^a$	Pnma Pnma	$Sm_5Ge_4$ $Sm_5Ge_4$	0.736 0.7352(3)	1.448 1.4499(6)	0.765 0.7636(3)	1.6	[2,3] This work <sup>b</sup>
10	DySi (HT) DySi (LT) <sup>a</sup> DySi (LT) <sup>a</sup>	Pnma Cmcm Cmcm	FeB CrB CrB	0.787 0.4237 0.4246(1)	0.380 1.0494 1.0485(2)	0.565 0.3818 0.3815(1)	3.3	[2,3] [2,3] This work <sup>b</sup>
11	$\begin{array}{l} DySi^{a}_{1.67} \\ DySi^{a}_{1.67} \\ \sim Dy_{33}V_{5}Si^{a}_{62} \end{array}$	P6/mmm P6/mmm P6/mmm	$\begin{array}{c} AlB_2 \\ AlB_2 \\ AlB_2 \end{array}$	0.383 0.3825(1) 0.3817(1)		0.411 0.4116(6) 0.4114(1)	4.9 2.6	[2,3] This work <sup>b</sup> This work <sup>b</sup>
12	$\begin{array}{c} \text{DySi}_2 \ (\text{HT}) \\ \text{DySi}_2 \ (\text{LT})^a \\ \text{DySi}_2 \ (\text{LT})^a \end{array}$	14 <sub>1</sub> /amd Imma Imma	$\begin{array}{c} {\rm ThSi}_2 \\ {\rm GdSi}_2 \\ {\rm GdSi}_2 \end{array}$	0.403 0.404 0.4032(1)	0.394 0.3933(1)	1.338 1.334 1.3306(2)	3.3	[2,3] [2,3] This work <sup>b</sup>

<sup>a</sup> Compounds belong to the isothermal cross-section at 1200 K.

<sup>b</sup> Data for compounds from X-ray phase analysis of the three-component samples.

under an argon atmosphere using a nonconsumable tungsten electrode and a water-cooled copper tray. Silicon, vanadium and disprosium (purity of each component  $\geq$ 99.99%) were used as starting components. Zirconium was used as an O<sub>2</sub> getter during the melting process. The alloys were remelted three times in order to achieve complete fusion and a homogeneous composition. The melted alloys were subjected to an anneal in evacuated quartz ampoules containing titanium chips as an O2 getter. The ampoules were placed in a resistance furnace. The alloys were annealed at 1200 K for 2 weeks. The samples were quenched from 1200 K in ice-cold water. The phase equilibria in the Dy-V-Si system were determined from X-ray phase analysis and metallographic analysis. Powder X-ray data were obtained on a Dron-3.0 diffractometer (CuK $\alpha$  radiation,  $2\theta = 20-70^\circ$ , step 0.05°, for 5 s per step).

The powder X-ray diffractograms obtained were identified by means of calculated patterns using the RIETAN program [5,6] in the isotropic approximation.

A 'Neophot' microscope was employed for metallograhic inspections ( $\times$  250,  $\times$ 500).

The results obtained were used in the construction of the isothermal cross-section of the Dy–V–Si system at 1200 K, presented in Fig. 1.

The  $DyV_{0.1}Si_{1.9}$  compound belongs to the extended region of an AlB<sub>2</sub>-type  $DySi_{1.56}$ -based solid solution. The other binary compounds do not show any visible solubility. No ternary compounds were detected in the Dy–V–Si system at 1200 K. No V<sub>6</sub>Si<sub>5</sub> compound was detected in the Dy–V–Si system at 1200 K.

It is obvious that the isothermal sections of the R-V-Si systems are similar to the Dy-V-Si isothermal section when R=Gd, Tb, Ho, Er, Tm.

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