FORMATION OF ALLOYS IN Ti-V SYSTEM IN HYDRIDE CYCLE AND SYNTHESIS OF THEIR HYDRIDES IN SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS REGIME

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Introduction

The developed last years at the Laboratory of High-temperature synthesis method of alloys receiving in hydride cycle provides wide opportunity for obtaining of a series of alloys of transition metals and their hydrides [1].

Some BCC alloys in Ti-V system, due to the peculiarities of their crystal structure, show high sorption-desorption characteristics being suitable as materials for hydrogen storage, and also as activators of absorption kinetics of hardly hydrogenated metals and alloys (for example, as Mg and its alloys) [2].

In the present work, the possibility of receiving of titanium and vanadium based alloys of BCC structure using "hydride cycle", through interaction TiH_2 and VHx (V) was investigated. The mechanism of formation of alloys in Ti-V system from the powders of hydrides TiH_2 and VHx (V) by compaction and further dehydrogenation of the received compact sample was studied; the interaction of the received alloys with hydrogen in combustion regime (self-propagating high-temperature synthesis, SHS) with formation of hydrides of these alloys [3] was studied.

Results and discussion

Earlier, in work [..] the principal possibility of formation of alloys of transition metals as a result of interaction of their hydrides at compaction of hydride powders followed by dehydrogenation of the compact sample has been shown.

In the present work, the experiments were curried out in the developed standard scheme: [4]

- receiving of TiH_2 and VHx hydrides in SHS regime;
- crushing and mixing of the powders of received hydrides;
- compaction of the mixture under pressure 40000 kgf;
- hydrogen removal - vacuum annealing which provides the active dissociation of hydrides according reaction:

$$xTiH_2 + (1\text{-}x)VH_y \rightarrow Ti_xV_{1-x} + H_2\uparrow;$$

$$xTiH_2 + (1\text{-}x)V \rightarrow Ti_xV_{1-x} + H_2\uparrow.$$

It was shown that the parameters of process, chemical peculiarities and ratio of initial components, phase transformations during dehydrogenation, etc. influence on the alloys formation in Ti-V system. The experimental results testify the dependence of structure of the formed alloys on the composition of initial charge. In Table 1, the characteristics of received alloys are listed. In Fig. 1 the thermogram the process of an alloy formation at dehydrogenation of $xTiH_2$ + (1)VH_y hydrides mixture is shown.

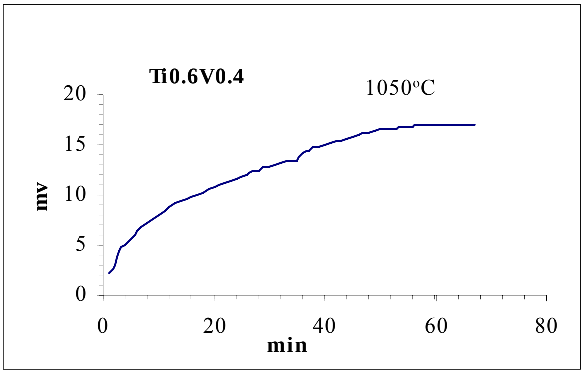

Fig.1.Thermogram of process of formation of $Ti_{0.6}V_{0.4}$ alloy.

The data of x-ray analysis show that during dehydrogenation, an alloy with BCC crystal structure is formed in accordance with the composition of initial charge: $0.6(TiH_2) + 0.4VH_y \rightarrow Ti_{0.6}V_{0.4}$. Besides, a small amount of other phase is present (no more than 10 %). In Fig. 2 the x-ray picture $Ti_{0.6}V_{0.4}$ alloy is presented. The identification of this picture shows that along with the basic BCC phase (a = 3.205 Å) there is also some amount of alpha phase (a=2.96; c=4.76 Å). The ratio of the intensities of these phases was estimated: $I_{bcc}/I_{alfa} = 3.4$.

The received compact alloys, the characteristics of which are listed in Table 1, interacted with hydrogen in combustion regime (SHS) at pressure of hydrogen 10-30 atm. This interaction led to the formation of hydrides of alloys with rather high hydrogen content. In Table

1 the characteristics of the received hydrides of alloys are presented also.

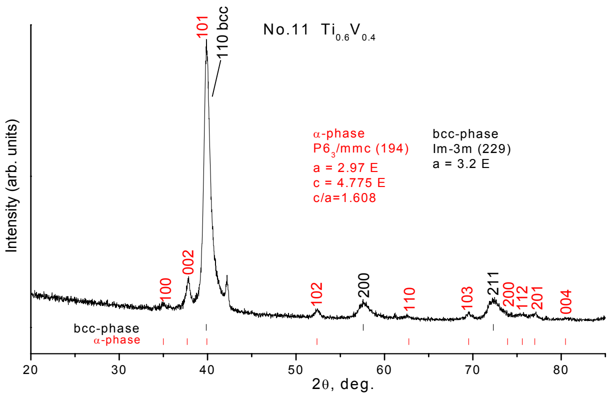

Fig. 2. The X-ray pattern of $Ti_{0.6}V_{0.4}$ alloy.

The repetition of SHS-hydrogenation-dehydrogenation cycle has shown that the process was reversible: after hydrogen removal and sintering at temperature 1000-1050°C, the alloy kept its phase composition and did not break up to the separate components.

Table 1

Alloy/hydride	Phase comp.	I_{BCC} / I_{HCP}	Cryst. lat. params, Å	H/Me
$Ti_{0.8}V_{0.2}$	**HCP*** **BCC**	-	*a*= 2.979 c=4.726	-
$Ti_{0.7}V_{0.3}$	BCC* HCP	3.2	*a* = 3.196;	-
$Ti_{0.7}V_{0.3}H_{1.9}$	FCC	-	*a*= 4.397	1.9
$Ti_{0.6}V_{0.4}$	BCC* HCP	3.4	*a* = 3.18	-
$Ti_{0.6}V_{0.4}H_{1.9}$	FCC	-	*a*= 4.39	1.9
$Ti_{0.5}V_{0.5}$	BCC* HCP	3.6	*a* = 3.170	
$Ti_{0.5}V_{0.5}H_{1.88}$	FCC		*a*= 4.353	
$V_{0.66}Ti_{0.18}Cr_{0.16}$	BCC*	3.8	*a*= 3.015	
$V_{0.66}Ti_{0.18}Cr_{0.16}H_{1.44}$	FCC		*a*= 4.266	1.44

According to DTA analysis, the temperature of decomposition was within 300-400°C depending on the ratio of metals in alloy. It was experimentally shown that the repeated cycling of hydrides ($Ti_xV_{1-x}H_{1.8-1} \leftrightarrow Ti_xV_{1-x} + H_2$) did not influence on their sorption/desorption characteristics. The sorption/desorption processes were completely reversible.

Conclusions

1. A number of Ti and V based alloys were received from their hydrides, TiH_2 and VH_x, using the developed in IChPh technique named "hydride cycle". Parameters of process of alloys formation were defined. The hydrides of these alloys were synthesized in the SHS regime.

2.The application of the developed by us technique gives the opportunity: to expand the assortment of multi-component alloys with small additives; to find new hydrogen-storage alloys; to influence effectively on the hydrogen sorption/desorption kinetic of these alloys changing their chemical composition by small additions of transition metals (Cr, Mn, Ni, Zr, etc.).

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