RECEIVING OF COMPACT SAMPLES OF HAFNIUM AND LIGATURE FROM WASTE IN «HYDRIDE CYCLE»

Dolukhanyan S.K., Aleksanyan A.G., Kotsar M. L., Pogosyan A.A.
A.B.Nalbandyan Institute of Chemical Physics of Armenian NAS, 5/2 P.Sevak str., Yerevan 0014, Armenia
(1) Institute of Solid State Physics of Russian Academy of Sciences, Chernogolovka, Moscow, Rassia. District, 142432
Fax: (37410 281634; *E-mail : a.g.aleks_yan@mail.ru*

Introduction

In the present work, the results of study of possibility of recycling of waste formed at machining of produces of cast refractory metals with the goal to receive a compact sample of metal are described. As example, waste shaving of Hf is used

The process of formation of hafnium based ligatures in «hydride cycle» is investigated also.

These researches are based on the scientific elaborations at the Laboratory of High-Temperature Synthesis and Technology of Inorganic Compounds of the Institute of Chemical Physics of Armenian HAS. On the basis of regular study of SHS processes in Me-H systems, an essentially new high-efficiency method of synthesis of hydrides of transition metals has been developed [1-2]. In this Laboratory, the ability of hydride powders to compaction and plastic deformation also have been studied which have led to the development of a new method of receiving of alloys and pure metals from their hydride powders of by compaction and further dehydrogenation.

Results and discussion

Preliminary, the process of combustion of hafnium shaving (waste) in hydrogen has been studied in depending on the hydrogen pressure which was varied in the limits 10 – 30 atm. It was shown, that the hafnium shaving interacts with hydrogen in a combustion regime.

Depending on the hydrogen pressure, the temperature of combustion can reach 520-950°C. As a result of this interaction, biphasic hydride of hafnium was formed: δ- phase with fcc lattice and ε-phase with bct lattice, in accordance with the state diagram in Hf-H system.

According to the state diagram 3 phases exist in Hf-H system: α-phase, solid solution of hydrogen in Hf, δ-phase with CaF_2 type grain centered cubic lattice, and ε-phase with body centered tetragonal lattice.

The hydrogen content in the formed hydride was in the limits ~ 0.9-1.1 wt % and depends on the ratio of δ (fcc)and ε (bct) phases. It was experimentally shown, that the received hafnium hydride, synthesized from the shaving in SHS regime, can be dispersed easily down to10-20 microns.

The dependence of process of compaction of HfH_X powder on the hydrogen content, dispersity and pressing pressure was studied.
It was shown that at pressure 45000kG, compact samples of hafnium hydride were received (d = 20 mm; h = 20 mm. P = 50 g).

The subsequent dehydrogenation of hafnium hydride led to the formation of compact sample of hafnium with density ρ = 11.3 - 11.5 g/cm^3. The shrinkage at dehydrogenation was up to 20-30 %.
The processes of formation of hafnium based different ligatures in «hydride cycle» are investigated.

An $HfH_{1.76}$ powder has been used as a basis. As additions powders of Re, Ni, and Mo, as well as zirconium hydride were used.
The influence of dispersion of hafnium hydride, loading at pressing, and temperature at dehydrogenation on the phase composition of received ligatures and on the density of samples has been studied also. In Table 1, some characteristics of received in hydride cycle ligatures are presented.

Table 1

Initial mixture	**Phase comp., Lattice parameter, Å**	**Density, g/cm^3**
$HfH_{1.76}$+25% ZrH_2	hcp;α-phase, a=3.21; c=5.089	9.19
$HfH_{1.76}$+25% ZrH_2	hcp;α-phase, a=3.20;c=5.079	8.99
$HfH_{1.76}$ + 5% Ni	hcp,α-phase a=3.88;c=5.045 intermetallic	10.9
$HfH_{1.76}$+ 10% Ni	hcp;α-phase, a=3.191;c=5.049	10.18
$HfH_{1.76}$+ 5% Mo	hcp;α-phase, a=3.192;c=5.064	10.87
$HfH_{1.76}$+ 10% Mo	hcp;α-phase, a=3.182;c=5.068	11.15

Conclusions

1. It was shown, that in hydride cycle a recycling of hafnium shaving – an example of waste at machining of produces from cast refractory metals, was possible by hydrogenation in SHS regime.

2. From the synthesized hafnium hydride, compact samples of hafnium were received with rather high density.

3. In hydride cycle, a wide spectrum of ligatures of the given composition was received.

4. These developments give the energy- and resource-saving effects and have wide perspectives for further use in the industry.

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