FORMATION OF Ti-Cr b.c.c. CONTINUOUS SERIES ALLOYS BY MECHANICAL MILLING OF Ti AND Cr POWDERS

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Introduction

Ti-Cr alloy is one of the most promising hydrogen storage alloys. It can absorb the large amount of hydrogen near room temperature and it is relatively lightweight [1]. However, solubility of Ti in Cr at room temperature is very limited because titanium have in equilibrium by low temperature h.c.p. structure-Ti and chromium b.c.c. Ti is in equilibrium with the extremely stable Laves phase ($TiCr_2$) existing in the middle of the phase diagram. Besides, it is difficult to obtain metastable Ti-Cr body center cubic (b.c.c.) phase. Here we would like to show that Ti-Cr b.c.c. alloys can be obtained by mechanical milling of Ti and Cr. It will be discussed how the excess energy derived during milling works on the formation of TiCr b.c.c. phase.

Experimental procedure

Elemental powders of Ti (produced by Zaporozhia plant, Ukraine) with the specific surface of 0,1 m^2/g and Cr (soviet chrome brand X 97, 5) with the specific surface of 0,2 m^2/g were blended to rich nominal compositions of: 1) $Ti_{20}Cr_{80}$, 2) $Ti_{50}Cr_{50}$, 3) $Ti_{80}Cr_{20}$ and 4) $Ti_{86}Cr_{14}$. The milling of titanium and chromium powders was performed into a planetary mill (soviet brand АИР-015М) at a rotation rate of 1440 rev/min under an argon atmosphere at room temperature for milling duration of 3 h. A steel ball-to-powder weight ratio was 20:1. The phases in the alloyed powders were identified by X-ray diffraction (XRD) using CuKα radiation at room temperature on a DRON. The powders were hydrogenated in a Siverts apparatus.

Results and discussions

The diffraction peaks of alloyed Ti-Cr powders are present on fig 1. The peaks are highly broadened. The size of particles calculated with Scherrer's formula is around 10 nm. It can be seen that alloying of Ti-Cr mixtures yielded the formation of single nano-sized solid solutions. The typical XRD patterns from b.c.c. structure were obtained for powders with different Ti content.

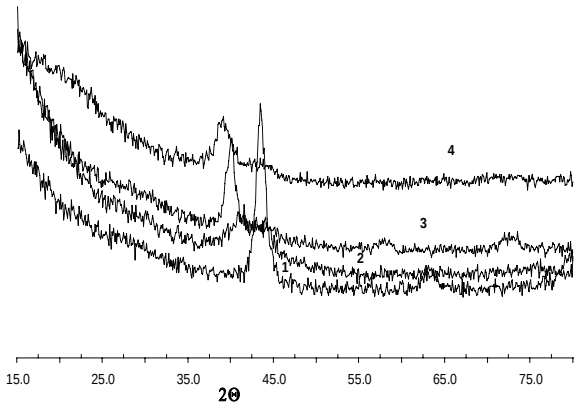

Fig. 1. XRD profiles of synthesized Ti–Cr alloys with different Ti compositions: 1—$Ti_{20}Cr_{80}$, 2—$Ti_{50}Cr_{50}$, 3—$Ti_{80}Cr_{20}$, 4—$Ti_{86}Cr_{14}$.

The diffraction peak angels moved to lower angel with increasing Ti composition, suggesting that b.c.c. lattice was expanded by substituting Ti with larger atomic size. Furthermore, it must be emphasized here that the excess energy derived during mechanical alloying yields the formation of metastable Ti-Cr b.c.c. phase at room temperature, which should appear at higher temperature according to equilibrium phase diagram. This is connect with appearance b.c.c. structure ßTi and nanoparticle (date of "Zetasiser"—5-10 nm).

Hydrogen consists in synthesized $Ti_{80}Cr_{20}$ alloy is around 2 wt.% at 10 MPa and 480 ^oC.

References

1. Akiba E., Okada M. Metallic Hydrides III: Body-Centered- Cubic Solid- Solution Alloys // MRS. Bulletin. September 2002. P. 699–703.