HIGH PRESSURE STUDIES OF URANIUM INTERMETALLICS - HYDROGEN SYSTEMS

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Intermetallic compounds with a general formula UTX (*T*= 3*d*, 4*d*, or 5*d* atom, and *X*= *p*-electron atom like Si, Ge, Al, In) are among widely studied systems. One of the most prominent structure types in which these compounds crystallize is the hexagonal ZrNiAl-type structure (space group $P\bar{6}2m$) [1]. The interest in this family of compounds stems mainly from their unusual magnetic properties [2].

Uranium and its compounds are used in nuclear industry, but several non-nuclear applications have been proposed [3, 4]. One of the possible applications is a hydrogen storage material. It is well known that uranium metal can absorb hydrogen at room temperature. The uranium intermetallic compounds with Laves phase structure type such as UNi_2 and UAl_2 showed an inertness towards hydrogen absorption up 2 to 10 MPa [5]. However, large hydrogen capacities were reported for the UTAl (T=Mn, Fe, Ni) with the hexagonal Fe_2P-type structure (space group $P\bar{6}2m$) [5, 6]. For example, UNiAl form two hydride/deuteride phases $UNiAlH_x$ (x=0.7– 0.8 for first one and x= 2.0 – 2.7 for the second).

In this work the hydrogen absorption of series of UTX (UCoAl, UPtAl and UCoSn) compounds (hexagonal ZrNiAl-type structure, space group $P\bar{6}2m$) by using high hydrogen pressure technique has been investigated.

Exposition of UCoAl at 0.5 GPa of hydrogen pressure and 100°C resulted in formation of $UCoAlH_4$ hydride. Hydrogen pressures lower than 0.1 GPa were insufficient for hydride formation in this alloy. The crystal structure of this new hydride was refined in the hexagonal AlB_2-type structure (P6/mmm space group, a=4.1773 Å and c=4.1254 Å). Magnetic properties of the UCoAl hydride, studied in the temperature range 2 – 300 K and fields up to 6 T, exhibit the Curie-Weiss susceptibility with effective moment $2.0\mu_B$/U and paramagnetic Curie temperature - 6 K.

In the case of UPtAl and UCoSn compounds we could not detect absorbed hydrogen after charging at 1 GPa(H_2) and 100°C. However, the crystal structure transformation from the hexagonal ZrNiAl-type (space group $P\bar{6}2m$) to the hexagonal AlB_2- type structure (space group P6/mmm) (like in $UCoAlH_4$ hydride) was observed for UPtAl intermetallic. In the UCoSn system high hydrogen pressure treatment does not change symmetry of its hexagonal structure but is accompanied with a small change of lattice parameters (from a=7.153Å, c=4.001Å for parent compounds to a=7.218 Å, c=3.992 Å).

References

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