High Pressure Studies Of Uranium Hydride – UH_3

I. Halevy, S. Salove, S. Zalkind and I. Yaar,

Physics Department, Nuclear Research Center - Negev, P.O. Box 9001, Beer-Sheva, Israel

A large variety of the lanthanide and actinide elements have the RH_2 and RH_3 compounds. Usually the RH_2 have the CaF_2 structure. The Uranium has an exemption and exhibits only the UH_3 compound. The UH_3 has two different unit cell parameters, one of which is unstable. The exposure of uranium metal to gaseous hydrogen leads to a direct reaction in which the metal is converted into the hydride UH_3. This work was done to gain a better understanding of why the uranium system is different.

The uranium hydride sample was prepared by a direct reaction in which the metal is converted into the hydride UH_3. The sample was kept under argon atmosphere. SEM examined the microstructure and the phases analyzed by EDS to determine the chemical compositions.

X-Ray powder diffraction measurements were taken at ambient and high pressure (up to 27GPa), using a Merrill-Bassett type diamond anvil cell (DAC). The experiments were carried out in a "Tel-Aviv"-type diamond-Anvil-Cell.

The $UH_3(\beta)$ -type structure of the UH_3 actinide compound is described by the cubic space group Pm3n (223). The unit cell contains eight formula units in the cell, H 24k (0.000 0.156 0.313), U1 2a (0 0 0) and U2 in 6c (0.250 0.000 0.500) (Fig 1.).

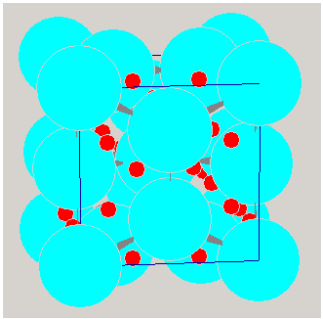

Fig 1. The crystallographic structures of UH_3

X-ray at ambient pressure: The powder diffraction spectra of the sample taken by Cu K_α radiation and SiO_2 monochromator is shown in Fig 2.

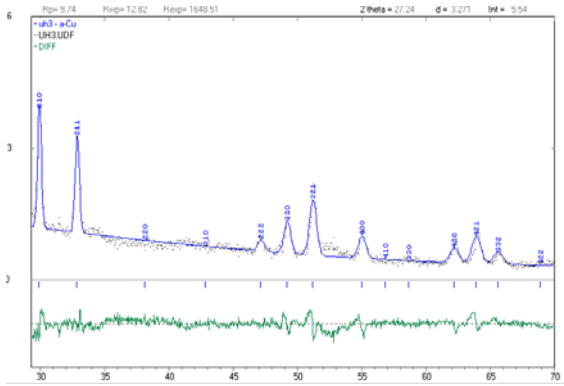

Fig 2. The powder diffraction spectra of UH_3 at ambient pressure.

UH_3 compound has a $UH_3(\beta)$-type, Pm3n symmetry cubic structure, with the lattice parameter a=6.6452(5)Å close to the unit cell that was reported by Rundle[1], Si was used as an external standard.

X-ray under pressure: The UH_3 maintains the cubic symmetry as a function of pressure, as was determined by the Rietveld[2] analysis. The volume-pressure curve calculated from the X-ray analysis is given in Fig 3. V/V_0=0.87 at 26.0GPa.

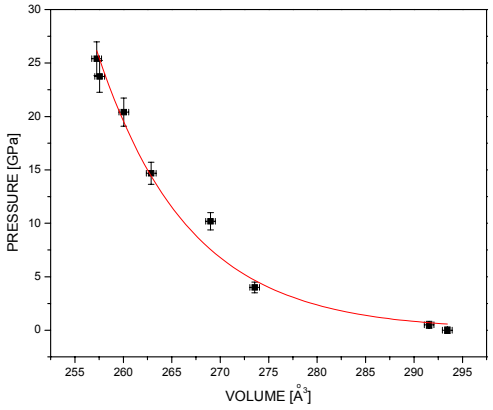

Fig. 3. Volume-Pressure curve calculated from the X-ray analysis.

References

[1] Rundle, R. , J. Am. Chem. Soc., 69 1719 (1947) Common Met., 149 (1989) 237.

[2] R.A. Young, A. Sakthivel, T.S. Moss, C.O. Paiva-Santos, " Rietveld Analysis of X-Ray and Neutron Diffraction Patterns, Georgia Institute of Technology Atlanta, GA 30332, 19 Dec. 1994.