4-3 Toward a Hydrogen Utilizing Society
−Hydrogenation of Aluminum with Hydrogen Fluid−

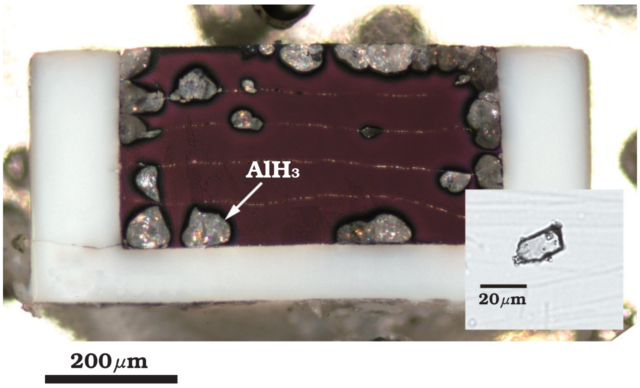

Fig.4-6 Optical micrograph of sample after treatment
The inner black portions are unreacted aluminum, and the glassy white particles are AlH_3. The grain size of recovered AlH_3 ranged from a few to several tens of microns. Inset shows a transmitting light micrograph of a single AlH_3 crystal.

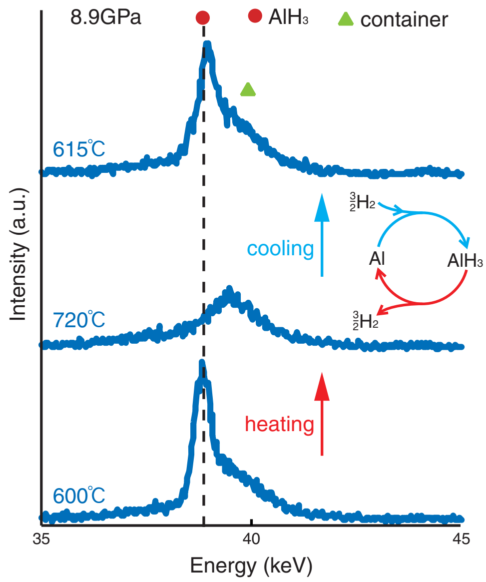

Fig.4-7 Powder X-ray diffraction profiles of aluminum sample immersed in high-pressure high-temperature hydrogen fluid
When the sample was heated from 600°C, where AlH_3 formed, at 8.9GPa, AlH_3 decomposed at 720°C. Upon subsequent cooling, aluminum was hydrogenated again at 615°C. Cyclic hydrogenation and dehydrogenation was achieved.

Hydrogen is an ideal energy carrier since it minimizes harmful effects on the environment. Development of a safe and efficient storage system of hydrogen is widely recognized as a key technological challenge which must be met to realize a hydrogen-based energy economy. Hydrogen can be stored as a pressurized gas, cryogenic liquid, and solid fuel; for example, hydrogen forms metal hydrides with some metals and alloys. These solid-state storage media provide a safety advantage over the gas and liquid storage methods.

Typical hydrogen storage alloys, such as $LaNi_5$, absorb hydrogen at relatively low pressure. In contrast to such hydrides, high pressure is needed to hydrogenate aluminum. Passivation film on the surface of aluminum also prevents the hydrogenation reaction. AlH_3 is, however, promising as a hydrogen storage material due to its large hydrogen content (10.1wt%). If the hydrogenation of aluminum is realized, it is expected to develop novel aluminum-rich alloy hydrides with moderate hydrogenation pressure.

We have succeeded in hydrogenation of aluminum and recovery of AlH_3 (Fig.4-6). The hydrogenation and dehydrogenation process was investigated by *in situ* X-ray diffraction measurement at SPring-8 (Fig.4-7). Highly reactive hydrogen fluid suppressed the influence of the chemically stable oxide layer on the aluminum surface.

In the future, we will elucidate the hydrogenation and dehydrogenation mechanism of aluminum, and develop novel aluminum-based alloy hydrides which can absorb hydrogen at practical pressure temperature conditions.

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Reference

Saitoh, H. et al., Formation and Decomposition of AlH_3 in the Aluminum-Hydrogen System, Applied Physics Letters, vol.93, issue 15, 2008, p.151918-1-151918-3.