Nanostructured surfaces

Deuterium desorption temperatures of Al-Ti composites prepared by the method of atom-by-atom component mixing

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Aluminium-based and magnesium-based alloys are promising in the view of present-day requirements to the metal-hydride hydrogen storage systems. Behavior of hydrogen in the aluminium-based magnesium-based alloys is of scientific and applied interest that is confirmed by many publications. However, the use of such alloys presents some difficulties because of the high hydrogen desorption temperature (550-600 K).

To manufacture Al-Ti composites the plasma evaporation-sputtering method was used enabling the atom-by-atom component growth. Thus, the composites with a wide range of the ratios of components were obtained. A composite was deposited on the molybdenum foils (0.2 mm thickness, 10 mm width, 250 mm length) placed between the cathode assemblies in the facility. Deuterium introduction into the samples was performed by the ion implantation method. Deuterium desorption temperature ranges and deuterium storage levels were determined by the thermal desorption spectroscopy (TDS).

A low aluminium concentration and, consequently, a high titanium concentration in the composite are demonstrated in the deuterium TDS as a single peak with a maximum temperature at 820-840 K as a function of the implanted deuterium dose and composite composition. A single-peak character of the deuterium TDS, observed for aluminium concentration values from 10 to 70 at.%, evidences on the homogeneity of composite structural state in this range.

As the aluminium concentration in composites increases the deuterium TDS is significantly changing and, as a result, the deuterium desorption temperature for $Al_{85}Ti_{15}$ composites sharply decreases (T_m~550 K). A step-like shape of the maximum temperature curve of thermoactivated deuterium desorption, as a function of the component concentration change, evidences on the existence of two different structural states of the Al-Ti system depending on the ratio of components.

The deuterium temperature decrease can be caused by filamentary inclusions formed, in the process of composite making and annealing, by the titan atoms providing the deuterium diffusion from the sample at a lower temperature (channels for deuterium diffusion through the surface barrier).