Hydrogen permeability of amorphous Ni-Zr thin-films with Functionally Gradient Composition

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The deciding factors for the performance and characteristic of hydrogen permeable thin film are; hydrogen permeability, hydrogen selectivity and chemical stability. The permeability is the gas quantity that permeated unit-area of thin film during unit-time. The selectivity is the permeation ratio of specific gas through the thin film in the presence of various gases. In the separation and refining of hydrogen, hydrogen molecules and impurities permeate through the thin film. At the time, the separation mechanisms are; (1) Knudson diffusion, (2) surface diffusion, (3) capillary condensation, (4) activation diffusion in the molecular sieve zone and, (5) solution diffusion. The separation mechanism of metal thin film is solution diffusion.

The hydrogen is dissociated into electron and proton at the metal thin film catalyst surface which is either thin film or film. The free electrons conduct at permeation thin film and hydrogen permeates by the rejoining of protons and electrons. The metal thin film has an advantage that it has higher hydrogen selectivity than other separation thin films; because it restricts the permeation of large molecules such as CO, CO_2, O_2 and N_2. However, it also has disadvantages that the hydrogen permeability and diffusivity are low. Therefore, studies are going on to achieve the thermal stability at high temperature and better permeability. Pd thin film and Au thin film had superior surface activity toward hydrogen permeability since long time ago. Therefore, the dissociation of hydrogen molecule is easy and they show higher permeability. However, the reactivity with impurities has higher priority and it decreases the characteristic of the thin film. In addition, the hydrogen permeable metal thin film with high solubility deteriorates by the hydrogen brittleness which decreases the durability. Recently, the development of non-Pd metal thin film is going on. Therefore, the purpose of a hydrogen permeable membrane is to improve hydrogen permeation through process improvement and microstructure improvement for reducing thickness of membrane with the goal of improvement of hydrogen permeation.

We have been interested in the outstanding features of amorphous alloy, such as their mechanical properties and excellent immunity from corrosion, which are superior to crystalline alloys. In this study, amorphous Zr-based alloy thin films were prepared by a sputtering technique, and the hydrogen permeation properties through those alloy thin films were examined. We also suggest to from surface layer which consist of DC-magnetron sputtered films with functionally gradient composition having ability capable of absorbing hydrogen and doing catalyst behavior. The existing Pd-based metal alloy's permeable membrane and characteristics were also comparatively analyzed by measuring microstructure, hydrogen transmittance and mechanical strength. Hydrogen permeation mechanism of the fabricated thin films was discussed on the basis of the hydrogen solubility and the diffusivity of the each gradient composition layers.

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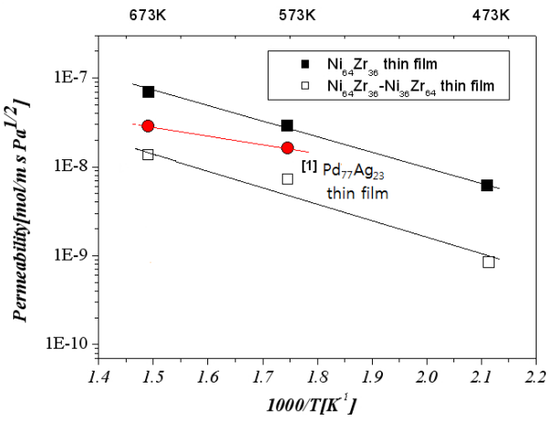

Fig. 1. Hydrogen permeability of the fabricated thin films as a function of inverse temperature.