Microstructure of $LaNi_5$-based Alloys during hydrogenation and dehydrogenation

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Hydrogenation is often accompanied by large volume expansion of hydrogen storage materials. This results in introducing lattice strain and lattice defects into the materials. $LaNi_5$-based intermetallic compounds expand more than 20 % in volume during hydrogenation. Dense dislocations are known to be introduced into the $LaNi_5$-based alloys after the first cycle of hydrogen absorption and desorption, which show large difference between the plateau pressures of hydrogenation and dehydrogenation.[1,2]

The plateau pressures of hydrogen storage materials are determined by van't Hoff equation relating to enthalpy and entropy changes. However, in many metals and alloys, hydrogen absorption pressures are higher than the desorption pressures. This is suggested to be due to lattice strain during hydrogenation, change of chemical potential of hydrides, and difference in size of hydride nuclei.[3]

As for $LaNi_5$-based alloys, no lattice defects such as dislocations and stacking faults are introduced into Si, Sn and Al -substituted $LaNi_5$-based compounds which show no or little difference in the plateau pressure, although lattice misfit between the hydride and the solid solution does not significantly depend on substitutions.

In this study, we have observed the $LaNi_5$-based compounds extracted during hydrogenation and dehydrogenation, by means of transmission electron microscopy (TEM), in order to elucidate the relationship between dislocation formation and hydride nucleation. As a result, it was found that hydride crystals smaller than 20 nm were formed with random orientations on the surface of the particles during hydrogenation. We suggest that there is the discrete interface between the hydride and the solid solution during hydrogenation in $LaNi_5$ and $La(Ni, Fe)_5$ which have dense dislocations and large differences between plateau pressures of hydrogenation and dehydrogenation.

References

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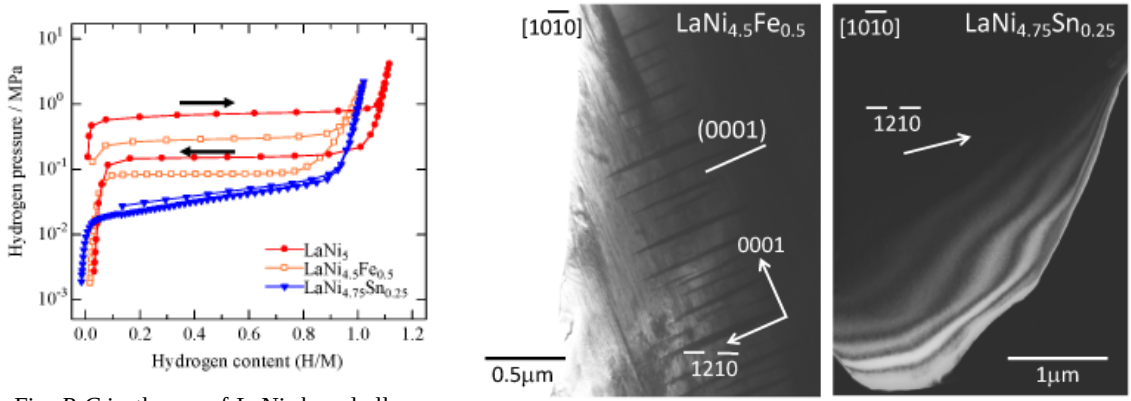

Fig. *P-C* isotherms of $LaNi_5$-based alloys measured at 298K.