307g Ni3al Intermetallics Catalyst for Hydrogen Generation from Methanol

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Hydrogen is attracting much attention as a clean and efficient energy source. Many efforts have been made to develop efficient, low-cost catalysts for hydrogen production. Some intermetallic compounds are known to have good catalytic selectivity and activity. For example, Ni3Sn increases the selectivity for hydrogen production [1], and PtGe and CoGe do for hydrogenation and dehydrogenation [2,3]. In Ni-Al system there are four stable intemetallic compounds, NiAl3, Ni2Al3, NiAl and Ni3Al. Among them a mixture of NiAl3 and Ni2Al3 (Ni-50 wt% Al) is used as a precursor alloy for Raney nickel catalysts: the Raney nickel catalysts are produced from the precursor alloy by leaching aluminum in a concentrated NaOH solution. For NiAl and Ni3Al, very limited studies have been carried out on the catalytic properties. Probably it has been thought difficult to effectively leach aluminum from them because of their low aluminum concentration [4], and thus high catalytic activity has not been expected, particularly for Ni3Al. Until now, Ni3Al is known as promising high-temperature structural materials because of its excellent high temperature strength and corrosion/oxidation resistance and thus many studies have been focused on the mechanical properties and the microstructures [5-7]. Our recent work showed that Ni3Al shows catalytic activity for methanol reforming [8]. In the present study, we examined the catalytic activity and stability of single-phase Ni3Al (Ni -24 at % Al) powder for hydrogen production from methanol in the temperature range of 513-633 K. It is found that the alkali-leached Ni3Al powders show a high catalytic activity and stability for the methanol decomposition (CH3OH 2H2+CO). The rate of hydrogen production increases rapidly with increasing reaction temperature. Furthermore, the Ni3Al catalysts suppress the formation of methane and water gas shift reaction, i.e. they show higher selectivity for methanol decomposition than nickel catalysts. Based on the surface characterization by SEM, XRD, and EDX analysis, we consider that the origin of the high selectivity and stable activity are attributed to the formation of porous structure composed of tiny Ni particles and carbon during reaction. These results indicate that the Ni3Al catalysts are highly promising as a catalyst for hydrogen production.

References [1] G.W. Huber, J.W. Shabaker, J.A. Dumesic. Science 2003;300:2075. [2] T. Komatsu, S. Hyodo, T. Yashima. J. Phys. Chem. B. 1997;101:5565. [3] T. Komatsu, M. Fukui, T. Yashima. In: J.W. Hightower et al, editor, 11th International Congress on Catalysis-40th Anniversary Studies in Surf. Sci. Catal. Vol. 101, Elsevier Science BV. 1996. p. 1095. [4] S. Tanaka, N. Hirose, T. Tanaki, Y.H. Ogata. J. Electrochemical Soci. 2000;147:2242. [5] D.P. Pope, S.S. Ezz. Int. Mater. Rev. 1984;29:136. [6] N.S. Stoloff. Int. Mater. Rev. 1989;34:153. [7] M. Demura, Y. Suga, O. Umezawa, K. Kishida, E.P. George, T. Hirano, Intermetallics 2001:9:157. [8] Ya Xu, S. Kameoka, K.Kishida, M. Demura, A.P. Tsai, T. Hirano. Intermetallics 2005:13:151.