REFERENCE

Adamson, K.A. (2004). Hydrogen from renewable resources-the hundred year commitment. Energy Policy, 32, 1231-1242.

Blanchard, D., Brinks, H.W., Hauback, B.C., and Norby, P. (2004) Desorption of $LiAlH_4$ with Ti- and V- based additives. Materials Science and Engineering, B108, 54-59.

Chen, P., Xiong, Z., Luo, J., Lin, J., and Tan, K.L. (2002). Interaction of hydrogen with metal nitrides and imides. Nature, 420, 302-304.

Deluchi, M. (1992). Hydrogen fuel cell (Institute of Transportation Studies, California University).

Grochala, W. and Edwards, P.P. (2004). Thermal decomposition of the non-interstitial hydrides for the storage and production of hydrogen. Chemistry Review, 104, 1283-1315.

Heung, L.K. (2003). Using metal hydride to storage hydrogen. Available from : sti.srs.gov/fulltext/ms2003172/ms2003172.pdf

Hodoshima, S., Nagata, H., and Saito, Y. (2005). Efficient hydrogen supply from tetralin with superheated liquid-film-type catalysis for operating fuel cells. Applied Catalysis A: General, 292, 90-96.

Houghton, J. (2004). Global warming. Reports on Progress in Physics, 68, 1343-1403.

Ichikawa, T., Isobe, S., Hanada, N., and Fujii, H. (2004a). Lithium nitride for reversible hydrogen storage. Journal of Alloys and Compounds, 365, 271-276.

Ichikawa, T., Hanada, N., Isobe, S., Leng, H., and Fujii, H. (2004b). Mechanism of Novel reaction from $LiNH_2$ and LiH to Li_2NH and H_2 as a promising hydrogen storage system. J. Phys. Chem. B, 108, 7887-7892.

Ichikawa, T., Hanada, N., Isobe, S., Leng, H.Y., and Fujii, H. (2005). Hydrogen storage properties in Ti catalyzed Li-N-H system. Journal of Alloys and Compounds, 404-406, 435-438.

Isobe, S., Ichikawa, T., Hanada, N., and Fujii, H. (2005). Effect of Ti catalyst with different chemical form on Li-N-H hydrogen storage properties. Journal of Alloys and Compounds, 404-406, 439-442.

Kojima, Y., Matsumoto, M., Kawai, Y., Haga, T., Ohba, N., Miwa, K., Towata, S., Nakamori, Y., and Orimo, S. (2006) Hydrogen absorption and desorption by the Li-Al-N- H. J. Phys. Chem. B., 110 (19), 9632-9636.

Leng, H.Y., Ichikawa, T., Hino, H., Hanada, N., Isobe, S., and Fujii, H. (2005). Synthesis and decomposition reactions of metal amides in metal-N-H hydrogen storage system. Journal of Power Sources.

Lien, H.L. and Zhang, W.X. (2001). Nanoscale iron particles for complete reduction of chlorinated ethenes, Journal of Colloids and Surfaces, 191, 97-105.

Lu, J. and Fang, Z. Z. (2005) Dehydrogenation of a combined $LiAlH_4/LiNH_2$.

Lu, J., Fang, Z. Z., and Sohn, H.Y. (2006) A new Li-Al-N-H system for reversible hydrogen storage. J. Phys. Chem. B., 110 (29), 14236-14239.

Luo, W. (2004). ($LiNH_2$-MgH_2): a viable hydrogen storage system. Journal of Alloys and Compounds, 381, 284-287.

Matsumoto, M., Haga, T., Kawai, Y., and Kojima, Y. (2006). Hydrogen desorption reactions of Li-N-H hydrogen storage system: Estimation of activation free energy. Journal of Alloys and Compounds.

Meisner, G.P., Pinkerton, F.E., Meyer, M.S., Balogh, M.P., and Kundrat, M.D. (2005). Study of the lithium-nitrogen-hydrogen system. Journal of Alloys and Compounds, 404-406, 24-26.

Ortiz, A.L., Osborn, W., Markmaitree, T., and Shaw, L.L. (2007) Crystallite sizes of LiH before and after ball milling and thermal exposure. Journal of Alloys and Compounds.

Pinkerton, F.E. (2005). Decomposition kinetics of lithium amide for hydrogen storage materials. Journal of Alloys and Compounds, 400, 76-82.

Schlapbach, L., and Züttel, A. (2001). Hydrogen-storage materials for mobile applications. Nature, 414, 353-358.

Shaw, L. L., Ren, R., Markmaitree, T., and Osborn, W. (2006) Effects of mechanical activation on dehydrogenation of the lithium amide and lithium hydride system. Journal of Alloys and Compounds.

Yoshihiro, N., Kadono, J., Nishiuchi, S., Yamamoto, S., Tanabe, T., and Miyake, H. (2006). Hydrogen-desorbing behavior of the hydrides in 15 rare earth elements measured by temperature swing column chromatography. Journal of Alloys and Compounds, 408-412, 355-358.

Zaluski, L., Zaluska, A., and Ström-Olsen, J.O. (1999). Recent developments in hydrogenation properties of complex alkali metal hydrides fabricated by mechano-chemical synthesis. Journal of Alloys and Compounds, 290, 71-78.

Zidan, R.A., Takara, S., Hee, A.G., and Jensen, C.M. (1999). Hydrogen cycling behavior of zirconium and titanium-zirconium-doped sodium aluminium hydride. Alloys and Compounds, 285, 119-122.

Zhou, L. (2004). Progress and problems in hydrogen storage. Renewable and Sustainable Energy Reviews, 9, 395-408.

Züttel, A. (2003). Materials for hydrogen storage. Materials Today, 6, 24-33.

(http://folk.uio.no/ravi/activity/hydride/hyd_tutorial.html)

(http://www.hydrogencomponents.com/hydride.html)

(http://www.ovonic-hydrogen.com/solutions/technology1.htm)

APPENDICES

Appendix A Calculated Volume of the Manifold and Sample Holder

Table A1 Manifold volume estimated by gas expansion

Experiment 1	P initial (psia)	P final (psia)	Volume (cm^3)
1	1458.75	1001.25	35.07
2	1001.25	693.75	35.60
3	693.75	481.88	35.82
4	481.88	335.63	36.01
5	335.63	234.38	36.17
6	234.38	165.00	36.51
7	165.00	114.38	35.97
Average			35.88

Experiment 2	P initial (psia)	P final (psia)	Volume (cm^3)
1	1475.63	1012.50	35.06
2	1012.50	699.38	35.49
3	699.38	485.63	35.81
4	485.63	339.38	36.13
5	339.38	236.25	36.05
6	236.25	165.00	36.21
7	165.00	116.25	36.57
Average			35.90

Table A1 Manifold volume estimated by gas expansion

Experiment 3	P initial (psia)	P final (psia)	Volume (cm^3)
1	1468.13	1006.88	35.04
2	1006.88	697.5	35.59
3	697.50	483.75	35.76
4	483.75	337.50	36.07
5	337.50	236.25	36.25
6	236.25	165.00	36.21
7	165.00	116.25	36.57
Average			35.93

Experiment	Volume (cm^3)
1	35.88
2	35.90
3	35.93
Average	35.90

Table A2 Dead volume of the sample holder

Experiment	P initial (psia)	P final (psia)	Volume (cm^3)
1	504.38	241.88	43.70
2	500.63	241.88	43.07
3	502.50	243.75	42.74
4	504.38	247.50	41.79
5	504.38	243.75	43.06

Appendix B Hydrogen Capacities of Li-N-H Systems

Table B1 Hydrogen Capacities of $LiNH_2$ and LiH Mixtures

1:1 mol ratio of $LiNH_2$ and LiH mixtures	Hydrogen Capacity (wt%)
1:1 mol ratio of $LiNH_2$ and LiH doped with 1 mol% TiO_2 mixed by mortar	0.50
1:1 mol ratio of $LiNH_2$ and LiH doped with 1 mol% Fe mixed by mortar	0.36
1:1 mol ratio of $LiNH_2$ and LiH mixed by mortar	0.40
1:1 mol ratio of $LiNH_2$ and LiH doped with 1 mol% TiO_2 mixed by ball milling	1.50
1:1 mol ratio of $LiNH_2$ and LiH doped with 1 mol% $ZrCl_4$ mixed by ball milling	0.78
1:1 mol ratio of $LiNH_2$ and LiH doped with 1 mol% Ni mixed by ball milling	0.76
1:1 mol ratio of $LiNH_2$ and LiH doped with 1 mol% Fe mixed by ball milling	0.68
1:1 mol ratio of $LiNH_2$ and LiH mixed by ball milling	0.44

Table B2 Hydrogen Capacities of $LiNH_2$ and $LiAlH_4$ mixtures

$LiNH_2$ and $LiAlH_4$ mixtures	Hydrogen Capacity (wt%)
1:1 mol ratio of $LiNH_2$ and $LiAlH_4$	2.62
1:3 mol ratio of $LiNH_2$ and $LiAlH_4$	2.47
1:5 mol ratio of $LiNH_2$ and $LiAlH_4$	5.19
1:5 mol ratio of $LiNH_2$ and $LiAlH_4$ doped with 1 mol% $ZrCl_4$	6.42
1:5 mol ratio of $LiNH_2$ and $LiAlH_4$ doped with 4 mol% $ZrCl_4$	7.84
1:5 mol ratio of $LiNH_2$ and $LiAlH_4$ doped with 4 mol% TiO_2	4.92
Two-layered 1:5 mol ratio of $LiNH_2$ and $LiAlH_4$ each of which doped with 1 mol% $ZrCl_4$	8.61
Two-layered 1:5 mol ratio of $LiNH_2$ and $LiAlH_4$ only $LiAlH_4$ doped with 1 mol% $ZrCl_4$	8.09
Two-layered 1:1 mol ratio of $LiNH_2$ and $LiAlH_4$ each of which doped with 1 mol% VCl_3	6.16
Two-layered 1:1 mol ratio of $LiNH_2$ and $LiAlH_4$ each of which doped with 1 mol% $ZrCl_4$	5.53

Appendix C Changes of Pressure during the Dehydrogenation

Table C1 Pressure Changing of 1:1 Mol Ratio of $LiNH_2$ and LiH

Pressure (psi)	Temperature (°C)
0.00	27.7
3.75	67.6
5.63	84.8
9.38	109.8
15.00	132.0
18.75	149.9
24.38	168.7
31.88	199.8

Table C2 Pressure Changing of 1:1 Mol Ratio of $LiNH_2$ and LiH doped with 1 mol% Fe

Pressure (psi)	Temperature (°C)
0.00	42.5
3.75	84.8
5.63	91.5
9.38	112.4
11.25	119.2
18.75	142.5
24.38	153.1
30.00	171.7
37.50	187.6
41.25	191.1
45.00	200.7

Table C3 Pressure Changing of 1:1 Mol Ratio of $LiNH_2$ and LiH doped with 1 mol% Ni

Pressure (psi)	Temperature (°C)
0.00	31.9
3.75	63.4
5.63	77.6
9.38	91.8
15.00	111.9
18.75	123.7
22.50	140.3
28.13	150.7
33.75	165.1
39.38	178.0
45.00	192.5
48.75	200.3

Table C4 Pressure Changing of 1:1 Mol Ratio of $LiNH_2$ and LiH doped with 1 mol% $ZrCl_4$

Pressure (psi)	Temperature (°C)
0.00	58.1
3.75	79.4
5.63	93.9
9.38	108.0
11.25	114.8
18.75	144.9
24.38	175.1
26.25	183.6
28.13	191.4
30.00	200.2

Table C5 Pressure Changing of 1:1 Mol Ratio of $LiNH_2$ and LiH doped with 1 mol% TiO_2

Pressure (psi)	Temperature (°C)
0.00	31.0
3.75	67.7
5.63	74.4
11.25	106.1
16.88	133.8
22.50	163.2
24.38	171.5
26.25	182.8
30.00	200.9

Table C6 Pressure Changing of 1:1 Mol Ratio of $LiNH_2$ and $LiAlH_4$

Pressure (psi)	Temperature (°C)
0.00	42.5
3.75	79.6
5.63	91.5
9.38	108.5
15.00	124.0
18.75	134.0
24.38	143.6
35.63	161.3
50.63	182.7
65.63	193.3
75.00	197.4
78.75	199.3
81.00	200.3

Table C7 Pressure Changing of 1:3 Mol Ratio of $LiNH_2$ and $LiAlH_4$

Pressure (psi)	Temperature (°C)
0.00	51.2
3.75	79.8
5.63	85.5
9.38	96.5
11.25	112.7
18.75	133.3
24.38	148.0
33.75	165.9
50.63	187.7
67.50	200.8

Table C8 Pressure Changing of 1:5 Mol Ratio of $LiNH_2$ and $LiAlH_4$

Pressure (psi)	Temperature (°C)
0.00	57.5
5.63	108.3
11.25	127.2
16.88	133.1
22.50	138.9
31.88	144.5
39.88	149.6
48.75	154.5
60.00	159.4
69.38	163.6
78.75	167.8
86.25	171.6
95.63	181.3
106.88	191.1
114.38	196.4
127.50	200.9

Table C9 Pressure Changing of 1:5 Mol Ratio of $LiNH_2$ and $LiAlH_4$ doped with 1 mol% $ZrCl_4$

Pressure (psi)	Temperature (°C)
0.00	41.6
5.63	72.6
9.38	81.7
16.88	90.7
30.00	100.1
46.88	109.3
73.13	118.3
97.50	127.3
108.75	136.4
116.25	145.0
121.88	153.2
129.38	161.2
135.00	168.8
142.50	175.8
153.75	182.5
165.00	188.8
178.13	194.2
193.13	199.6

Table C10 Pressure Changing of 1:5 Mol Ratio of $LiNH_2$ and $LiAlH_4$ doped with 4 mol% $ZrCl_4$

Pressure (psi)	Temperature (°C)
0.00	44.1
5.63	76.5
11.25	83.1
16.88	89.7
26.25	96.2
39.38	102.5
52.50	108.6
63.75	114.5
71.25	120.3
80.63	131.3
88.13	141.8
95.63	151.8
103.13	161.4
106.88	166.0
118.13	174.6
127.50	182.6
136.88	189.8
146.25	199.4

Table C11 Pressure Changing of 1:5 Mol Ratio of $LiNH_2$ and $LiAlH_4$ doped with 4 mol% TiO_2

Pressure (psi)	Temperature (°C)
0.00	39.9
5.63	91.6
15.00	108.6
24.38	116.8
39.38	125.1
52.50	133.2
65.63	148.4
73.13	162.3
88.13	185.8
110.63	199.3

Table C12 Pressure Changing of two-layered on 1:5 Mol Ratio of $LiNH_2$ and $LiAlH_4$ each of which doped with 4 mol% $ZrCl_4$

Pressure (psi)	Temperature (°C)
0.00	44.1
7.50	66.4
16.88	75.7
28.13	85.7
50.63	96.2
99.38	107.4
180.00	118.7
211.88	130.0
226.88	141.0
260.63	162.7
281.25	173.2
301.88	183.0
318.75	192.7
330.00	200.5

Table C14 Pressure Changing of two-layered on 1:1 Mol Ratio of $LiNH_2$ and $LiAlH_4$ each of which doped with 4 mol% VCl_3

Pressure (psi)	Temperature (°C)
0.00	36.3
5.63	60.9
13.13	77.1
26.25	94.4
54.38	112.1
93.75	129.6
114.38	138.0
131.25	146.2
142.50	153.9
155.63	169.0
168.75	182.3
193.13	199.2

Table C13 Pressure Changing of two-layered on 1:1 Mol Ratio of $LiNH_2$ and $LiAlH_4$ each of which doped with 4 mol% $ZrCl_4$

Pressure (psi)	Temperature (°C)
0.00	36.3
5.63	68.0
13.13	87.0
28.13	109.2
37.50	117.6
52.50	129.0
69.38	145.7
80.63	163.0
91.88	175.5
101.25	181.5
146.25	199.7

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2. Thipmongkolsilp, S., Suttisawat, Y., Rangsunvigit, P., and Kulprathipanja, S. (2006, November 21-23) Effect of Transition Metals (Fe, Ni, TiO_2) on Hydrogen Absorption/Desorption on/from a Li-N-H System, Sustainable Energy and Environment Conference (SEE2006 *"Technology and Policy Innovations"*), Bangkok, Thailand.