Anomalous Exothermic and Endothermic Data Observed by Nano-Ni-Composite Samples

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PNZ2B3,4#2 (after forced-oxidation)

Gas flow rate: $H_2$: 3.1 sccm vs. $D_2$: 3.7 sccm

$W_{D(H)}$ (W), $P_{D(H)}$ (MPa)

$L = \frac{[H(D)]}{[Pd_1+Ni_7]}$

$1^{st}$ Phase

Time (min)

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Isotopic Effect on Dynamic Sorption Energy is Large: Nuclear Effect!? 

PNZ2B3,4#3  
\[ \eta_{D(H)}(eV/D(H)) \quad W_{D(H)}(W) \]

PNZ2B3,4#3  
\[ \eta_D/\eta_H \]
Summary of Results for Pd1Ni7/ZrO2 (PNZ2B)

- As-received samples gave anomalously large loading \([D(H)]/[Pd1Ni7]= \text{ca.3.0}\) and large specific absorption energy \(E_1=\text{ca.2.0 eV/atom} - [M] \text{ with } [M] = [Pd1Ni7]\)

- Data after forced-reduction were comparable to those for as-received samples

- Additive of Pd to Ni-nano-particle seems working as strong catalyzer for D(H)-absorption into Ni particles.

- What will be happening if Pd-additive is replaced with other element like Cu?
Aim and Results

Recently Anomalous Excess Heat Phenomena in Ni-H systems have been reported by Piantelli, Rossi, Defkalion, Celani, Kobe-Technova etc. This work aims to elucidate the underlying physics of anomalous excess heat phenomena in Ni-nano-composite samples under D(H)-gas loading at room and elevated temperatures. We compare phenomena between Pd-Ni and Cu-Ni composite samples.

Results in Brief View

Cu-Ni nano-composite samples showed no excess heat nor meaningfully visible D(H)-loading at Room Temperature. Anomalous Excess Heat for weeks were observed at 523K and 573K, repeatedly for Ni/ZrO2, Cu0.08Ni36/ZrO2 and Cu21.4Ni21.4/ZrO2 samples. Anomalously large integrated heat ca. 800ev/atom-Ni at most. Cu0.08Ni36/ZrO2 samples gave 10 fold larger excess heat level than Ni/Zr2 samples and 4 fold larger than those by Cu21.4Ni21.4/ZrO2 samples. In pretreatment, anomalous endothermic effect was repeatedly observed.
A_1\cdot A_2 twin system for simultaneous D_2/H_2 absorption experiments

- Amplifier, data processor, and power supplies
- Vacuum gauge
- Pressure gauge
- Room temp. is controlled to 20-28\(^\circ\)C ± 0.1\(^\circ\)C
- SuperNeedle
- Chiller for water
- \(\gamma\)-ray counter
- Neutron counter
- A_1 chamber
- A_2 chamber
- TMP kit for evacuation
Schematic of one of the twin absorption system.
Experimental Procedure

Mount sample powders in twin reaction chambers

Evacuate chambers

Baking at 440K for 3 hours (out-gas of impurity)

Pretreatment at 573K by D(H)-gas charging

Elevate chamber temperature (373K, 473K, 523K, 573K)

D(H) gas loading and acquire temperatures, pressures, radiation (gamma and n) and heater power
CNZ compared with NZ samples: Effect of Cu substitution for Pd on absorption at elevated temperature

<table>
<thead>
<tr>
<th></th>
<th>NZ 20[g]</th>
<th>CNZ 10[g]</th>
<th>CNZII 20[g]</th>
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<tbody>
<tr>
<td></td>
<td>Cu</td>
<td>Ni</td>
<td>Zr</td>
</tr>
<tr>
<td>Average grain size (nm)</td>
<td>---</td>
<td>23.3</td>
<td>---</td>
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<tr>
<td>Molar fraction (%)</td>
<td>0</td>
<td>35.8</td>
<td>64.2</td>
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<tr>
<td>Weight content (g)</td>
<td>0</td>
<td>5.4</td>
<td>14.6</td>
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<tr>
<td>Specific surface area (m^2/g)</td>
<td>27.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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テクノバ6201-R-023
Elevated Temperature Runs; Ni(0.36)/ZrO$_2$ Ni:5.4[g]

15W 373K

43.5W 473K

70W 523K

105W 573K

Time (hour)
Elevated Temperature Runs; Cu(0.214)Ni(0.215)/ZrO$_2$ Ni:2.44[g]
Elevated Temperature Runs; Cu(0.08)Ni(0.35)/ZrO$_2$; repeatability test Ni:2.07[g]

Long Term Excess Heat by Cu(0.08)Ni(0.35)/ZrO$_2$ Is Repeatable
Anomalous Abrupt Desorption was repeatedly observed to show big Endothermic Effect!

Ni(0.36)/ZrO₂

Cu(0.08)Ni(0.35)/ZrO₂

Cu(0.214)Ni(0.215)/ZrO₂
\( \eta(t) \equiv \frac{\int_{t}^{t+\Delta t} W_{\text{true}}(t) \, dt}{L(t + \Delta t) - L(t)} \)

\( \eta(t) \approx \frac{\int_{t}^{t+\Delta t} W(t, \tau) \, dt}{L(t + \Delta t) - L(t)} \)

\[ W(t, \tau) = \frac{\int_{t}^{t+\tau} W_{\text{mead}}(t) \, dt}{\tau} \]
Negative ΔL

Excess heat during desorption!

CNZ3,4#5_523K

Excess H By In/Out Of D(H)!
CNZ-II 573K: Pretreatment Run

Abrupt Desorption at High L! Large Heat Sink!

Graph showing various parameters over time.
Anomalous Endothermic Effect
By H + Ni knock-out (ca. 50 eV/H)

H(D)-Cluster Formation
In Vacancy; TSC Fusion

Knocked out

D₂ molecule

SNH

4H(D)-cluster

D₂ molecule

SNH
Specific Output Energy [eV/Ni-atom]; s-phase

NZ; Ni(0.36)/ZrO₂
CNZ; Cu(0.08)Ni(0.35)/ZrO₂

573K: CNZ:
800[eV/atom-Ni]
Non-Chemical Heat!
Conclusions

• Present 3 kinds of Ni-nano-composite samples gave anomalous and long-lasting excess heat data at elevated (523K,573K) condition.

• Cu-Ni-Zr nano-composite samples gave several fold larger heat level than Ni-Zr nano-composite sample.

• Cu additive seems working as strong catalyst for Ni-core particle to absorb D(H)gas and releasing anomalously large excess heat. However, the reason why H-gas loading gave much larger heat-level than D-gas loading is yet to study.

• 8% Cu-added Ni-nano sample showed ca. 4 fold larger heat level per g-Ni than that of 21.4% Cu-added Ni-nano sample and data were repeatable.

• In pretreatment runs, anomalous abrupt desorption/endothermic effect was repeatedly observed for three kind of samples. The mechanism is yet to study.

• At 573K, η-values were anomalously large as $100 \sim 600$ eV/H, and integrated heat was 800 eV/atom-Ni for CNZ samples. This seems non-chemical reaction heat, but the explanation by nuclear mechanism is yet to study.

• Very slight cross correlation between heat-level evolution and gamma-ray counting were recorded, and no visible increase in neutron level. Further confirmation by scaled-up device is expected.