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

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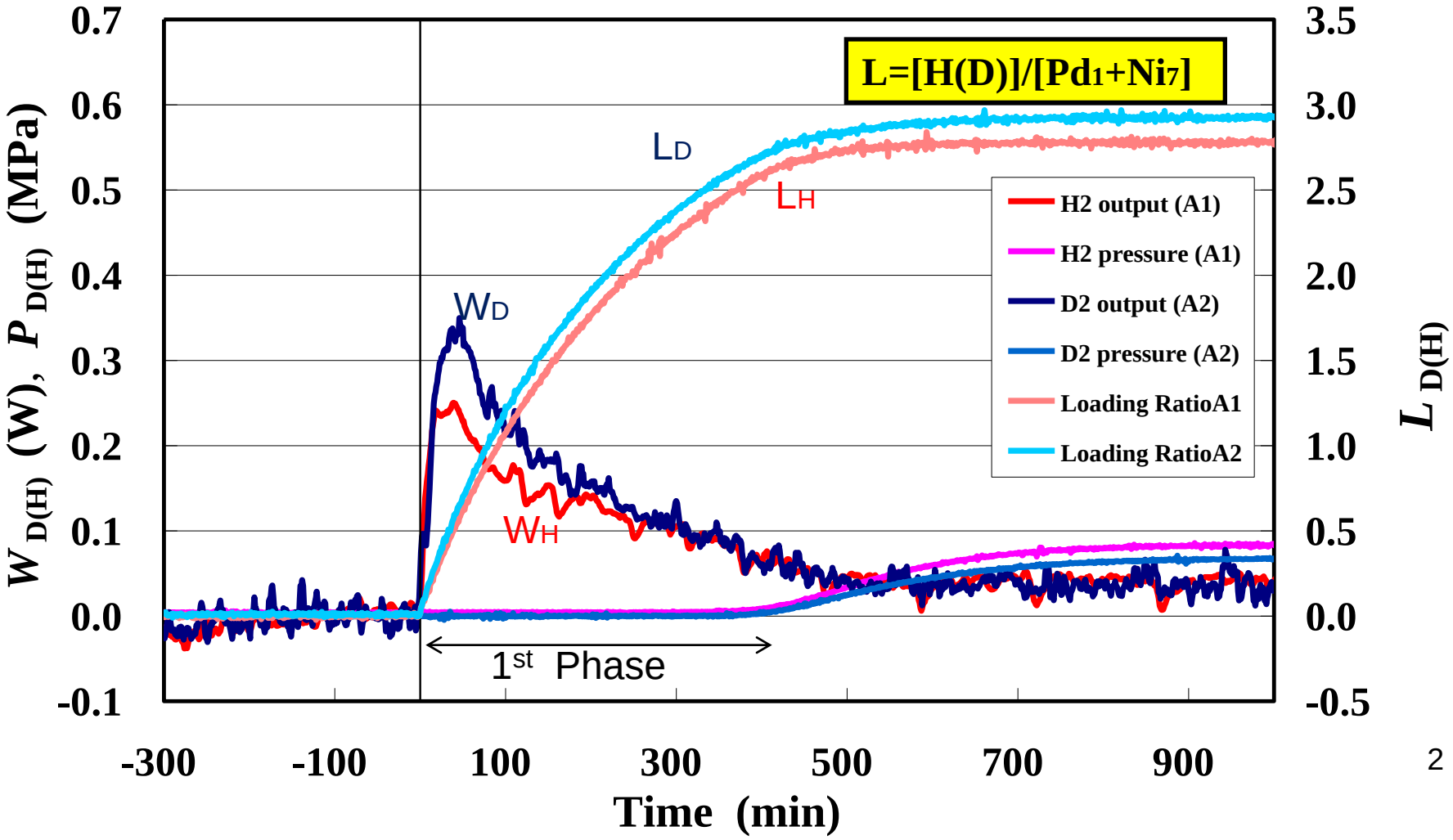
JCF-11

PNZ2B3,4#2 (after forced-oxidation)

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

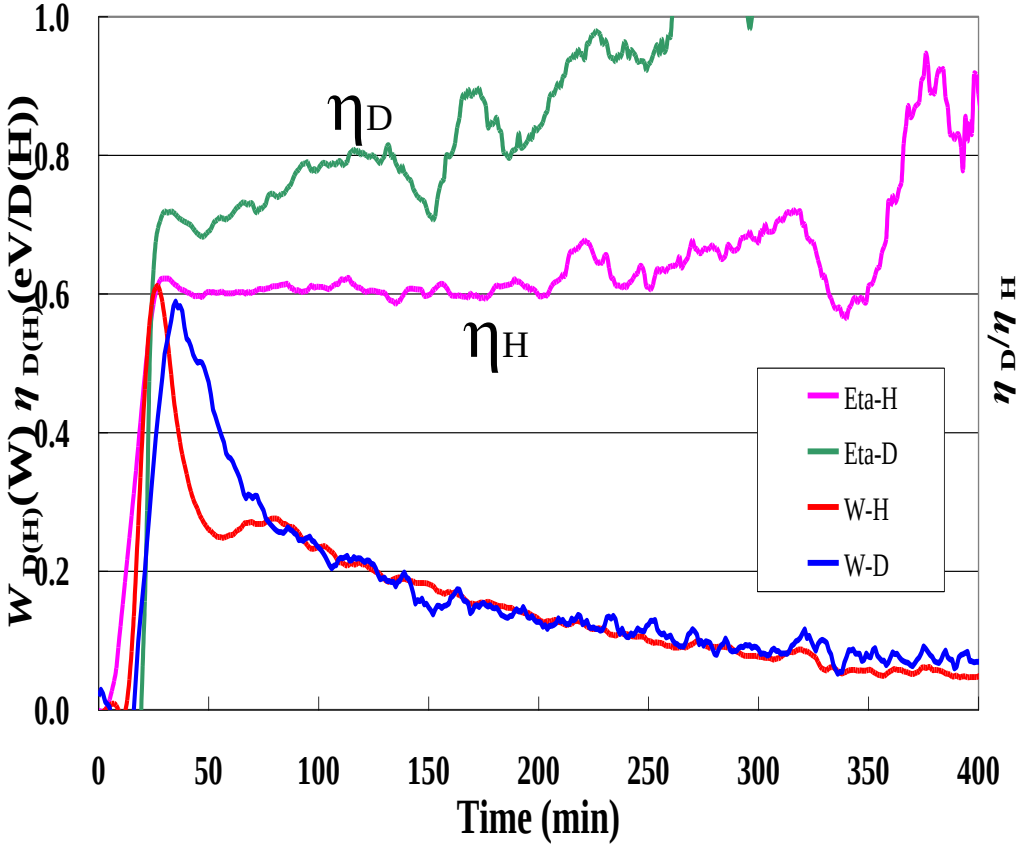


JCF-11

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

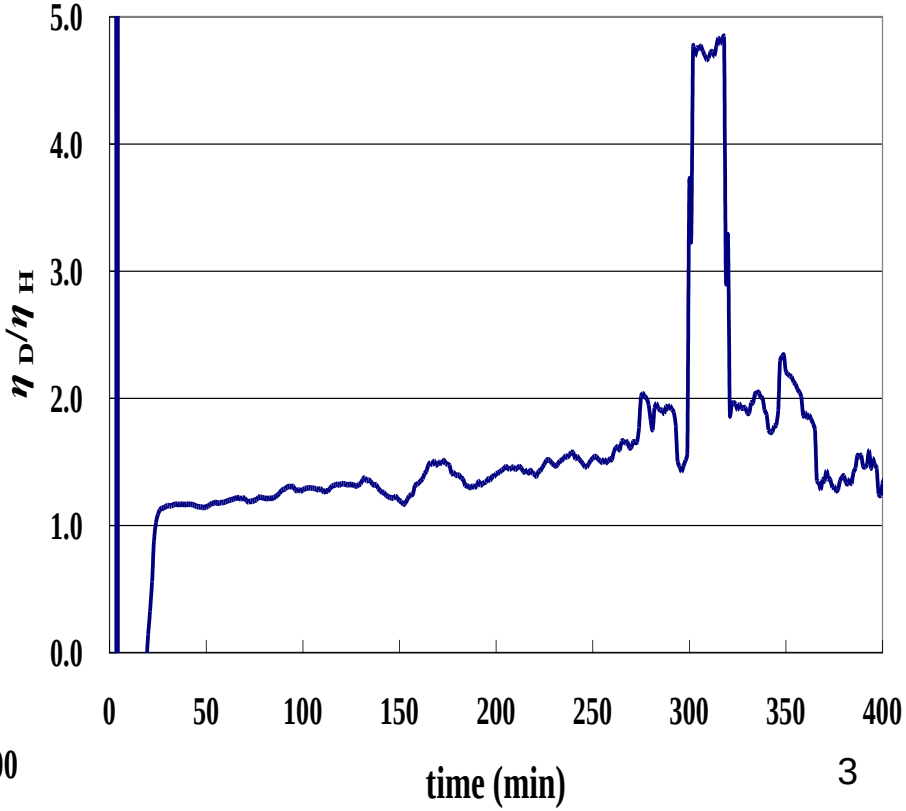
PNZ2B3,4#3

$\eta_{D(H)}$(eV/D(H))　$W_{D(H)}$(W)



PNZ2B3,4#3

η_D/η_H



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Summary of Results for Pd1Ni7/ZrO2 (PNZ2B)

- As-received samples gave anomalously large loading [D(H)]/[Pd1Ni7]= ca.3.0 and large specific absorption energy *E*1=ca.2.0 eV/atom-[M] 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?**

JCF-13 and after

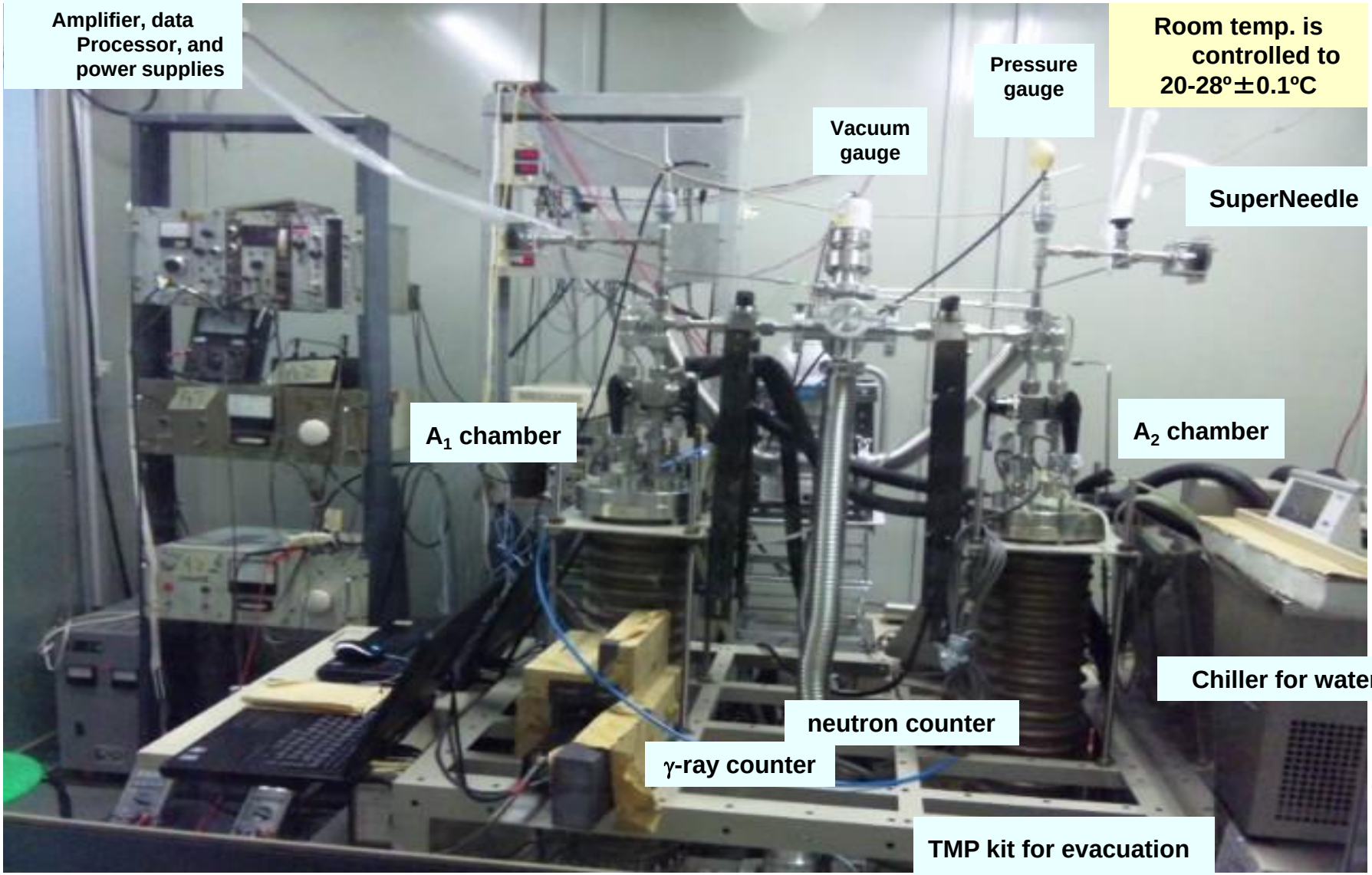
Aim and Results

- 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**.

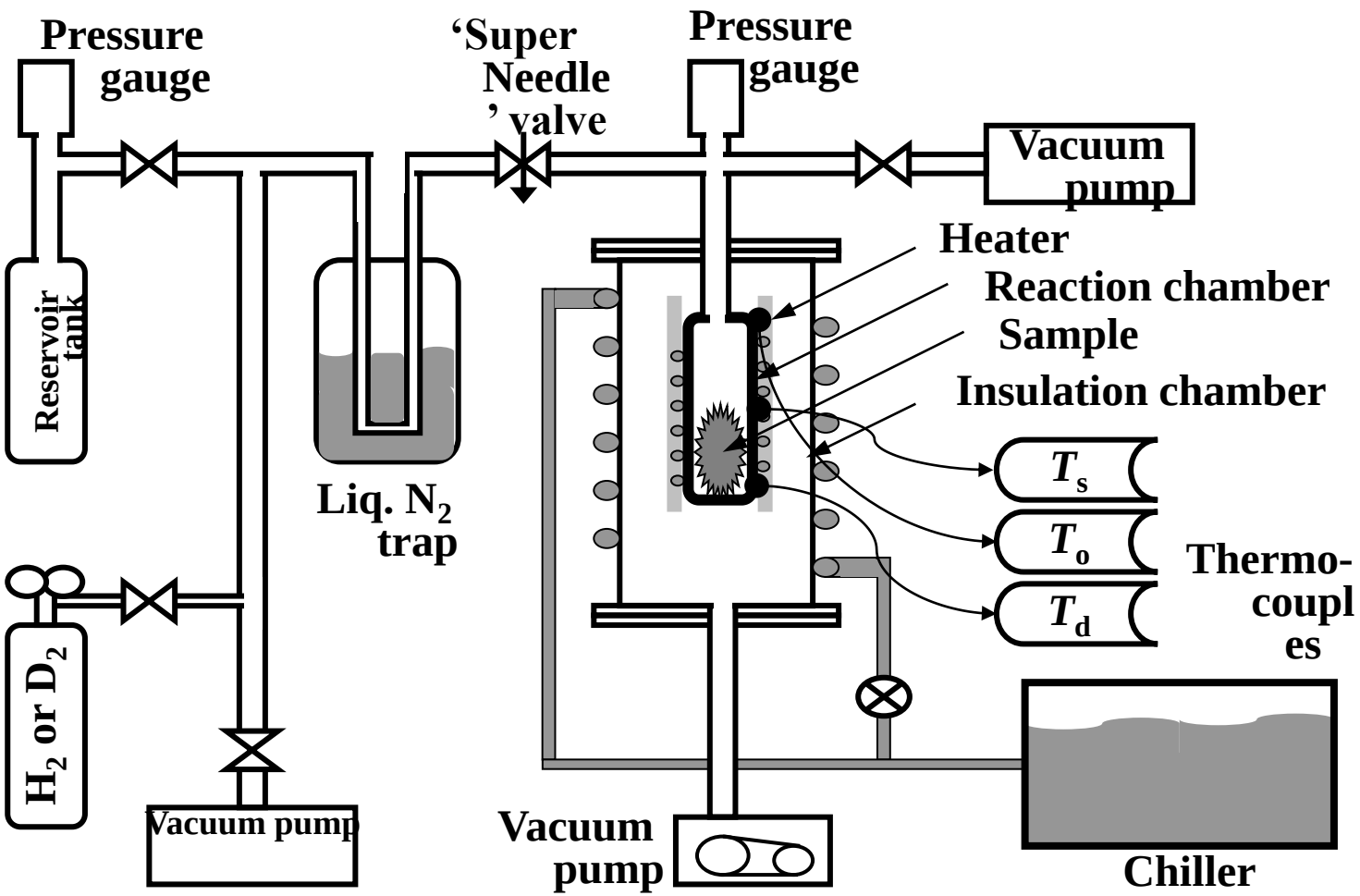
Results in Brief View

- 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



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）

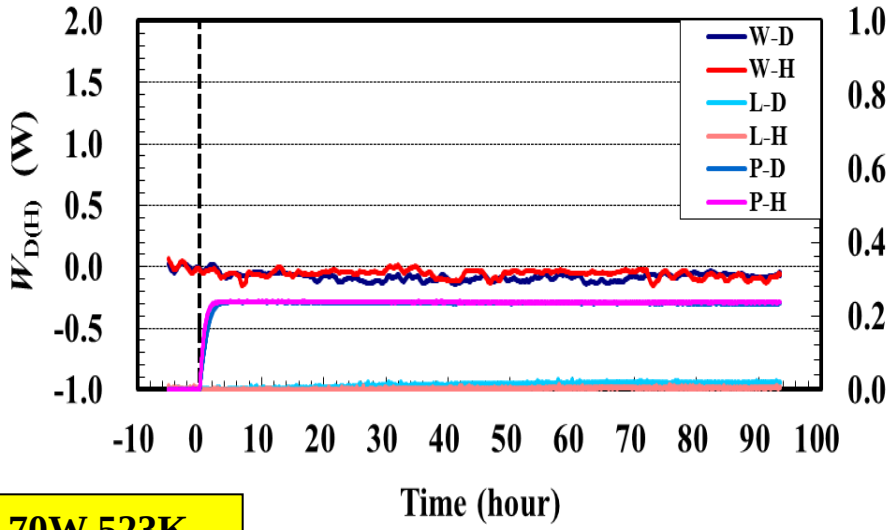
D(H) gas loading and acquire temperatures, pressures, radiation (gamma and n) and heater power

CNZ compared with NZ samples: Effect of Cu substitution for Pd on absorption at elevated temperature

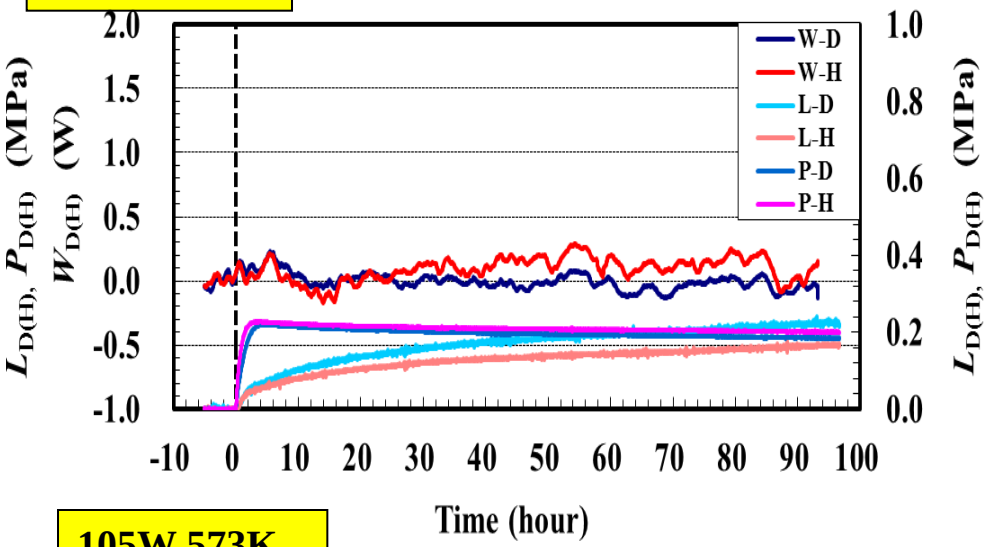
	NZ 20[g]			CNZ 10[g]			CNZII 20[g]		
	Cu	Ni	Zr	Cu	Ni	Zr	Cu	Ni	Zr
Average grain size (nm)	---	23.3	---	6.8	24.5	---	24.2	18.2	---
Molar fraction (%)	0	35.8	64.2	7.9	36	56.1	21.4	21.5	57.1
Weight content (g)	0	5.4	14.6	0.49	2.07	7.44	2.64	2.44	14.9
Specific surface area (m2/g)	27.6			45.3			44.2		

Elevated Temperature Runs; Ni(0.36)/ZrO_2 Ni:5.4[g]

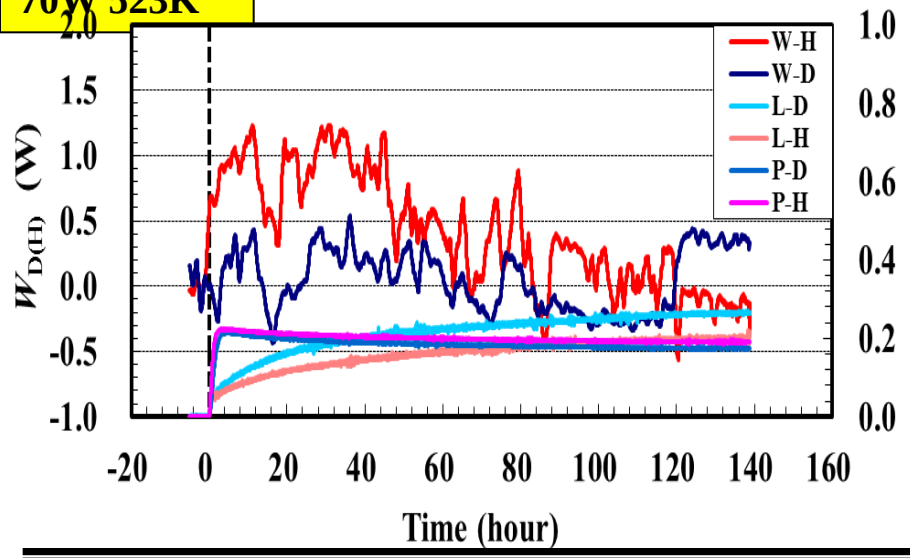
15W 373K



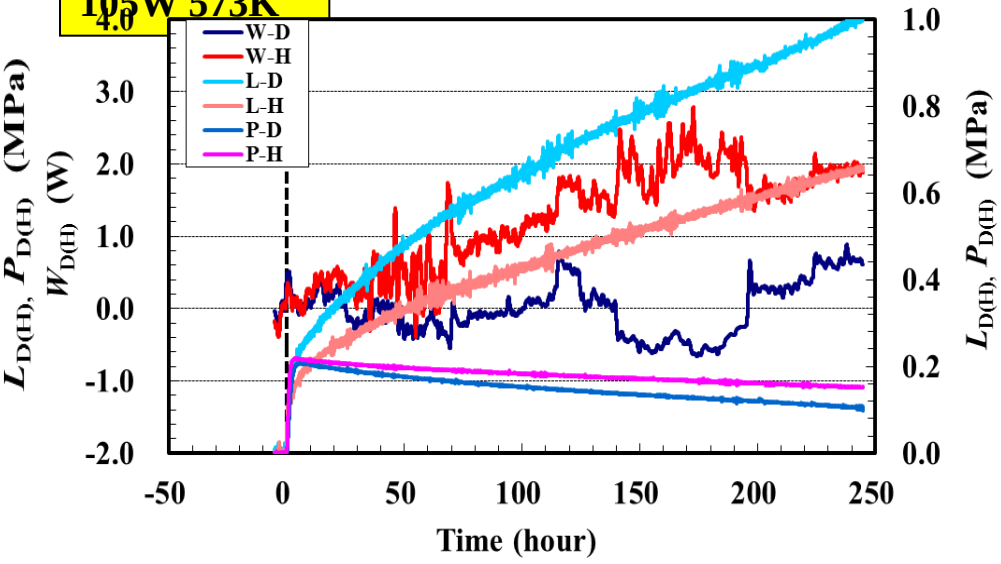
43.5W 473K



70W 523K

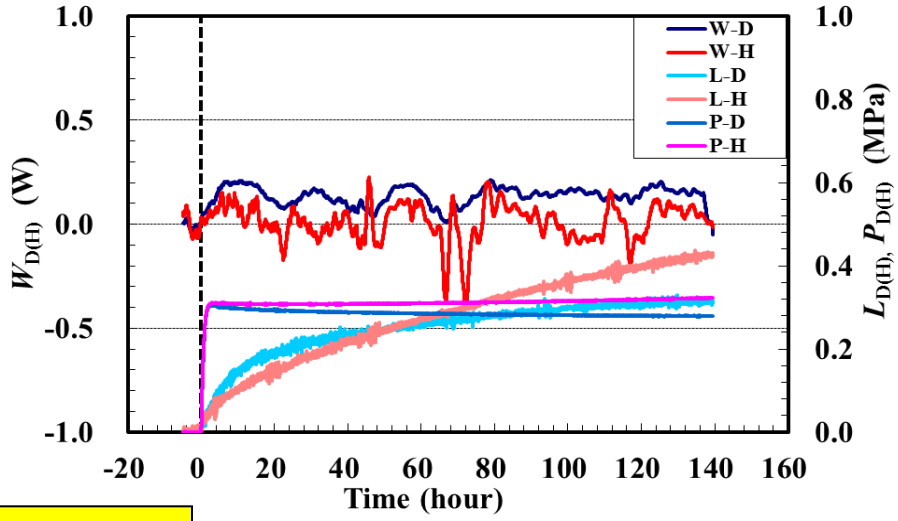


105W 573K

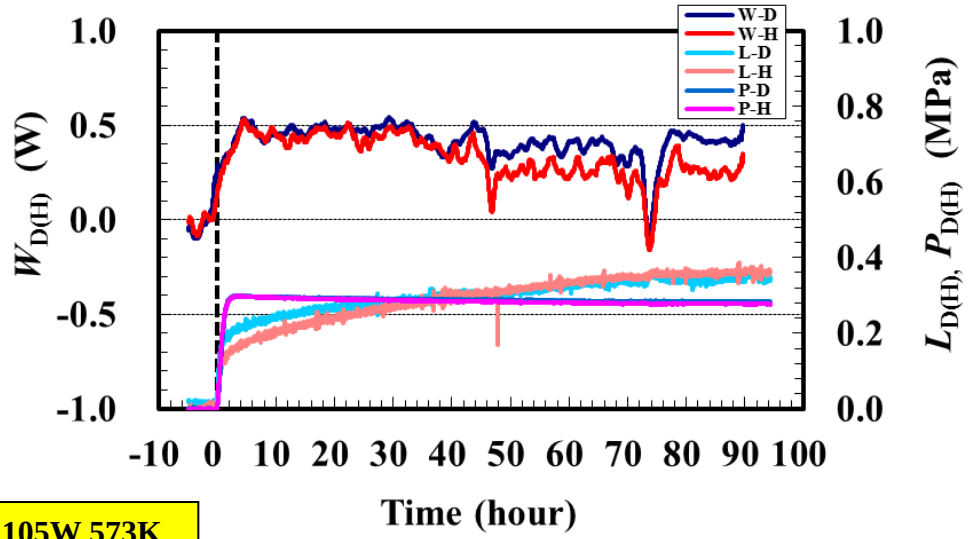


Elevated Temperature Runs; Cu(0.214)Ni(0.215)/ZrO_2 Ni:2.44[g]

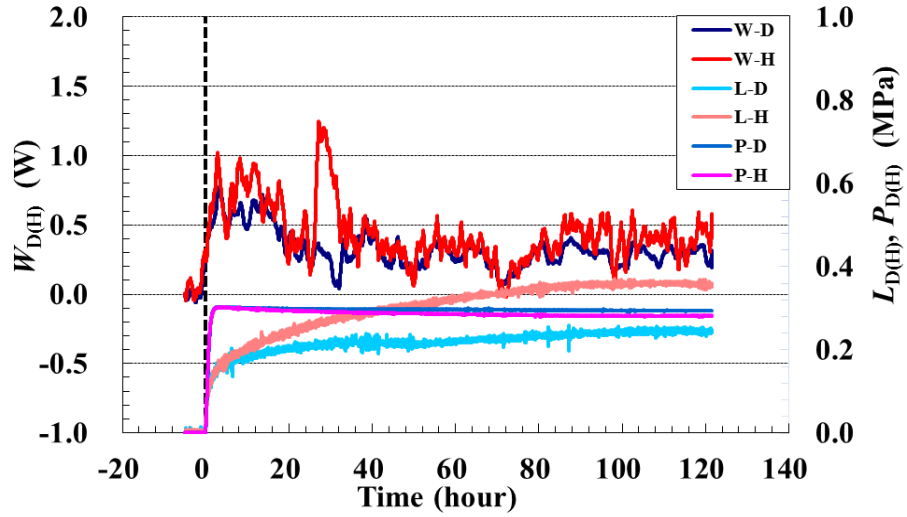
15W 373K



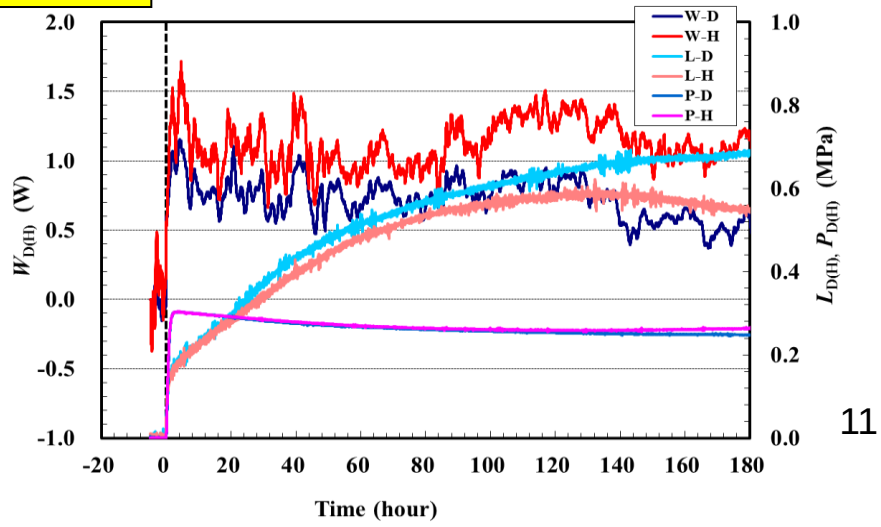
43.5W 473K



70W 523K

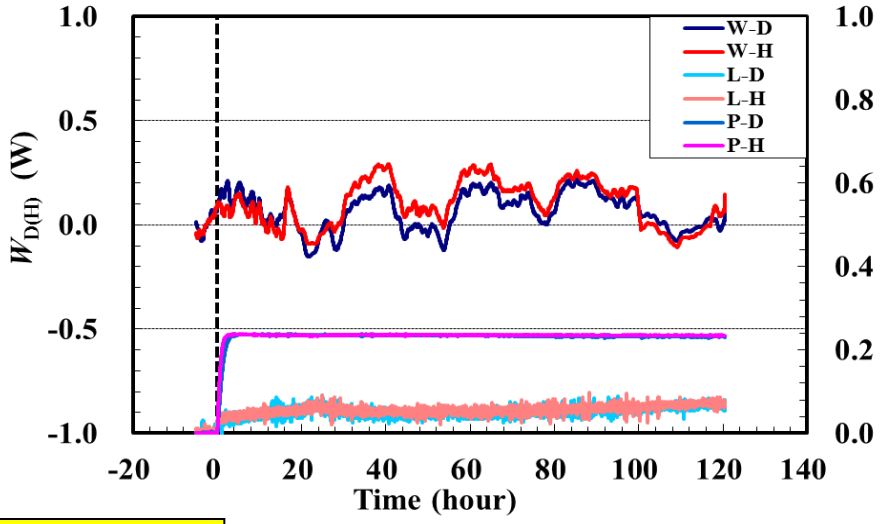


105W 573K

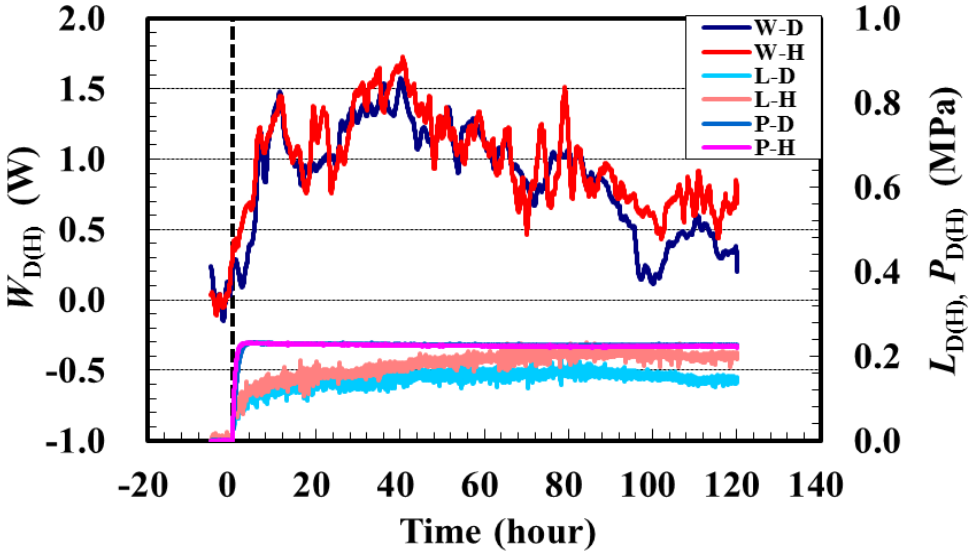


Elevated Temperature Runs; Cu(0.08)Ni(0.35)/ZrO_2; repeatability test Ni:2.07[g]

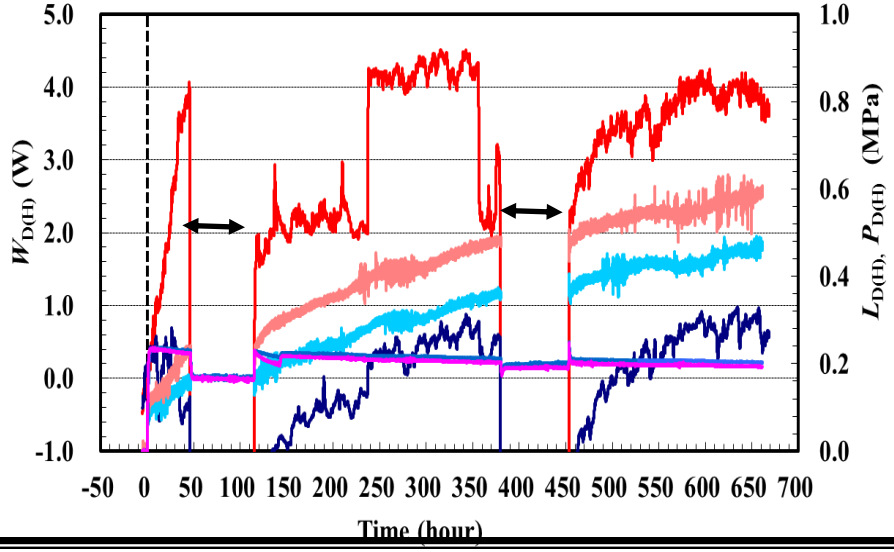
43.5W 473K



70W 523K



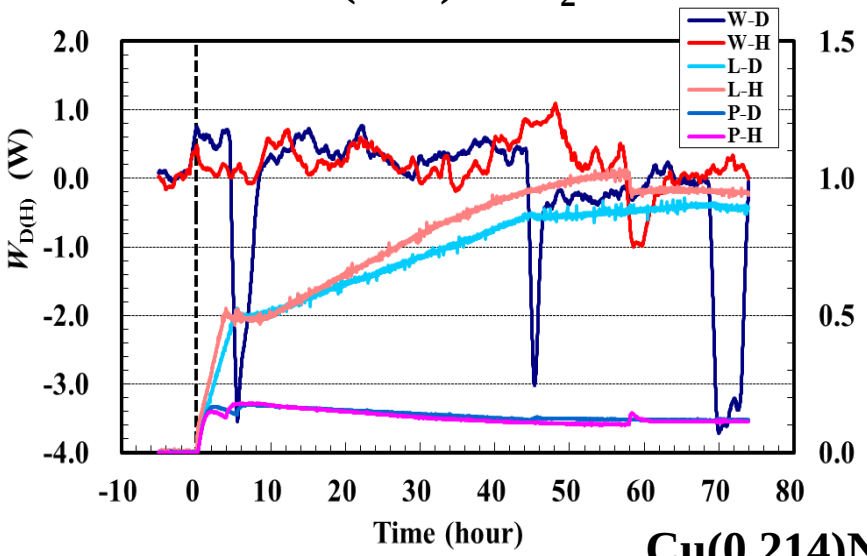
105W 573K



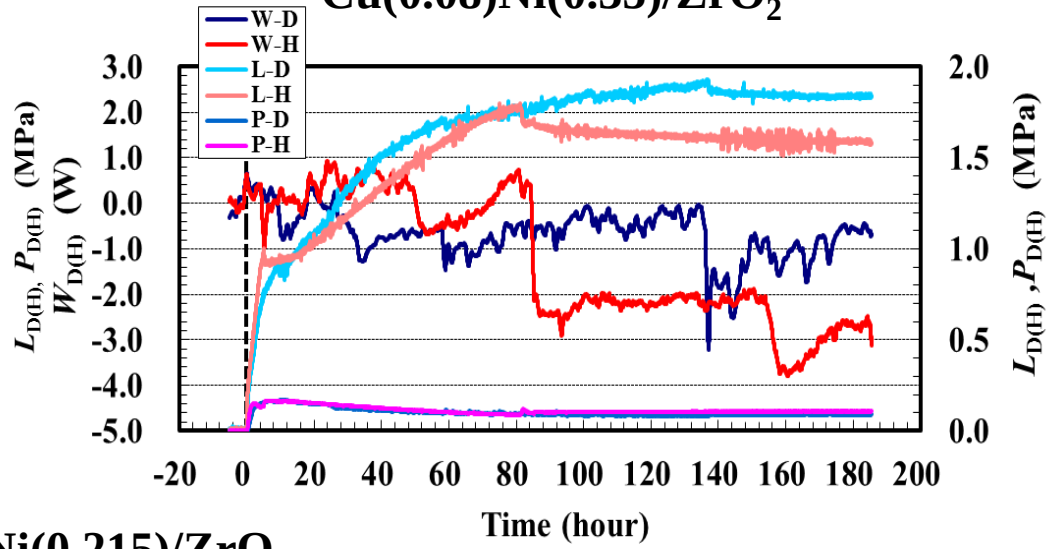
Long Term Excess Heat by Cu(0.08)Ni(0.35)/ZrO_2 Is Repeatable

Anomalous Abrupt Desorption was repeatedly observed to show big Endothermic Effect!

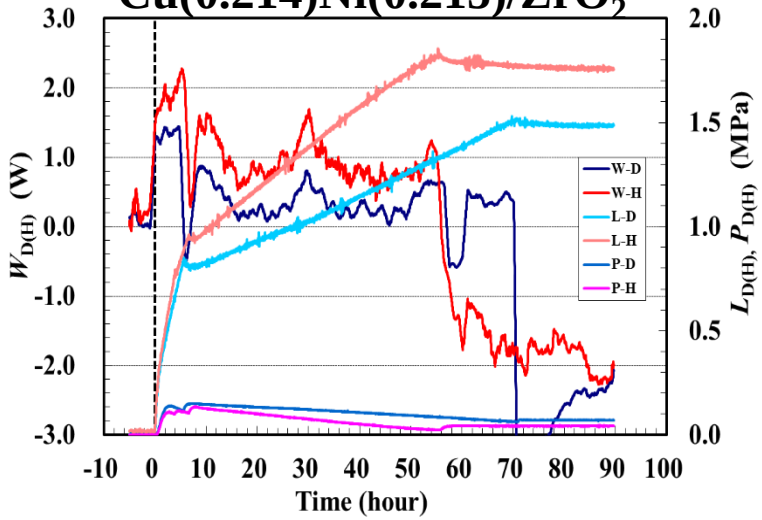
$Ni(0.36)/ZrO_2$



$Cu(0.08)Ni(0.35)/ZrO_2$



$Cu(0.214)Ni(0.215)/ZrO_2$

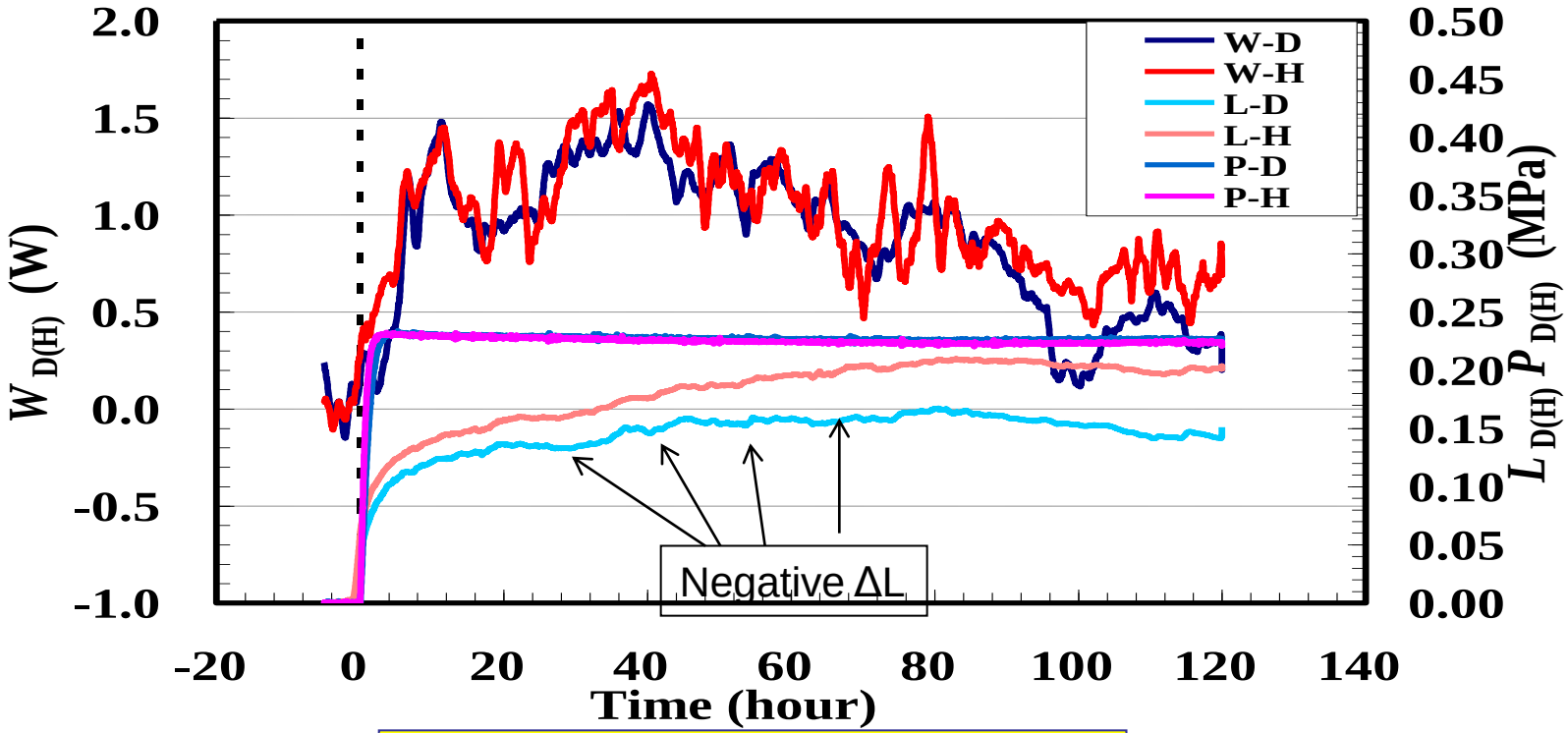


η : Dynamic Sorption Energy

$$\eta(t) \equiv \frac{\int_t^{t+\Delta t} W_{\text{true}}(t)\,\mathrm{d}t}{L(t+\Delta t) - L(t)}$$

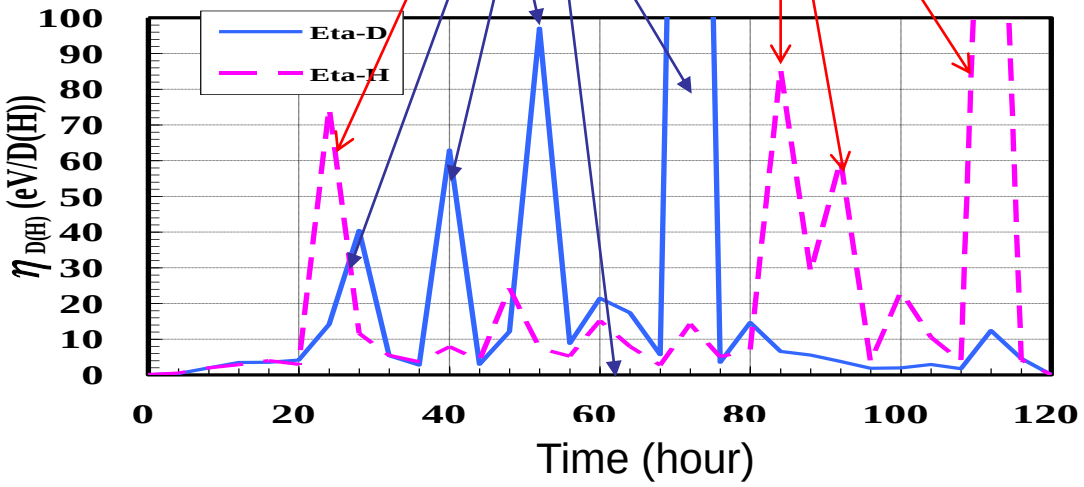
$$\eta(t) \approx \frac{\int_t^{t+\Delta t} \overline{W(t,\tau)}\,\mathrm{d}t}{L(t+\Delta t) - L(t)}$$

$$\overline{W(t,\tau)} = \frac{\int_t^{t+\tau} W_{\text{mead}}(t)\,\mathrm{d}t}{\tau}$$

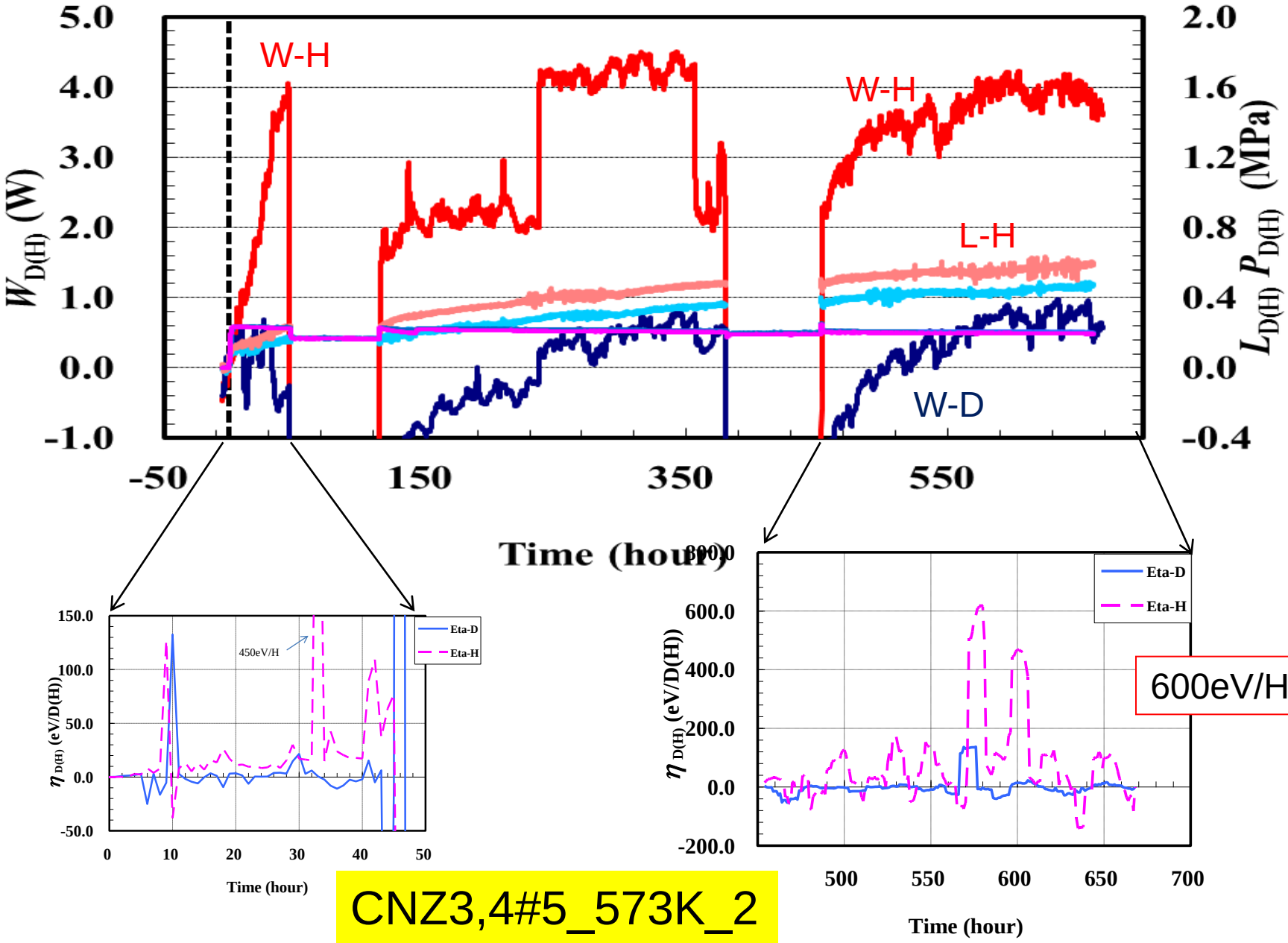


Excess-heat during desorption !

CNZ3,4#5_523K

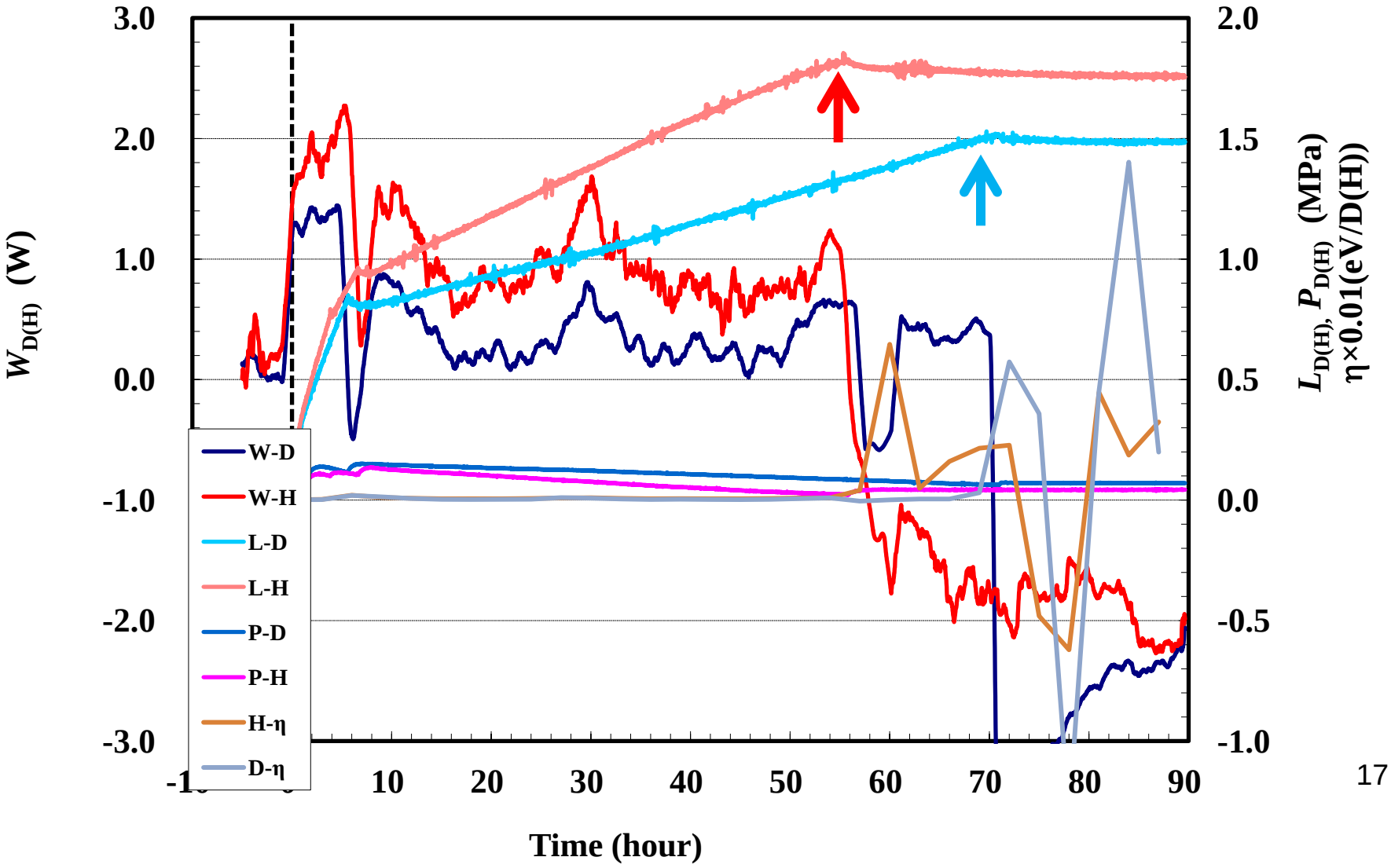


Excess H By In/Out Of D(H) !


W-H
W-H
L-H
W-D
$W_{D(H)}$ (W)
$L_{D(H)}$ $P_{D(H)}$ (MPa)
Time (hour)
Eta-D
Eta-H
450eV/H
$\eta_{D(H)}$ (eV/D(H))
Time (hour)
600eV/H ！
CNZ3,4#5_573K_2

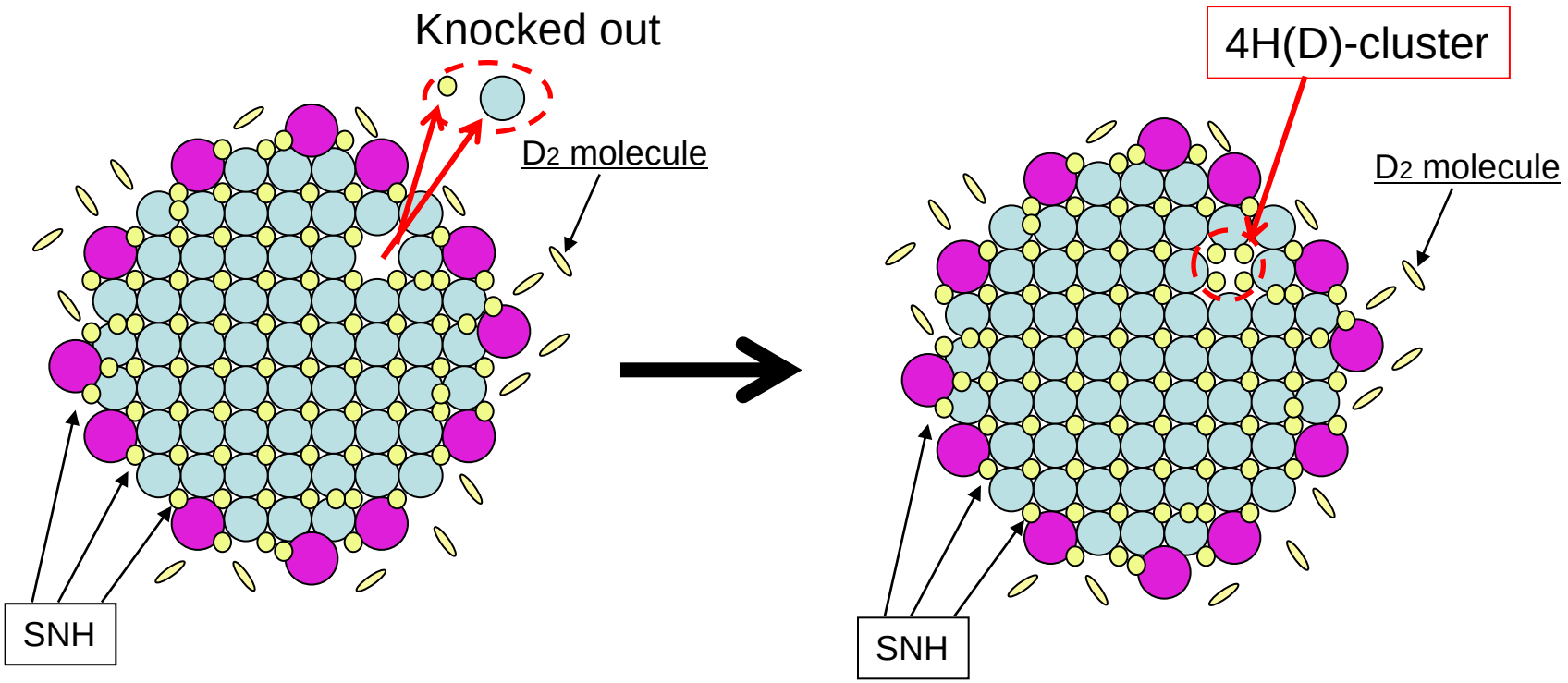
CNZ-II 573K: Pretreatment Run

Abrupt Desorption at High L!
Large Heat Sink!

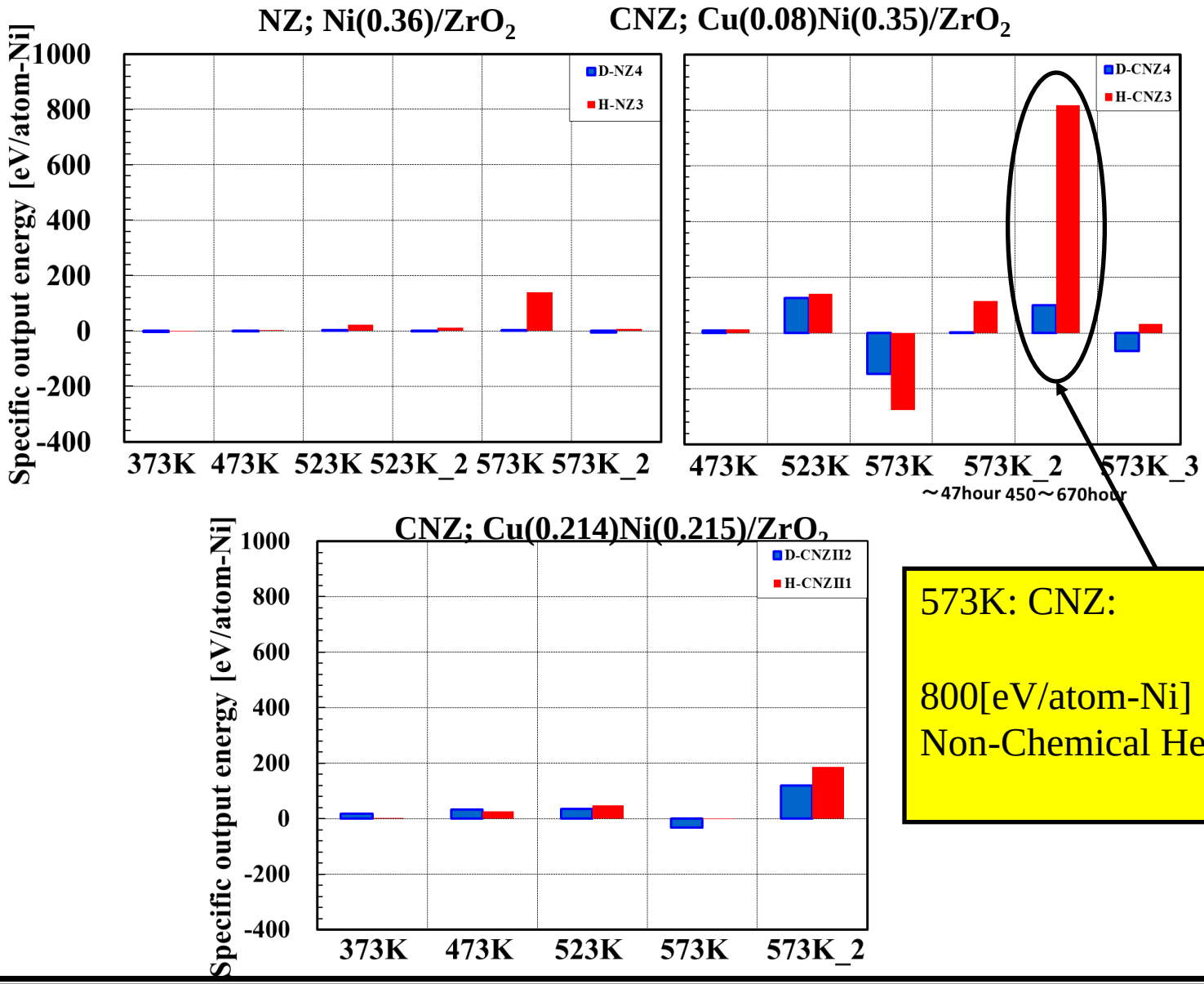


Anomalous Endothermic Effect
By H + Ni knock-out (ca. 50 eV/H)

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



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



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 as100～600 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.