Anomalous Excess Heat Generation by the Interaction between Nano-structured Pd/Ni surface and D_2/H_2 gas

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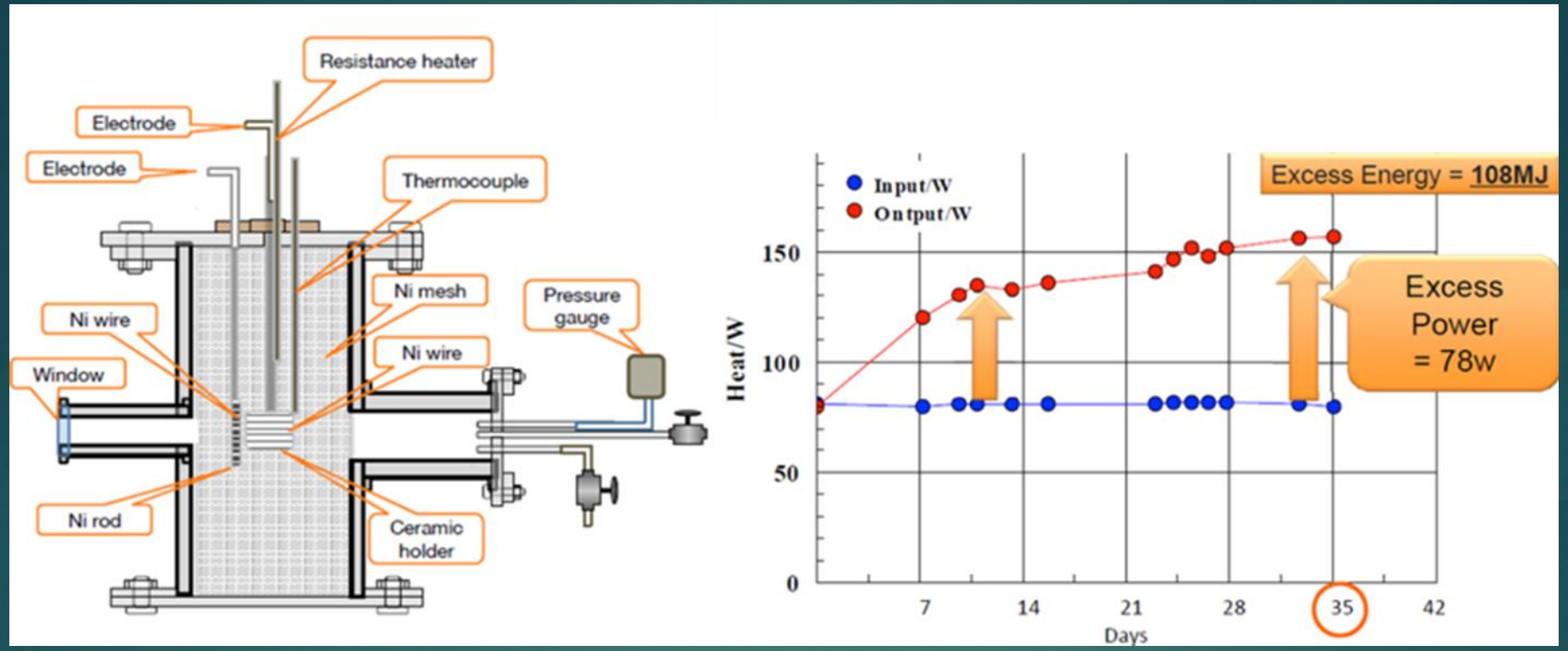
1. Background

Dr. Mizuno's Experiment



1. Make Pd/Ni Nano Structure Surface in the chamber using Plasma Discharge
2. D_2/H_2 gas Introduced Chamber
3. Observe Anomalous Excess Heat Generated

[1] T. Mizuno, "REACTANT, HEATING DEVICE, AND HEATING METHOD", Patent Application, WO2015/008859 A2.
[2] H. Yoshino, E. Igari and T.Mizuno, Presentation at 2014 CF/LANR Colloquium at MIT, March.21-23, 2014, Massachusetts Institute of Technology, Cambridge, MA, USA.

Objective

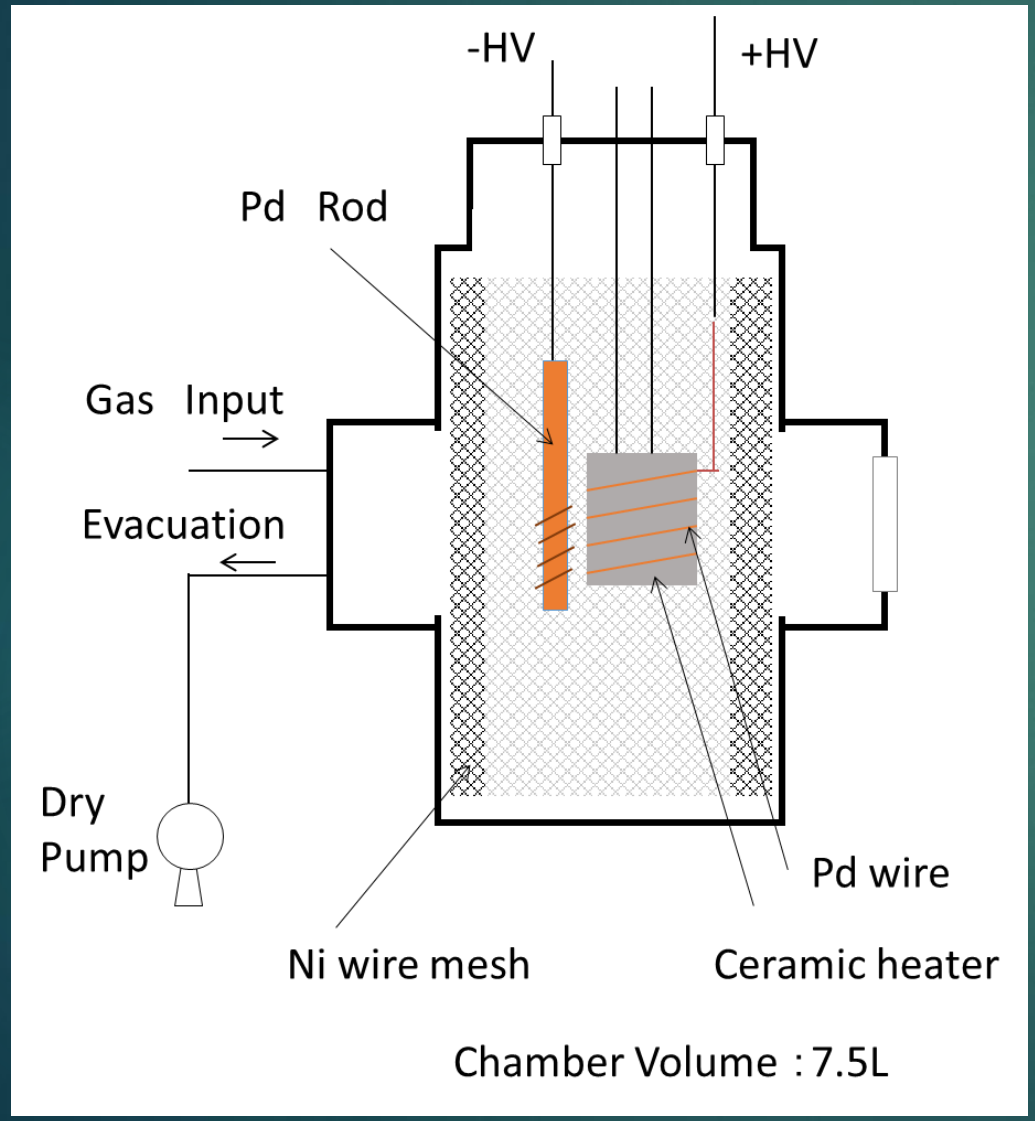
Condensed Matter Nuclear Reaction Division
at Tohoku Univ. (April 2015 ~)

This Paper:
Replication of the anomalous heat generation
reported by **T. Mizuno**
as a first step on Excess Heat Resaerch

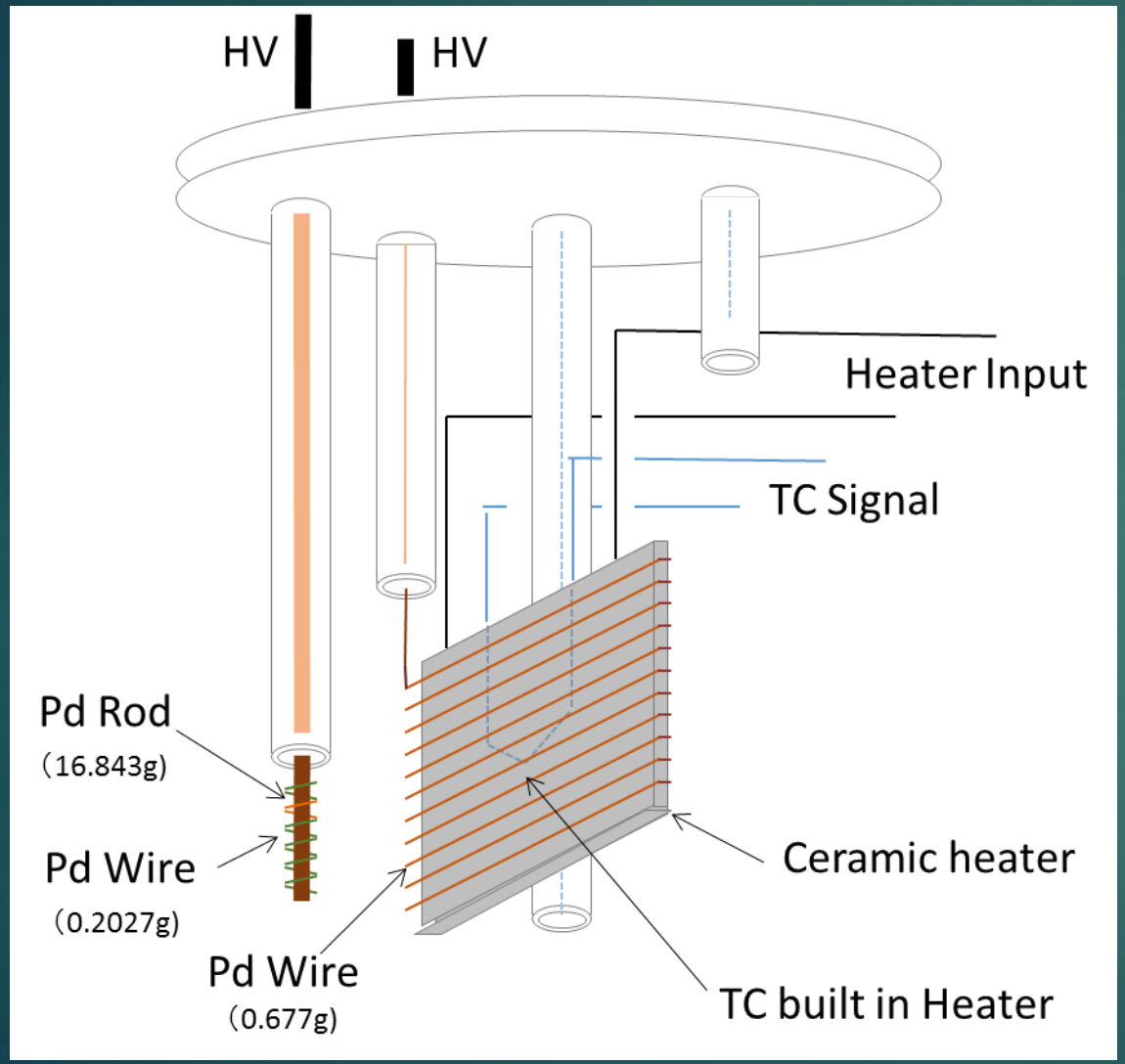
Explore its Feasibility as a new energy source

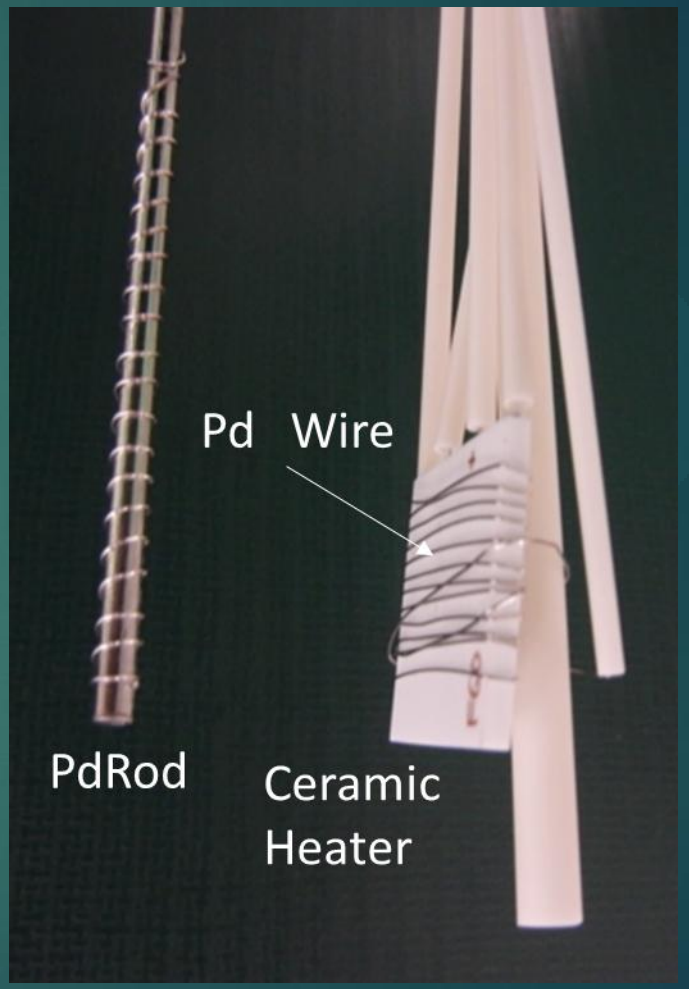
2. Experimental

Experimental Apparatus

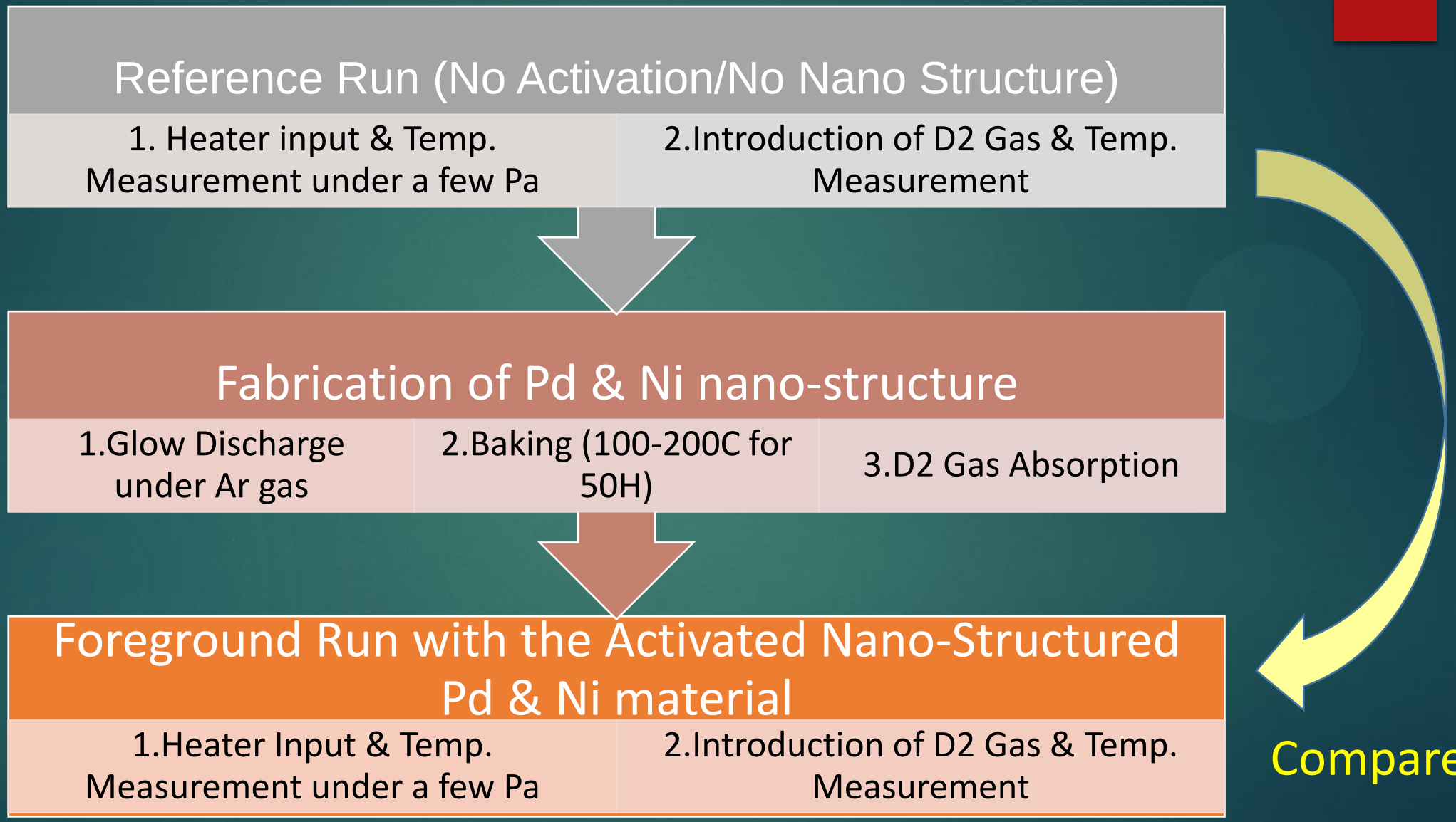


Heater, Pd Wires and Pd Rod

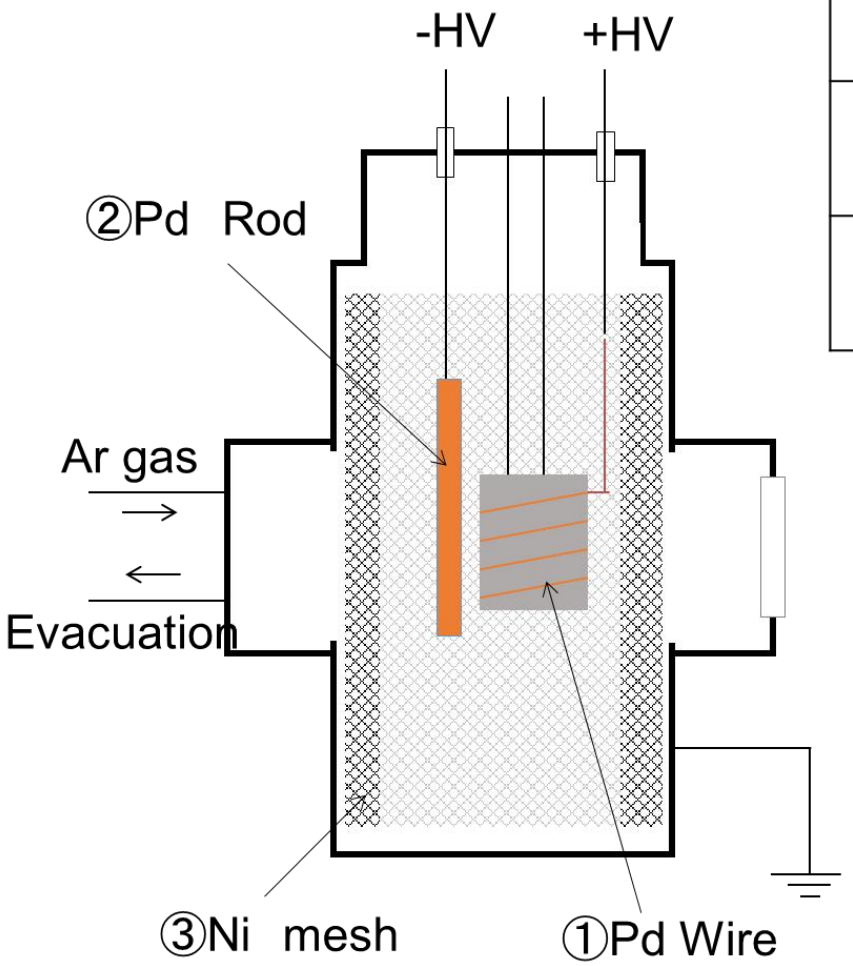




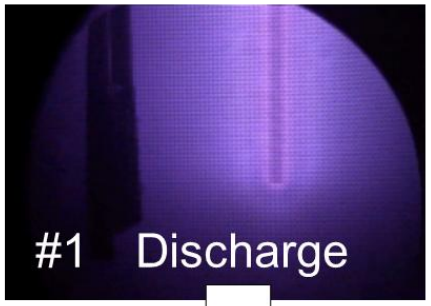
Experimental Procedure

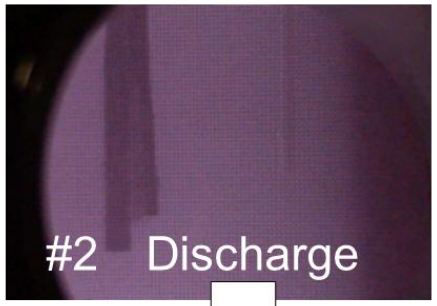


Fabrication of the nano–structured Ni and Pd surface



	①Pd Wire	②Pd Rod	③Ni Mesh
#1	Float	-HV (1kV)	Grounded
#2	+HV（500-700V）	Float	Grounded





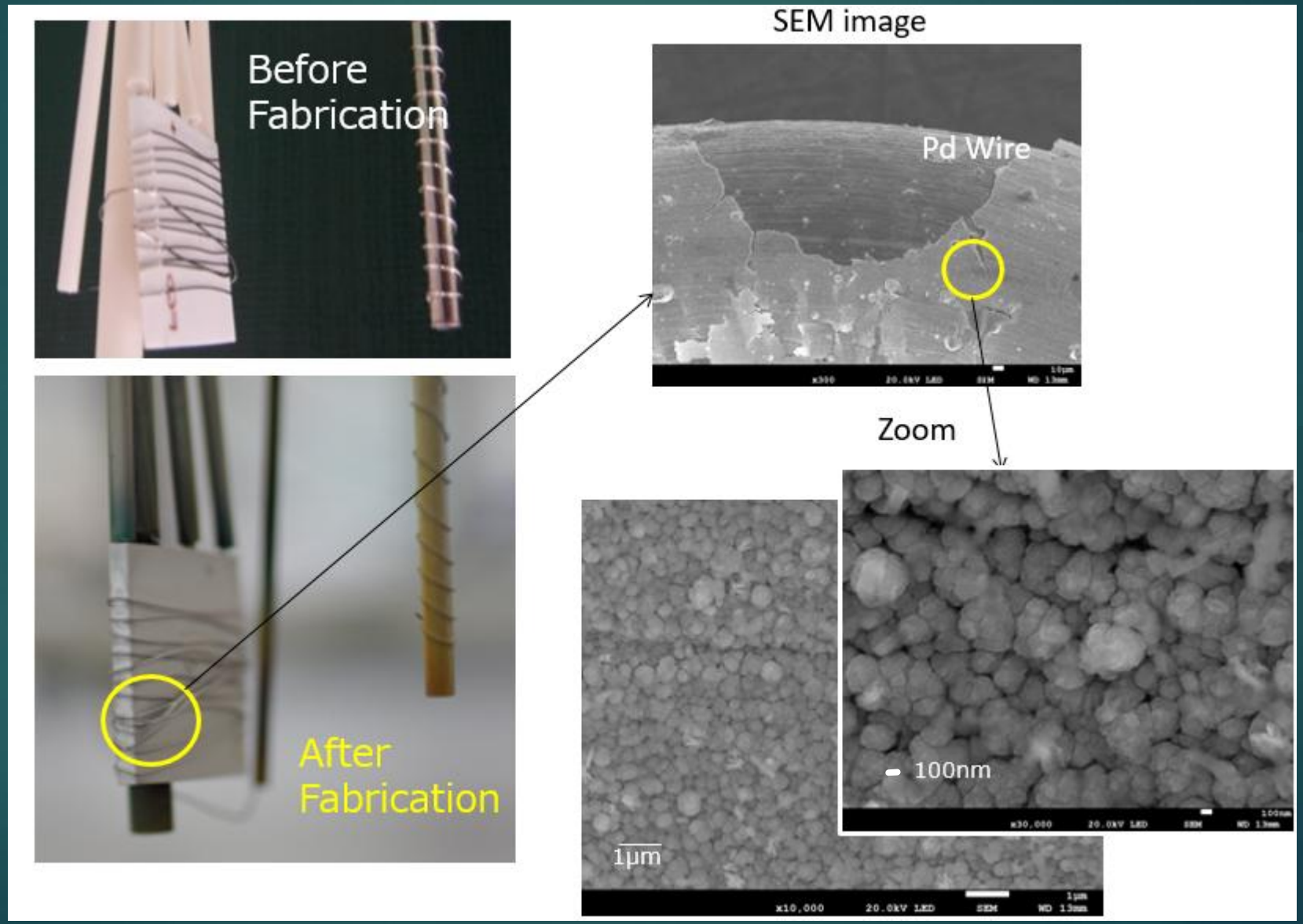
Pd Sputtering

Ni Sputtering

#1 and #2 processes alternately repeated

Pd–Ni Nano-Structure

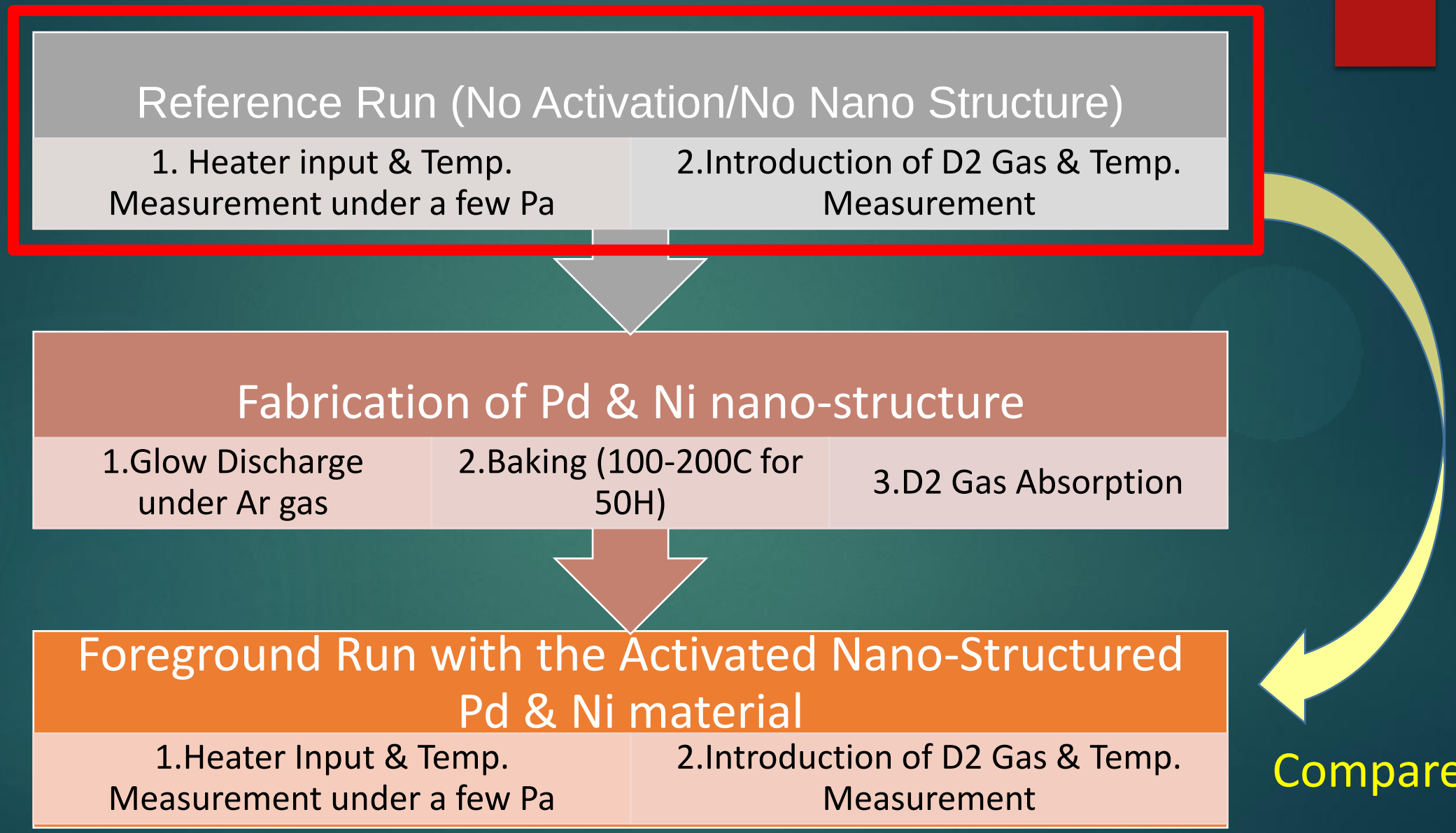
Fabricated Nano–structured Ni and Pd surface



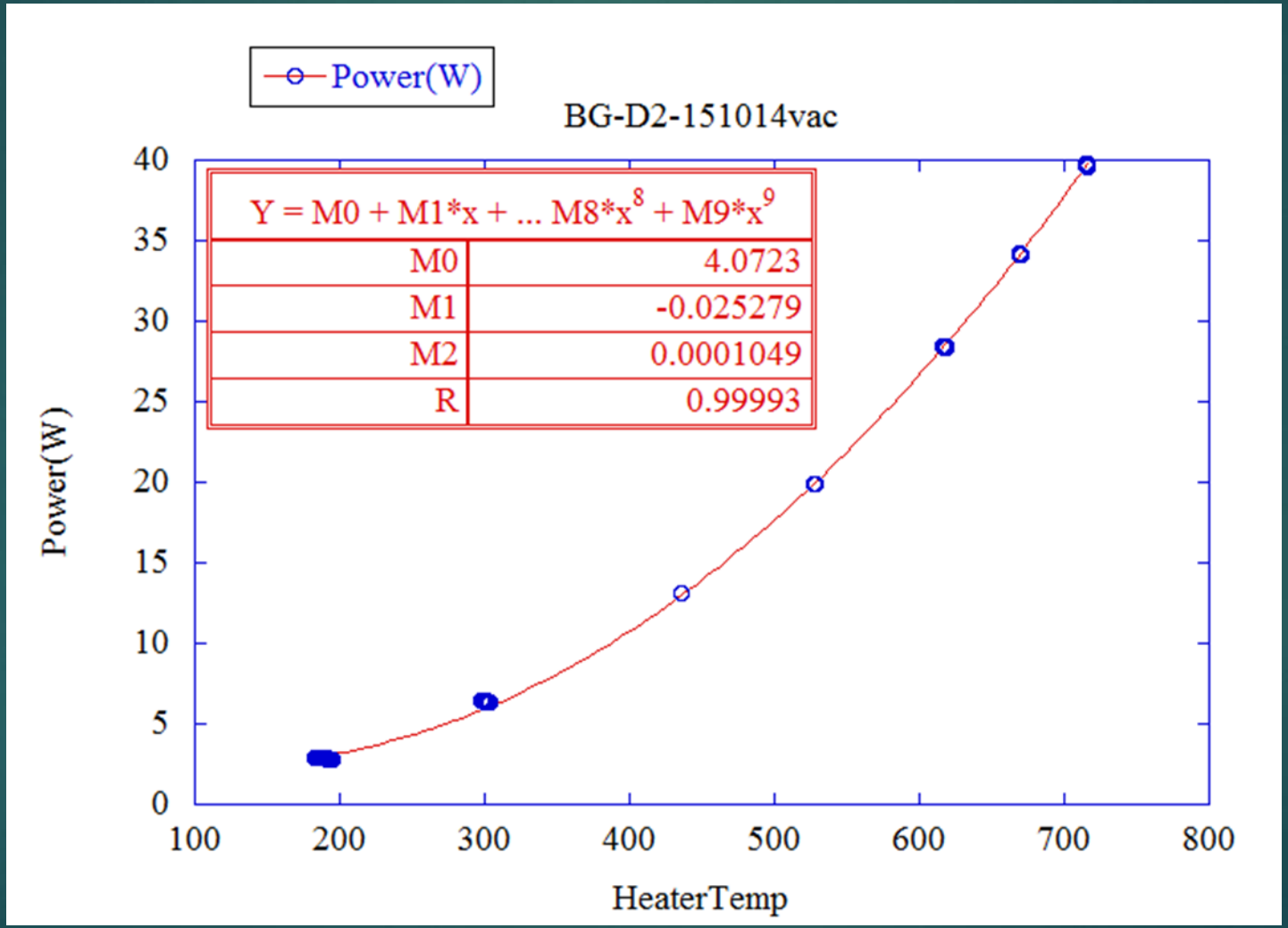
3. Experimental Results

3-1. D_2 gas Experiments

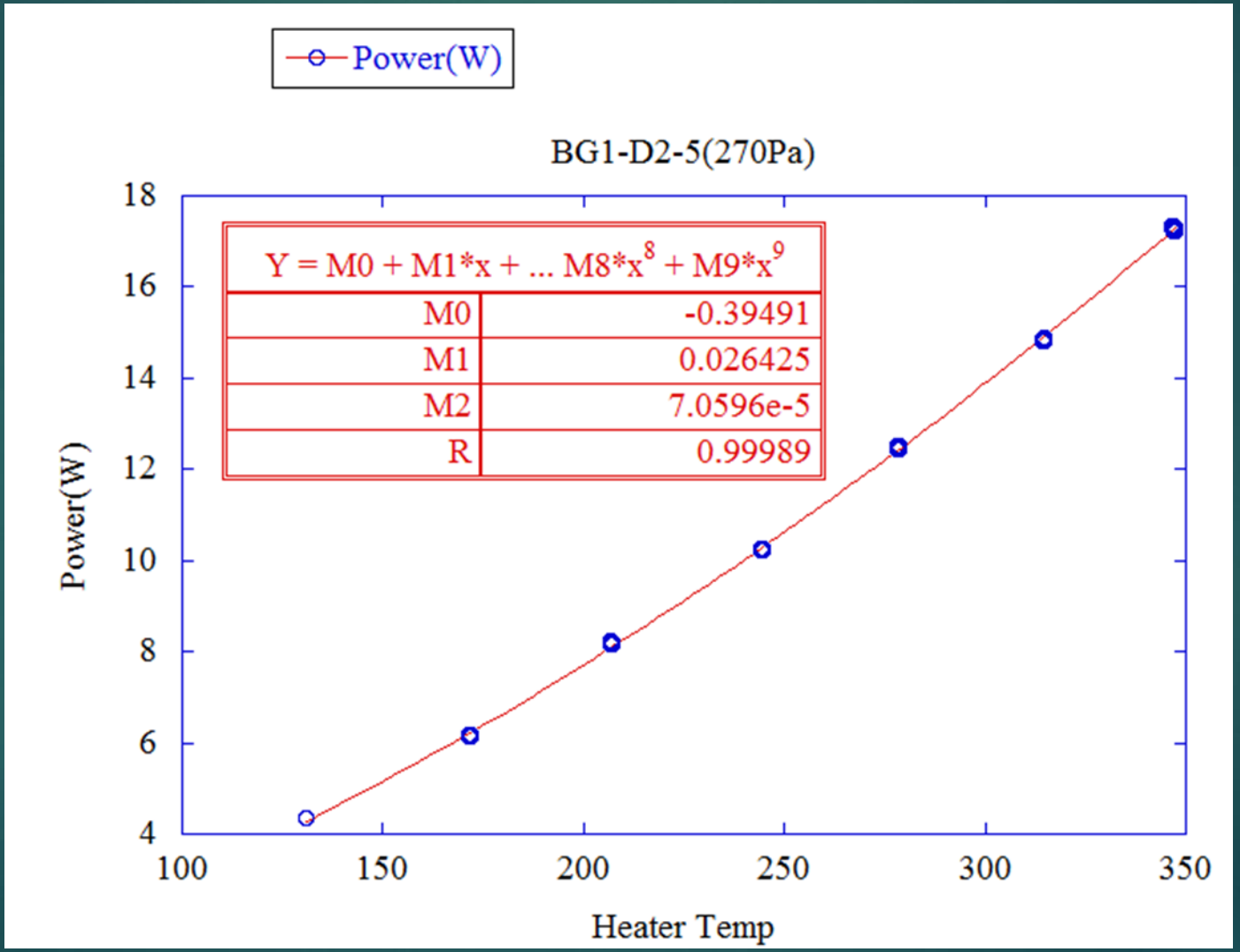
Experimental Procedure



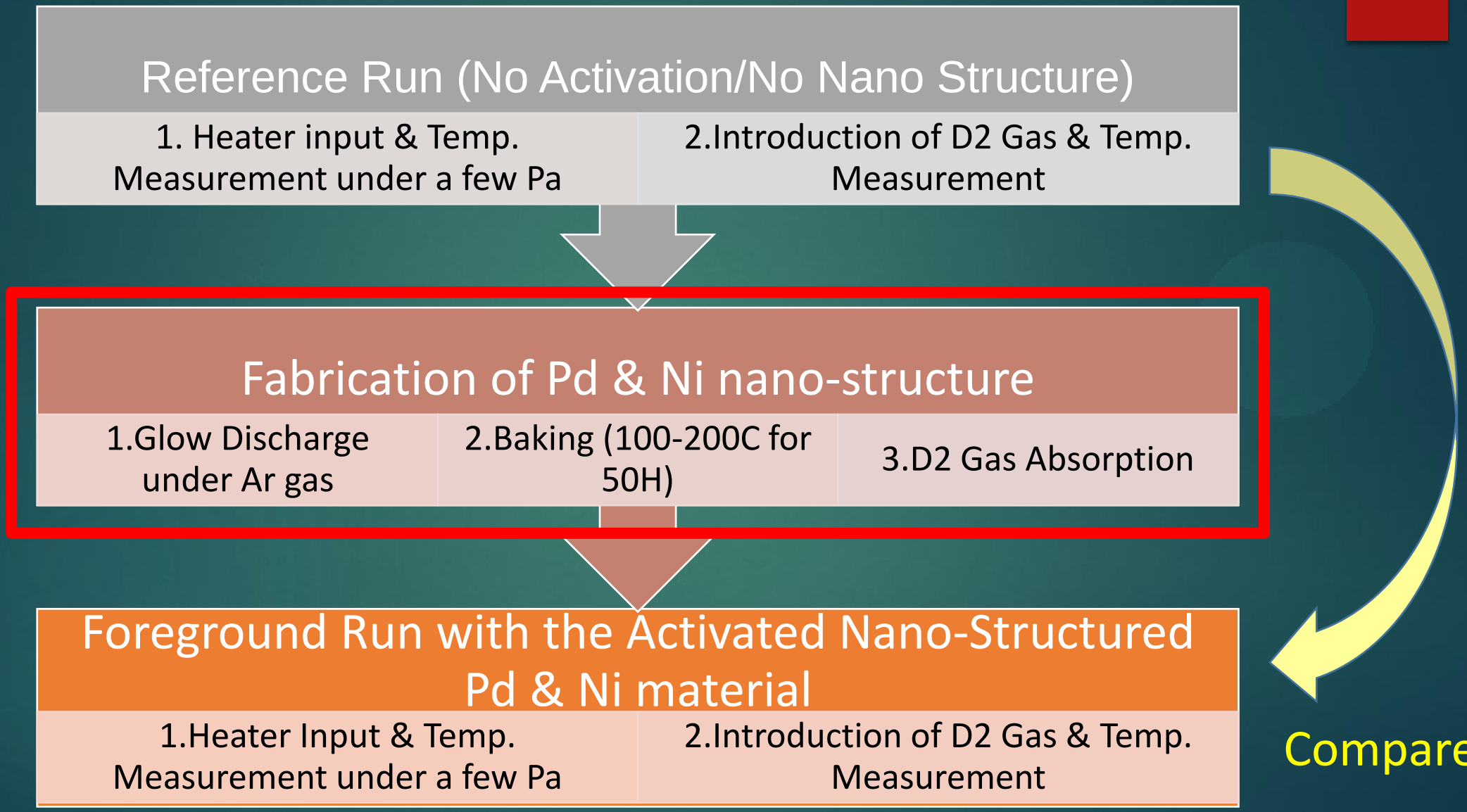
Reference Data; ~1Pa



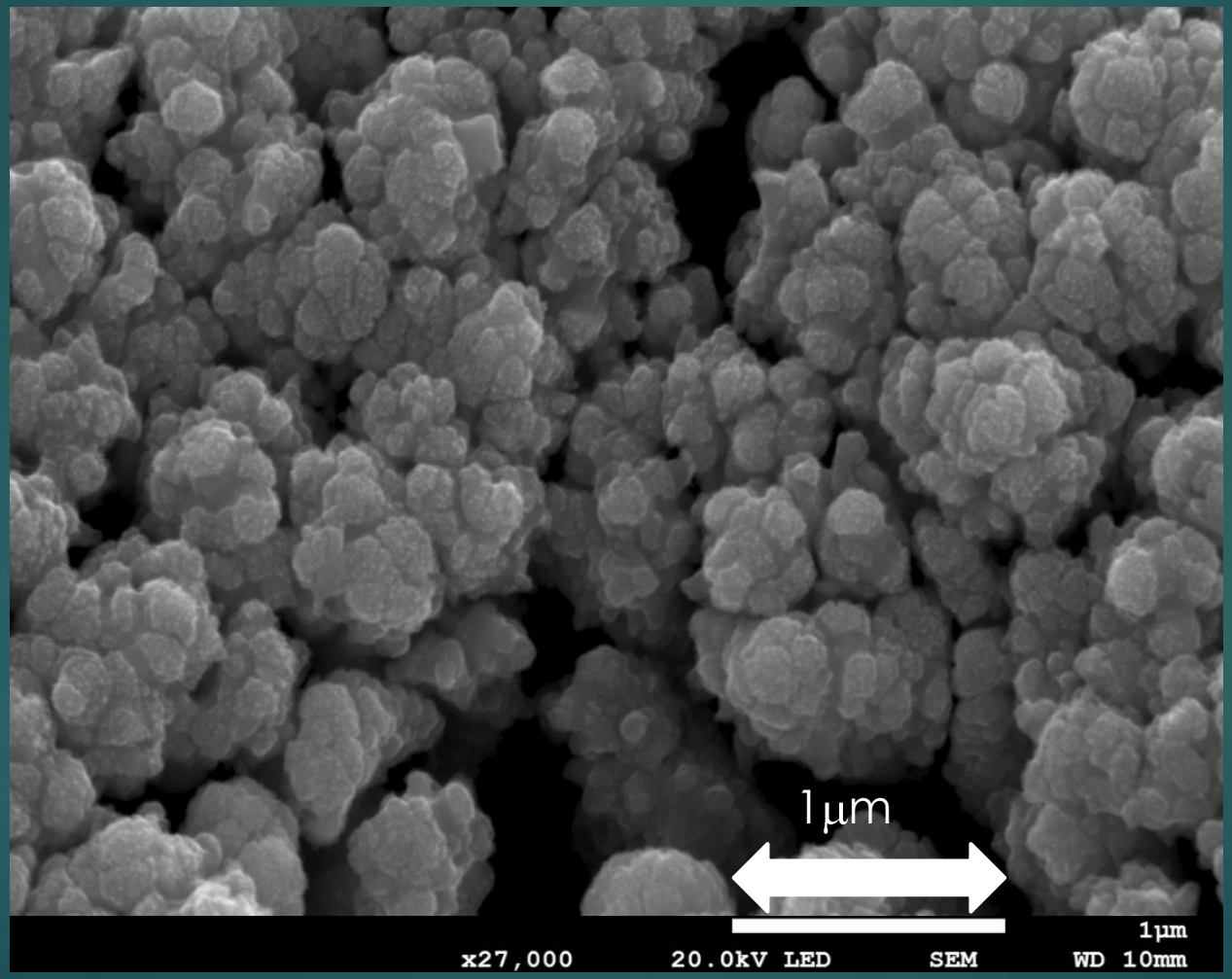
Reference Data; ~270Pa



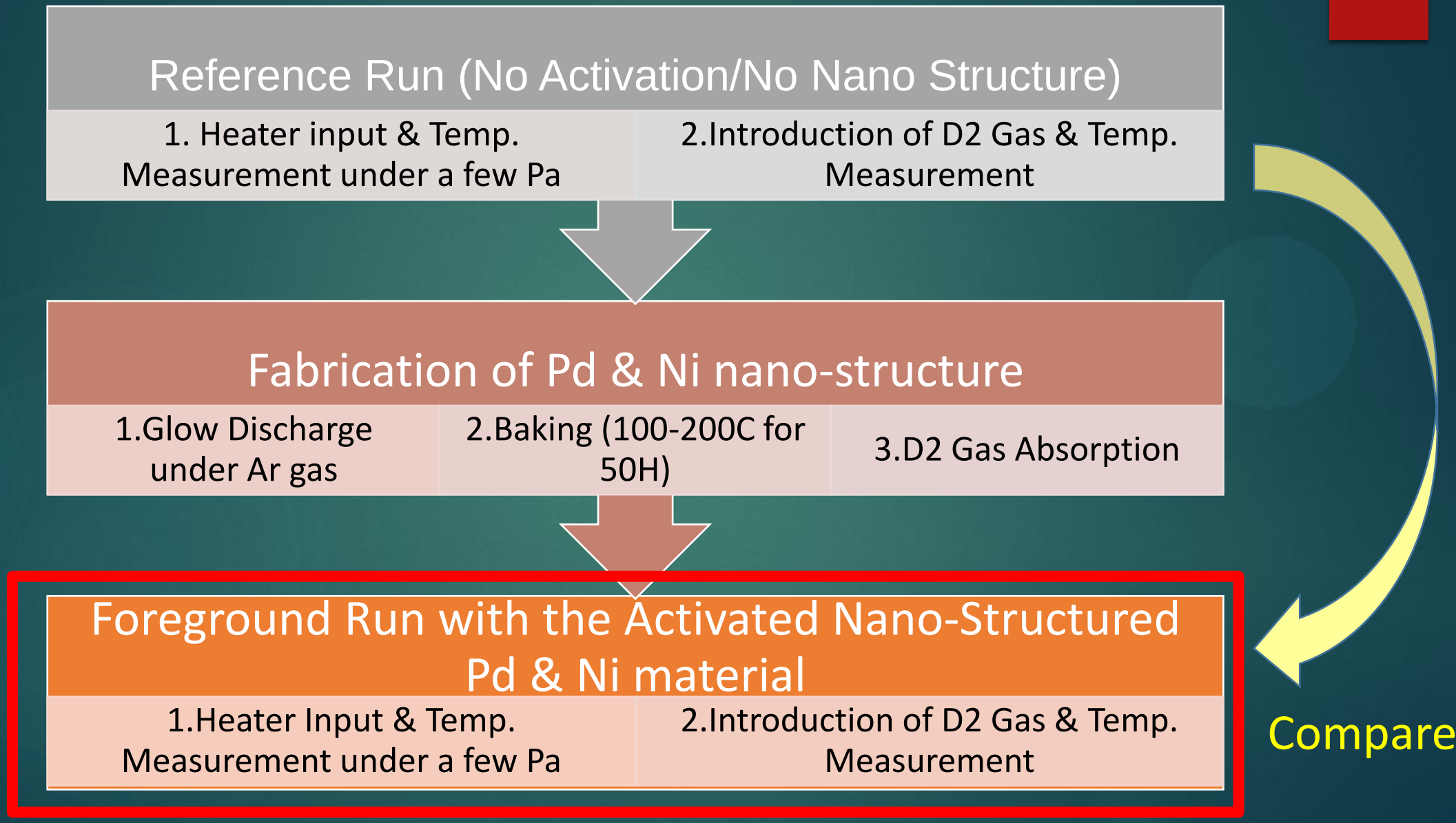
Experimental Procedure



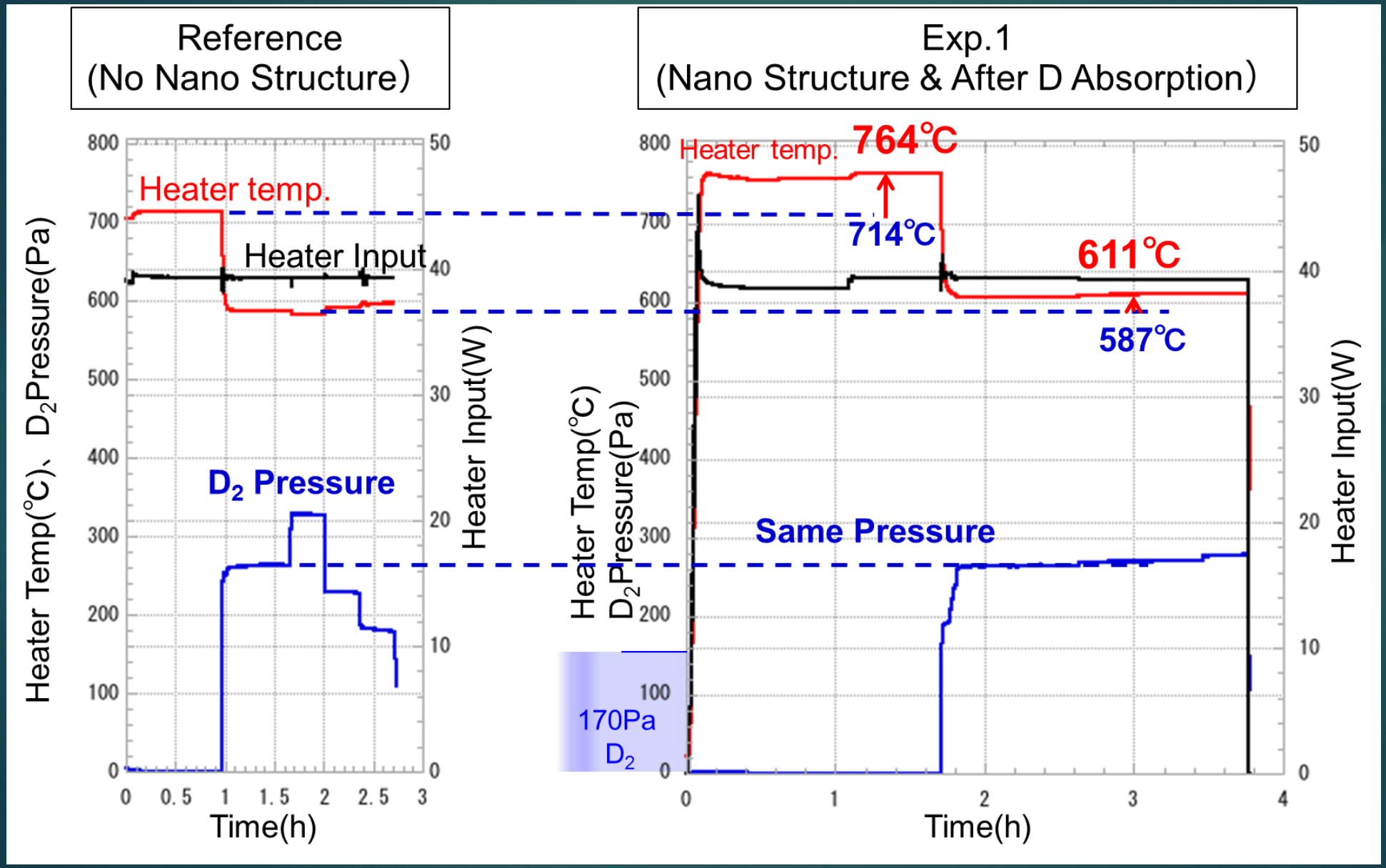
Fabricated Nano–structured Ni and Pd Surface



Experimental Procedure



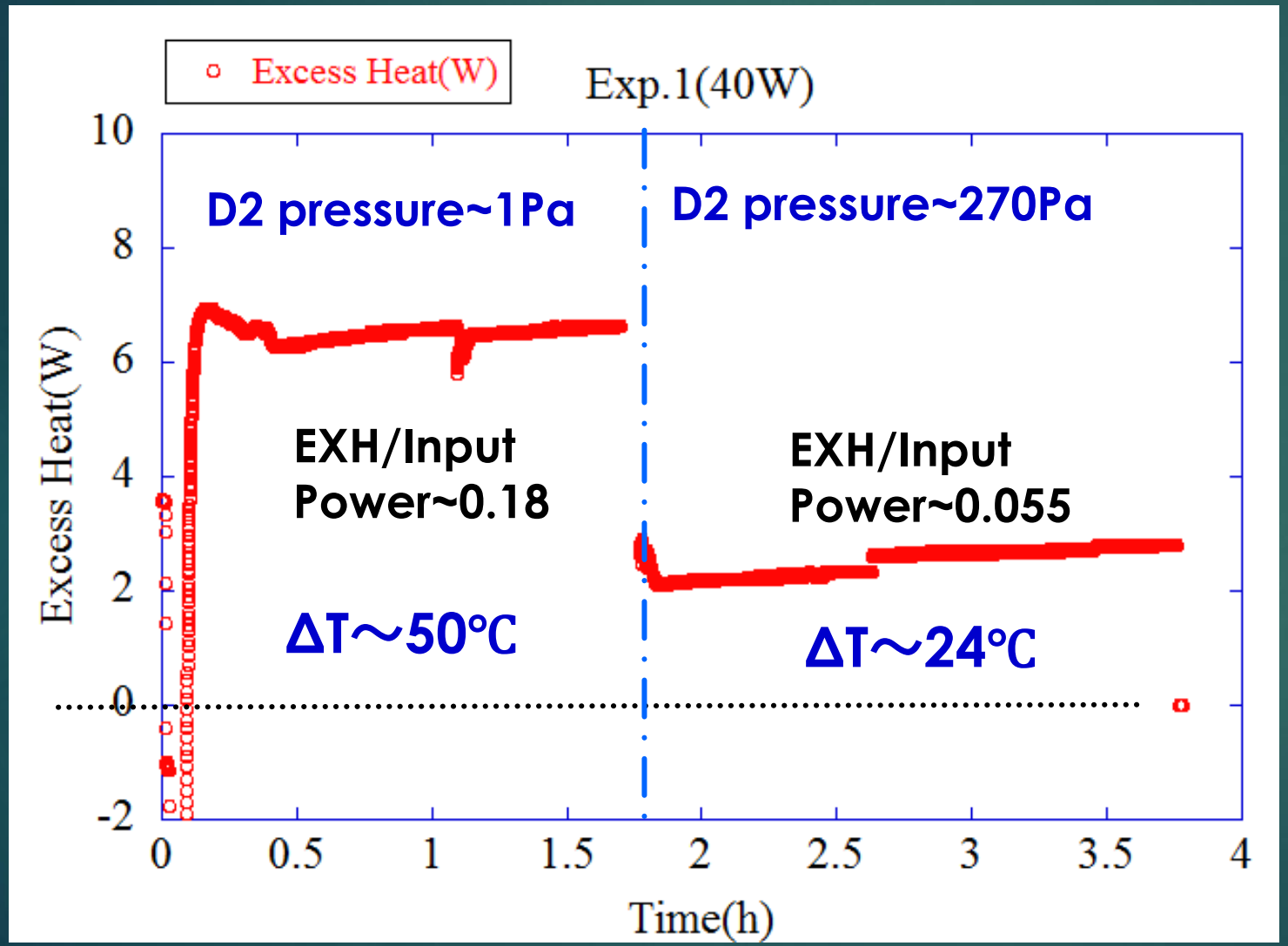
Exp.1 (D_2 Gas)around 700C (40W Input)



ΔT～50℃
at 1 Pa

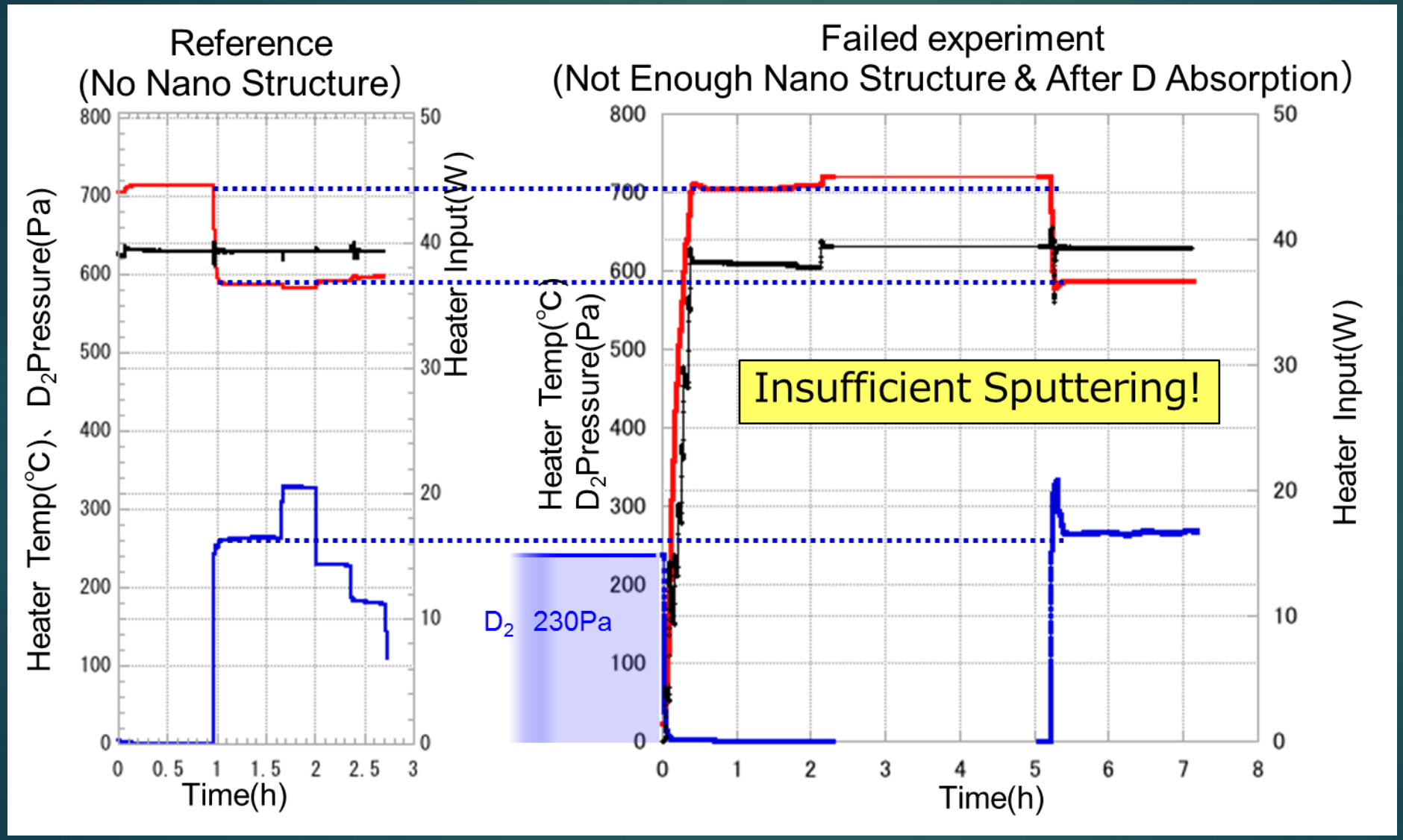
ΔT～24℃
at 270Pa

Exp.1(D_2 Gas) around 700C(40W Input)



EXH/Input Power
18% for 1Pa
5.5% for 270Pa

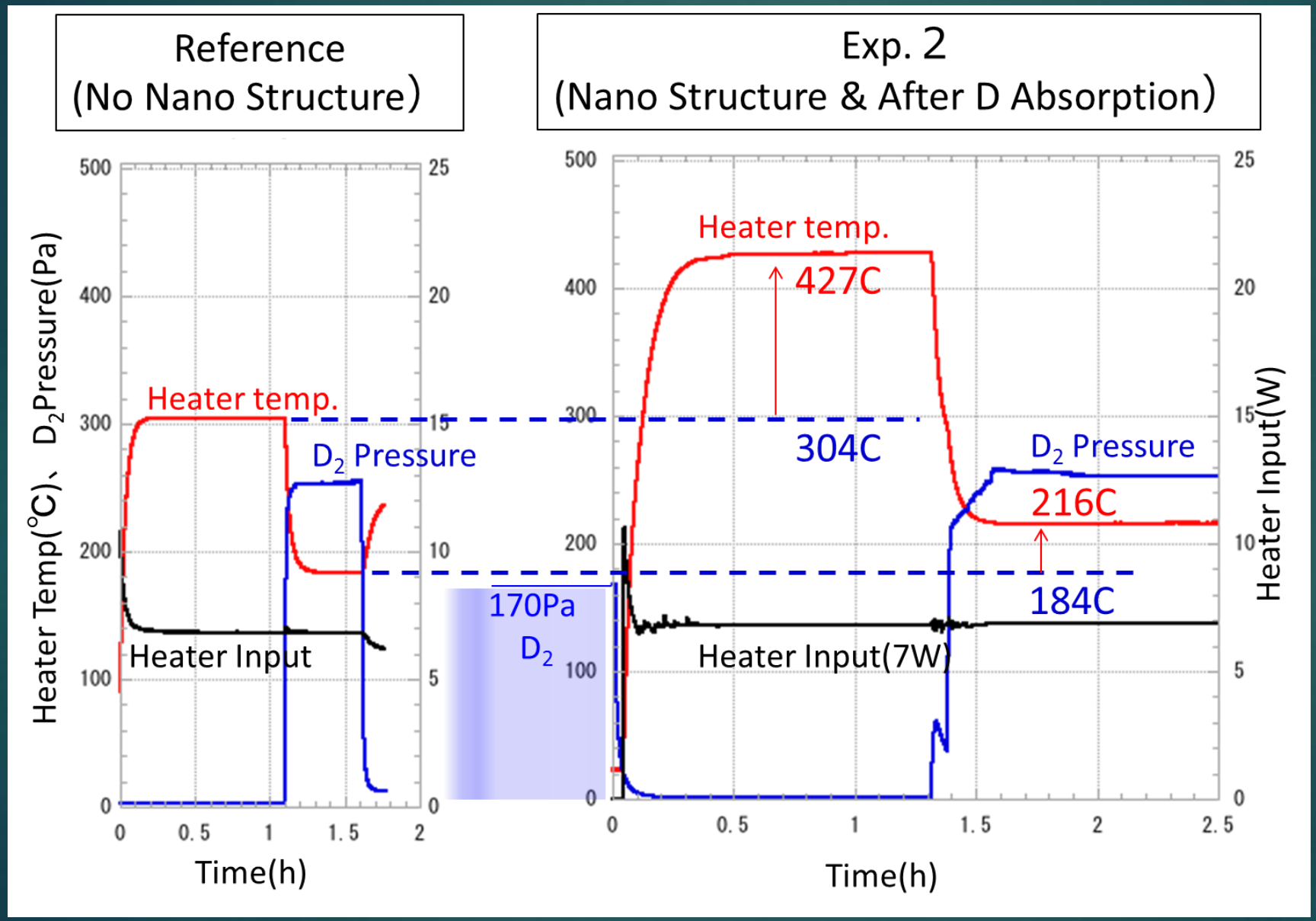
Failed Experiment: NO Excess Heat



ΔT～0℃
at 1 Pa

ΔT～0℃
at 270Pa

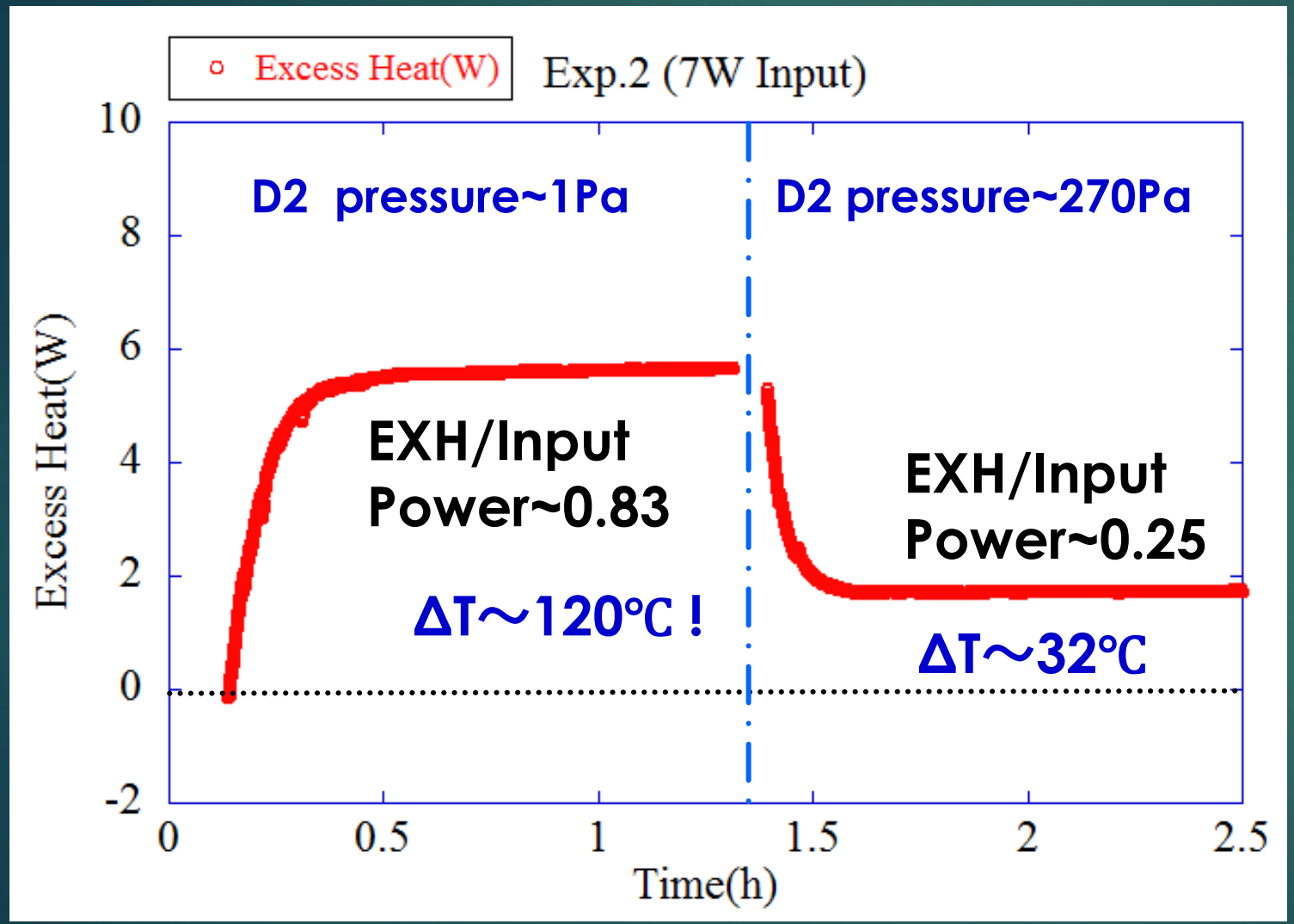
Exp.2(D_2 Gas) around 300C (7W Input)



ΔT～120℃ !
at 1 Pa

ΔT～32℃
at 270Pa

Exp.2(D_2 Gas) around 300C(7W Input)



EXH/Input Power reached~0.8

3. Experimental Results

3-2. Numerical Radiation Heat Analysis

Estimation of Radiation Heat Transfer by Numerical Calculation

Governing Equations

$$\rho c_p \left(\vec{u} \cdot \nabla T\right) + \nabla \cdot q = Q$$

$$\vec{q} = -k \nabla T$$

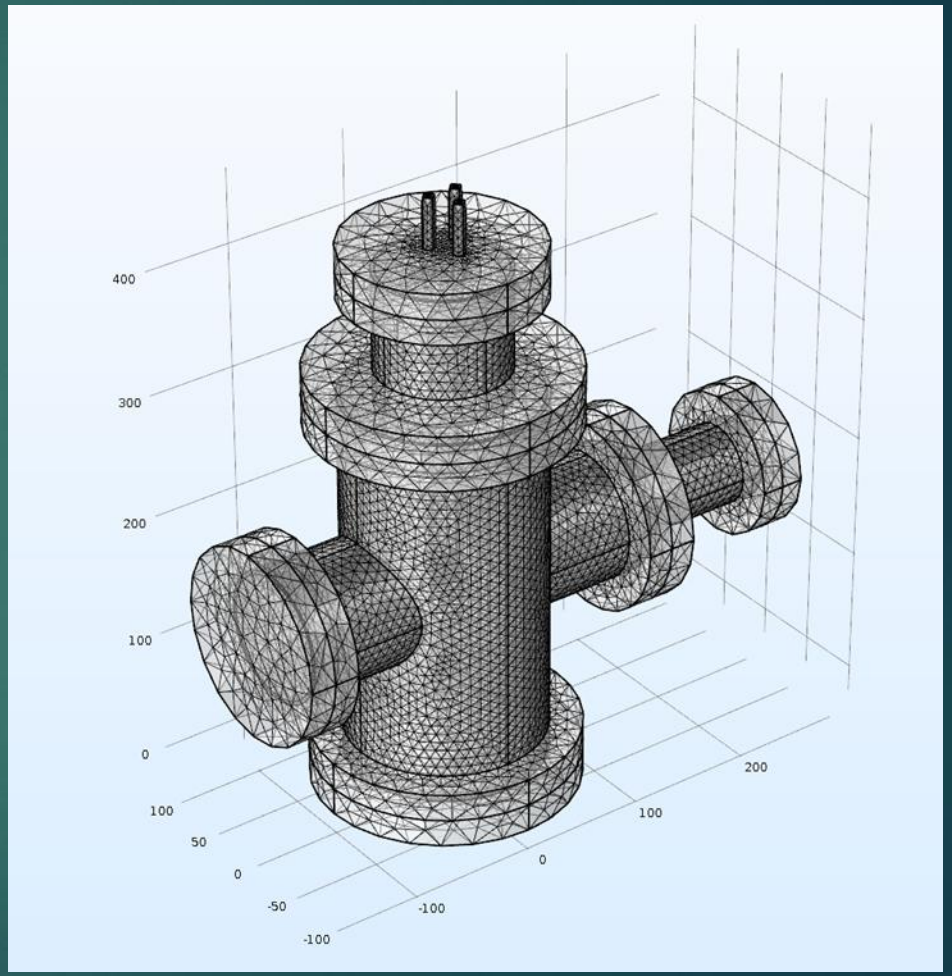
Boundary Conditions

$$-\vec{n} \cdot \vec{q} = \varepsilon \left(G - e_b(T)\right)$$

ε: Total emissivity
G: Irradiation
$e_b(T)$: Total emissive power of black body

Software

COMSOL Multiphysics 5.2 Heat transfer module



Number of Mesh; 207,479 (Free tetrahedral)

Estimation of Radiation Heat Transfer

Exp.1; 700C

Emissivity of Pd-Ni nano-structured material go down 0.1 due to its structure

About 50C increase would be expected

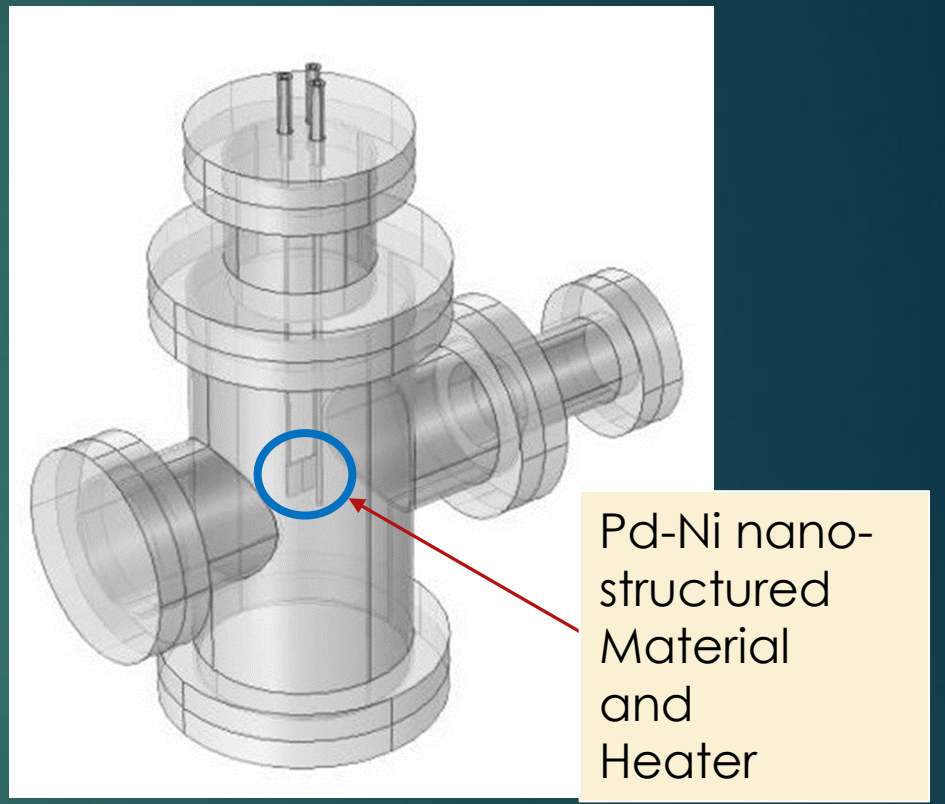
Due to dfference of radiation heat transfer ?

Exp.2; 300C

Even if Emissivity go down from 0.7 to 0.4

About 70C increase would be expected

Difficult to explain over 100C increase

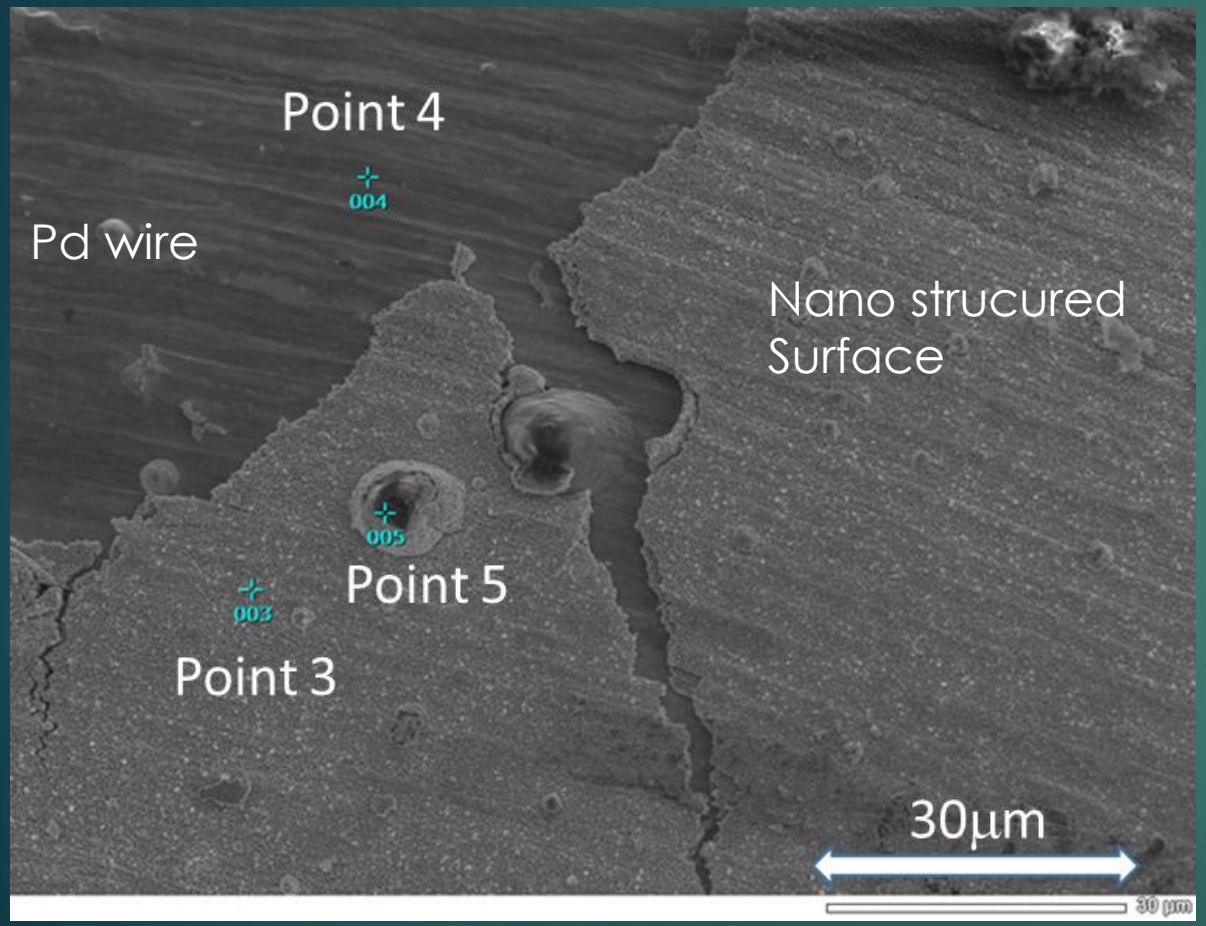


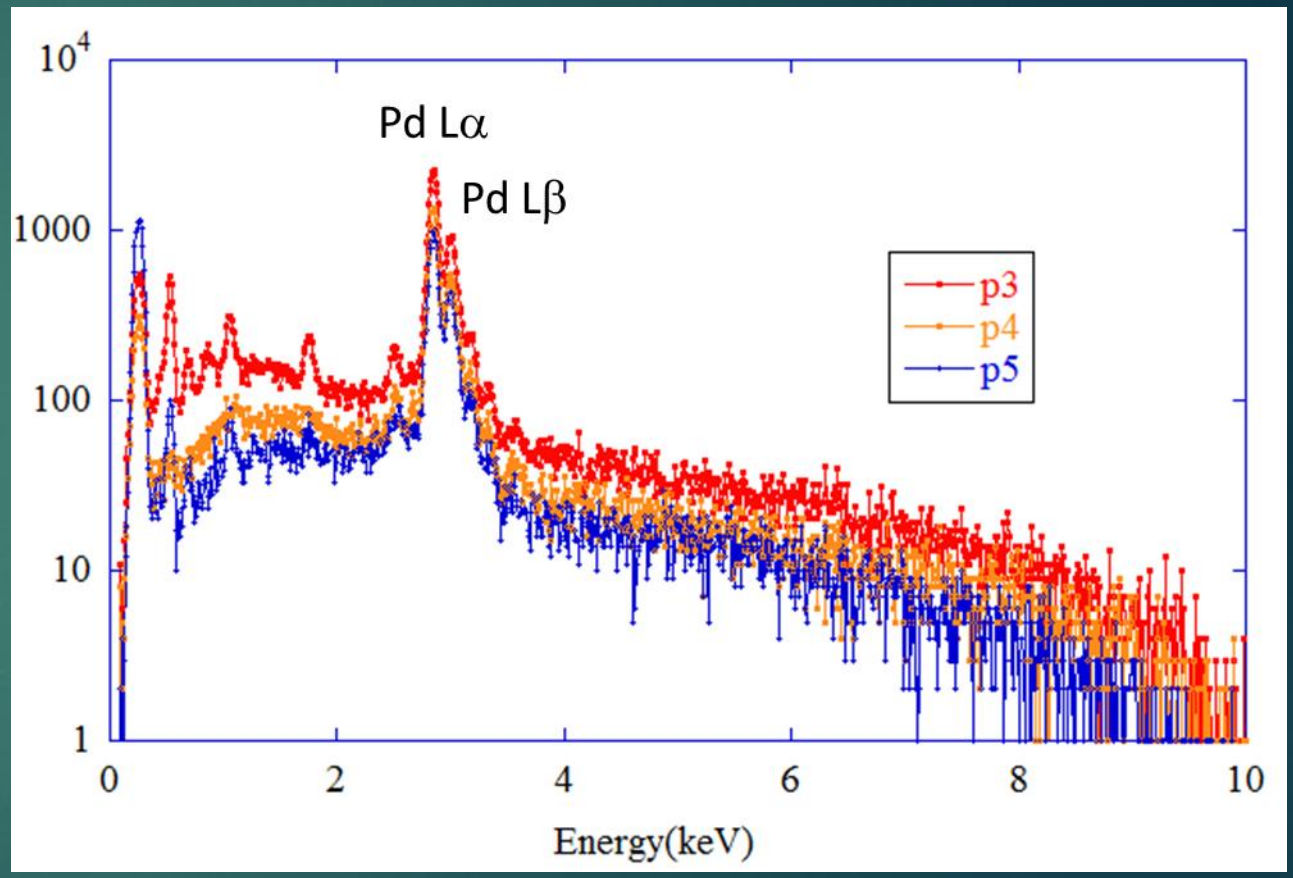
Anomalous Heat Effect

3. Experimental Results

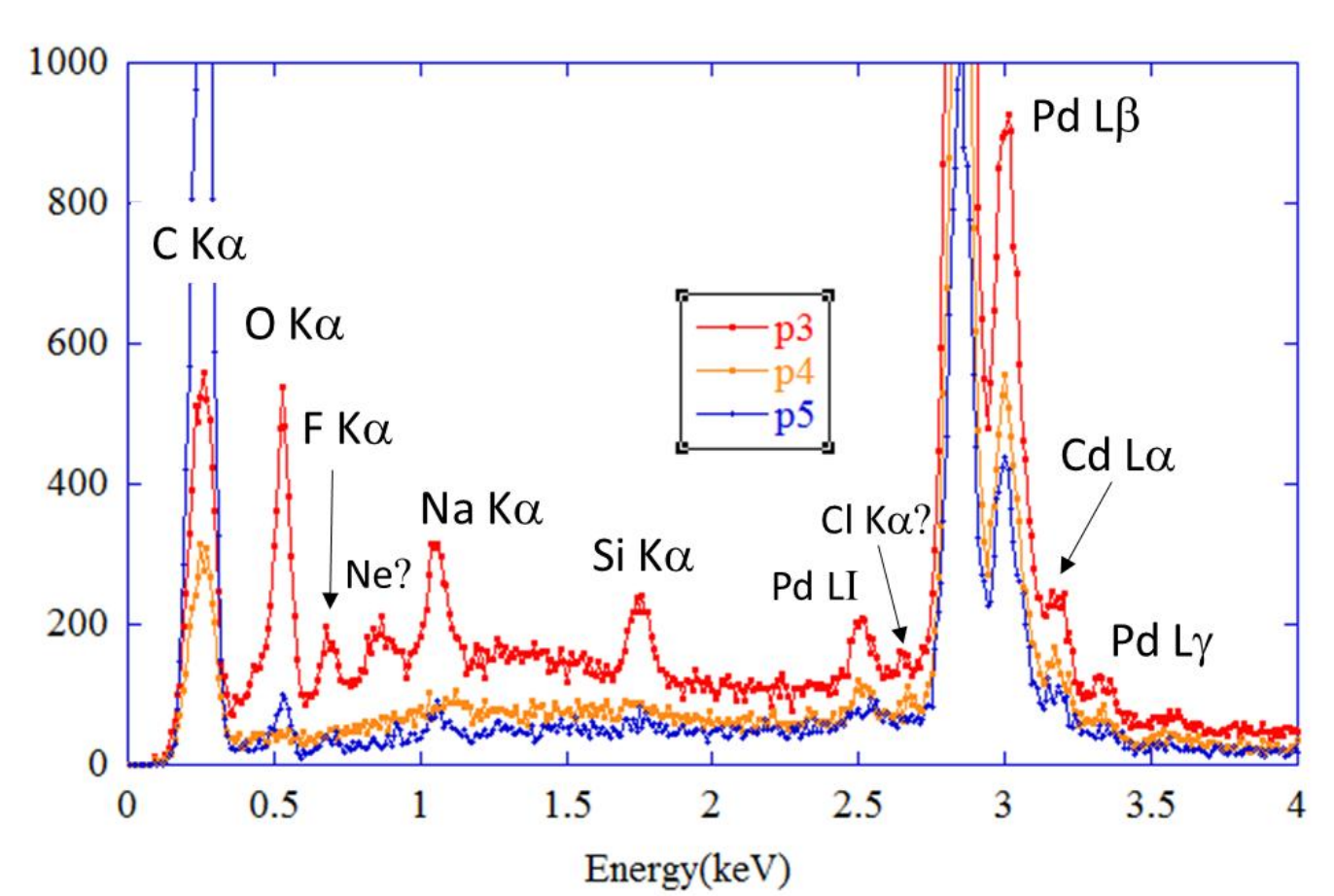
3-3. Elemental Analysis by EDS and SEM

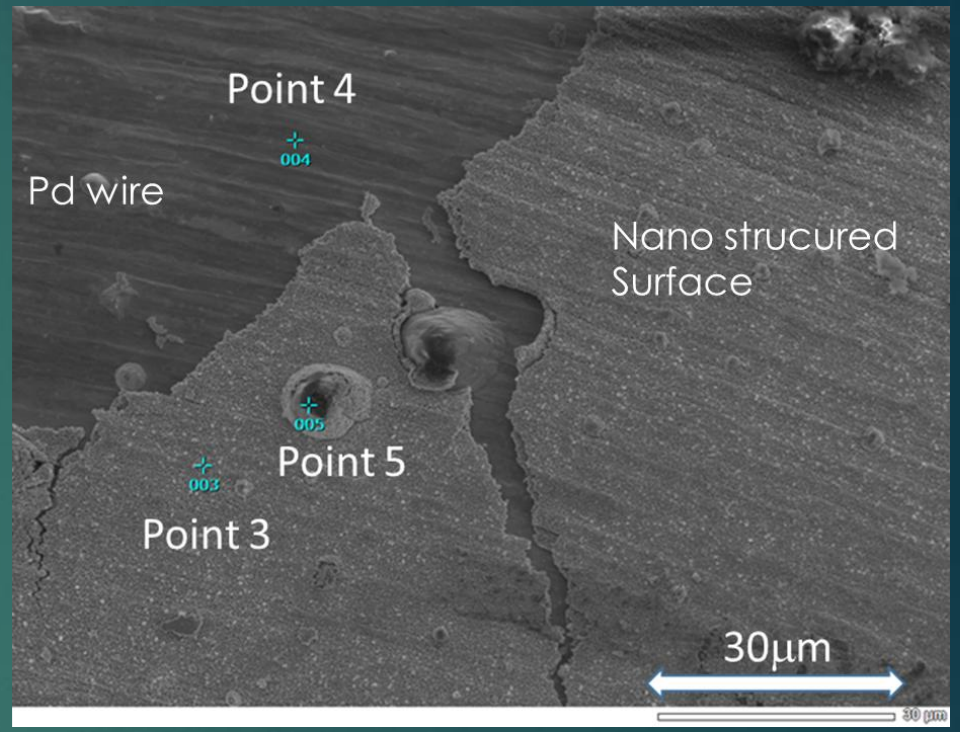
Pd Wire after Experiments(1)





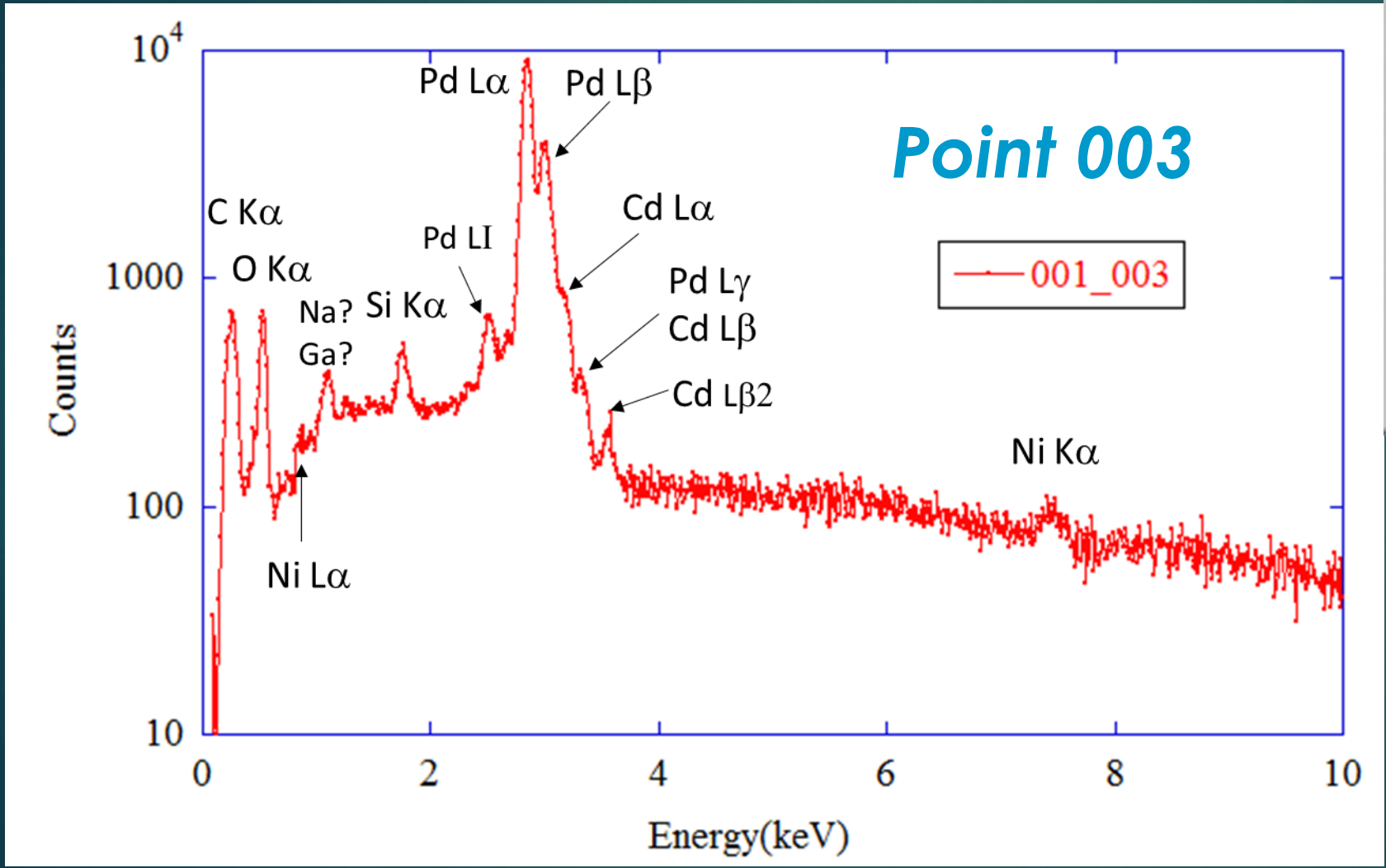
Pd Wire after Experiments(2)

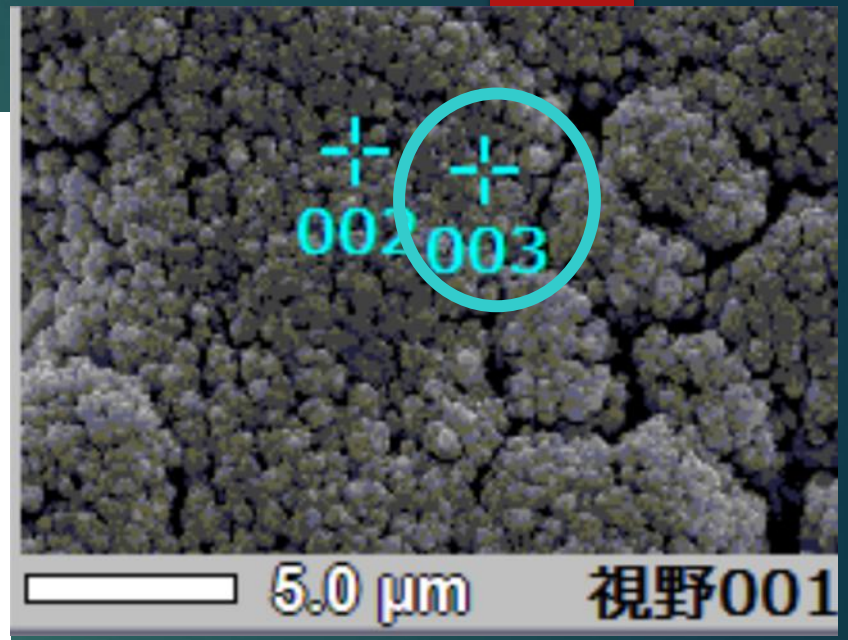




Many elements were detected especially at **point3** on the nano-structured surface.

Elemental Analysis of Nano Structure after Experiments





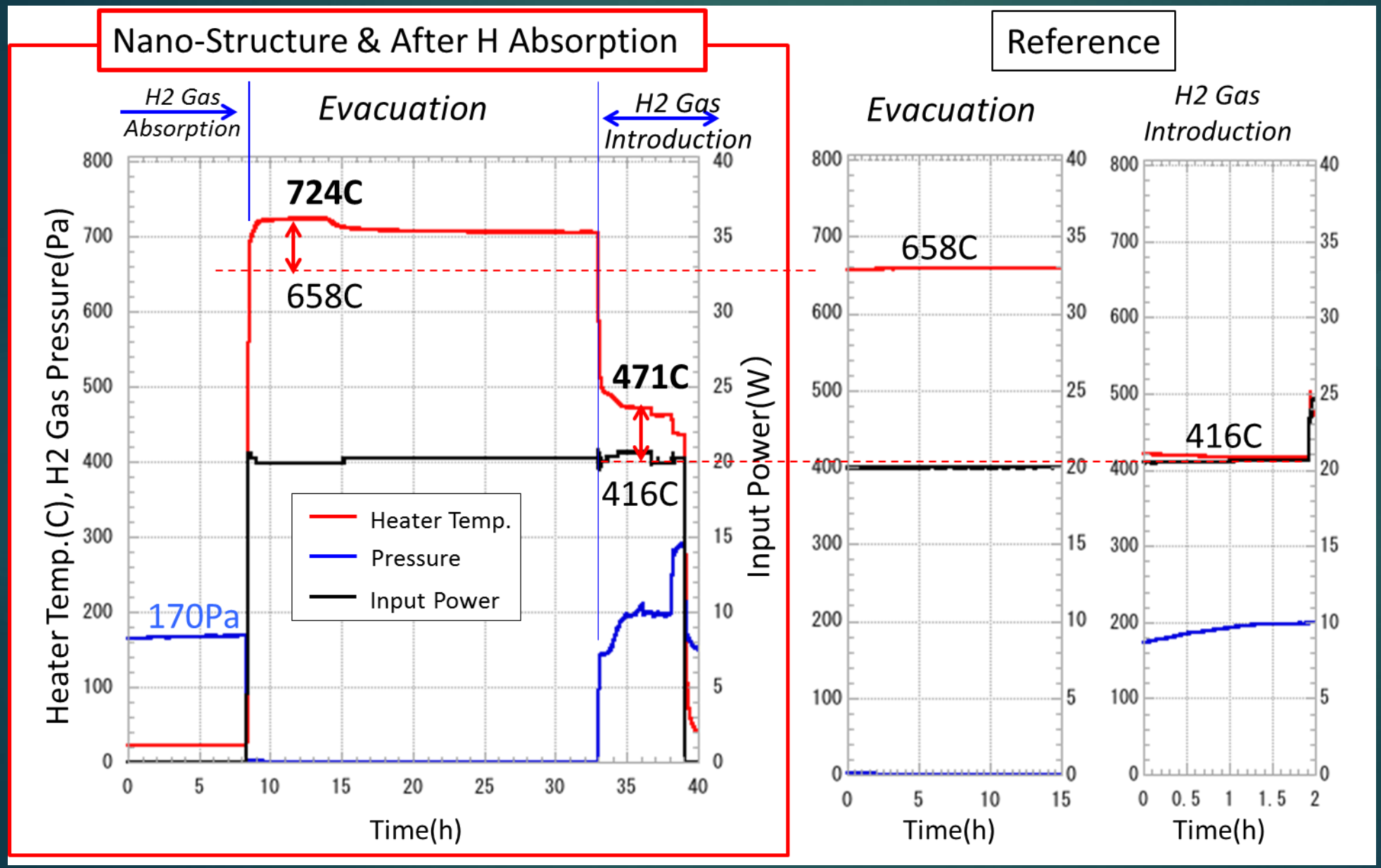
$$^{108}_{46}Pd + 2\,^{2}_{1}d \rightarrow ^{112}_{48}Cd \quad ?$$

Mass analysis is necessary !

3. Experimental Results

3-4. H_2 gas Experiments

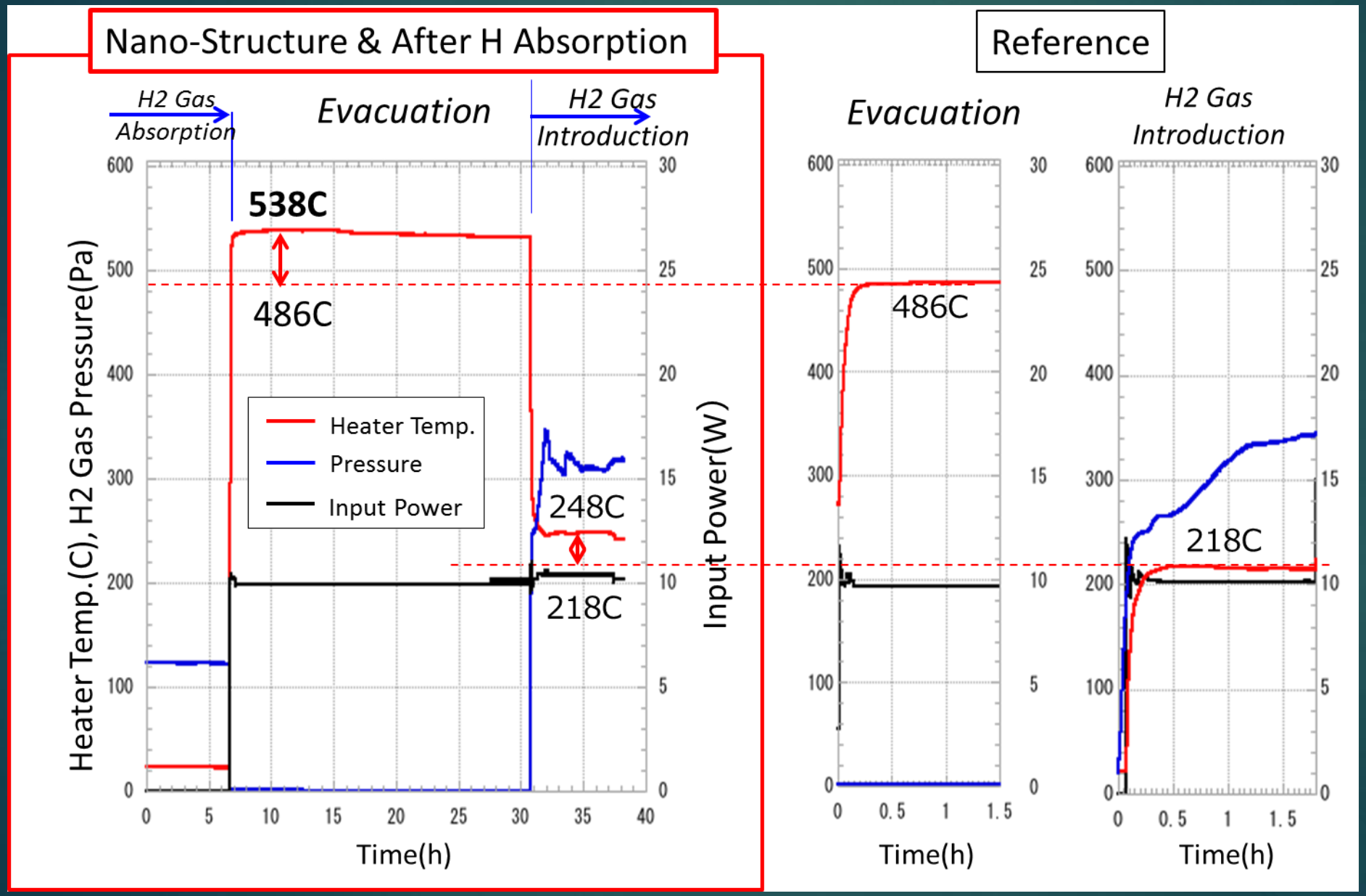
Exp.3 (H_2 Gas) around 700C(20W Input)



ΔT～66℃
at 1 Pa

ΔT～55℃
at 200Pa

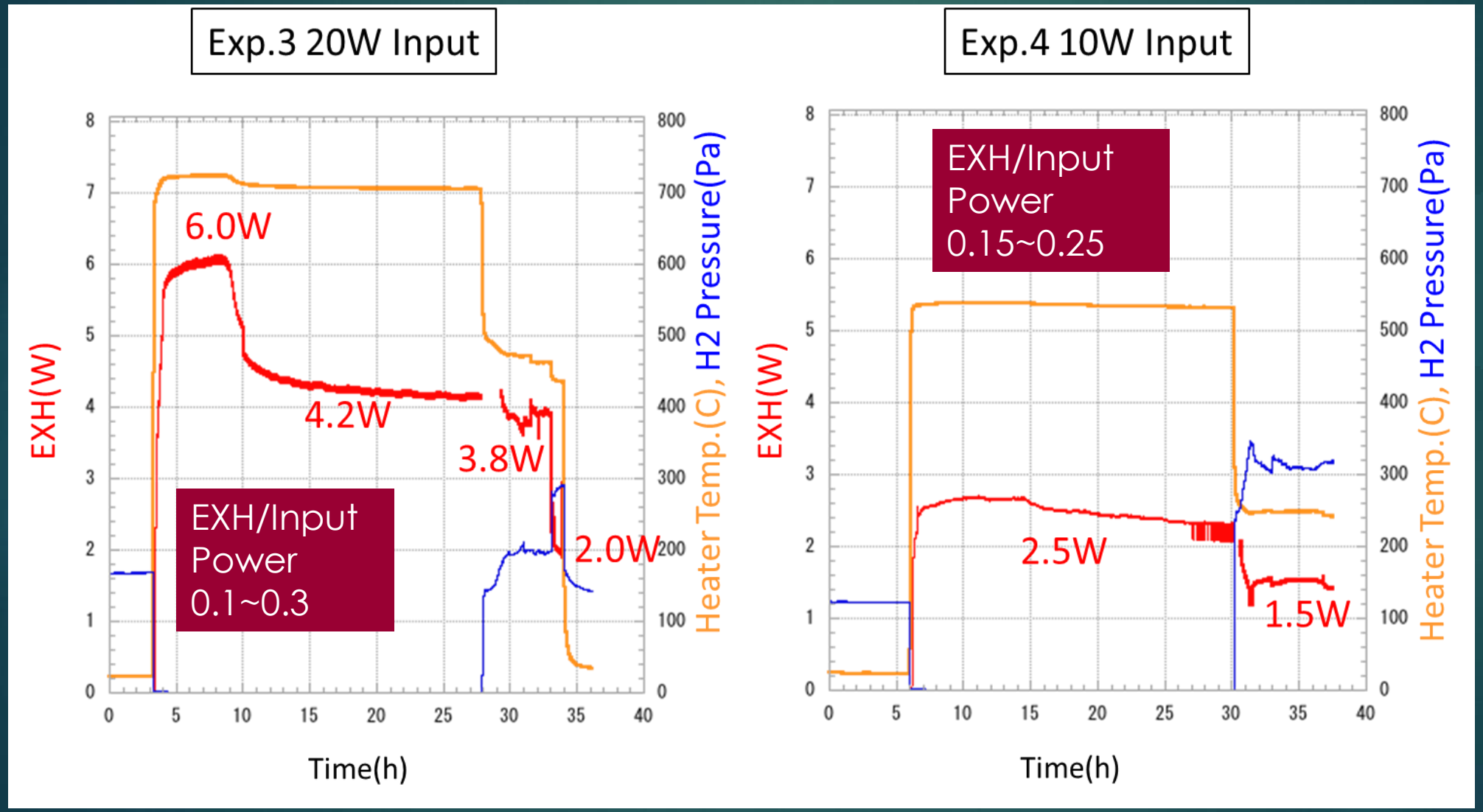
Exp.4 (H_2 Gas) around 500C(10W Input)



ΔT～52℃
at 1 Pa

ΔT～30℃
at ~320 Pa

Excess Heat of H_2 Gas Experiments



Concluding Remarks

- A new experimental setup based on the **Mizuno's work** was introduced in our lab in order to confirm the anomalous heat effects.
- For all the cases except for an insufficient nano-structured Pd/Ni case, **significant temperature increases** compared to reference experiments were observed. It is possible that we **successfully replicated Mizuno's work**.
- Experimental and numerical results strongly suggest that **anomalous excess heat** was generated by the **interaction between nano-structured Pd/Ni surface and D_2 or H_2 gas.**
- According to EDS analysis, **a lot of elements** were detected on the nano- structured surface. It suggests that **transmutation reactions played some roles** for the observed anomalous excess heat generation, however, **further analysis is necessary** to obtain a solid conclusion.

Acknowledgement

- The authors would like to appreciate Dr. T. Mizuno for his valuable advice.
- The authors would like to acknowledge Prof. Hidetoshi Hashizume and Prof. Noritaka Yusa for their corporations on the numerical analysis.
- All the activities are supported by CLEAN PLANET Inc. and Research Center for Electron Photon Science, Tohoku University.
- The author would like to appreciate Mr. H. Yoshino, Mr. M. Hattori and S. Hirano for their supports.

Back up Slides

Condensed Matter Nuclear Reaction Division (April 2015 ~)

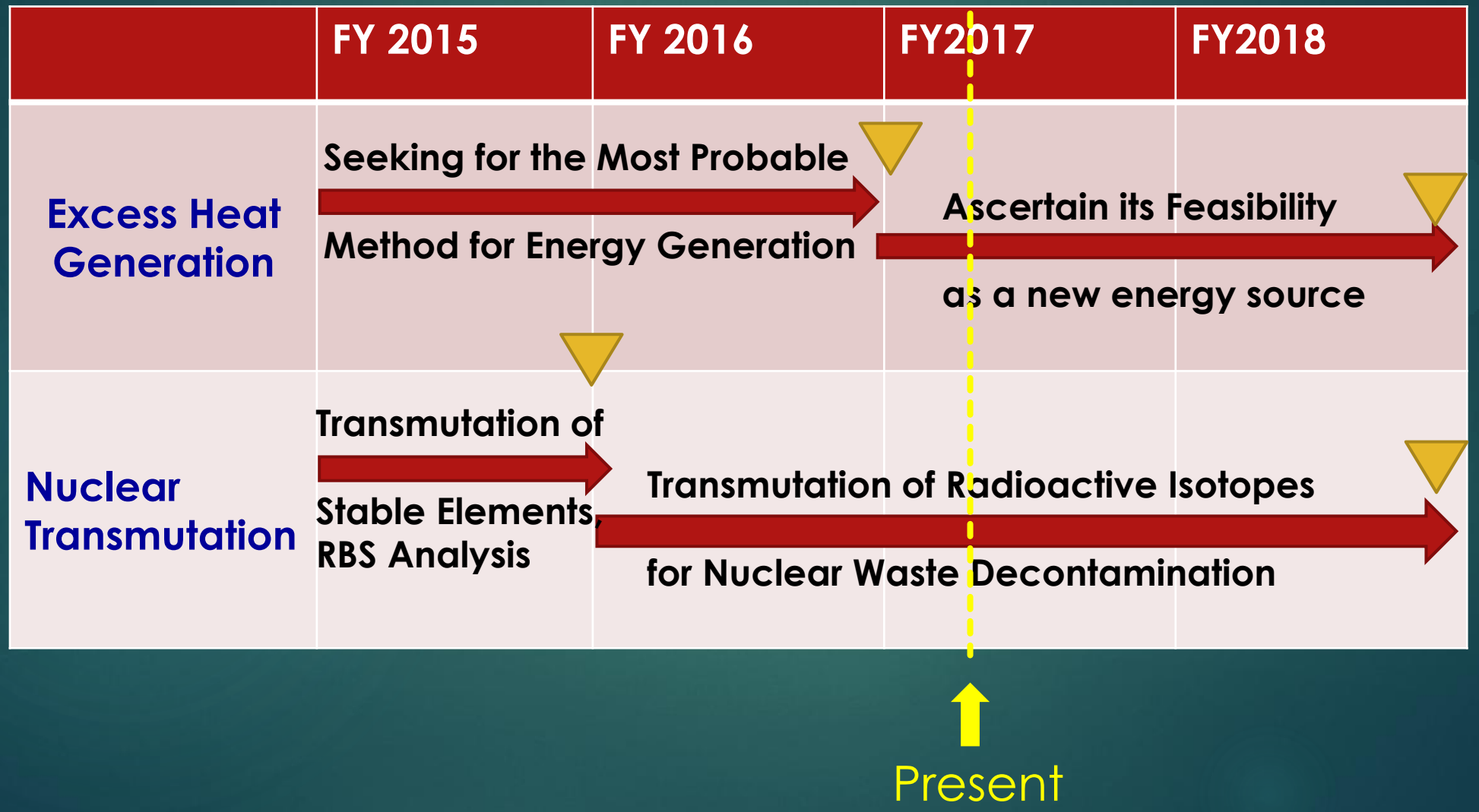
It belongs to

Research Center for Electron Photon Science,

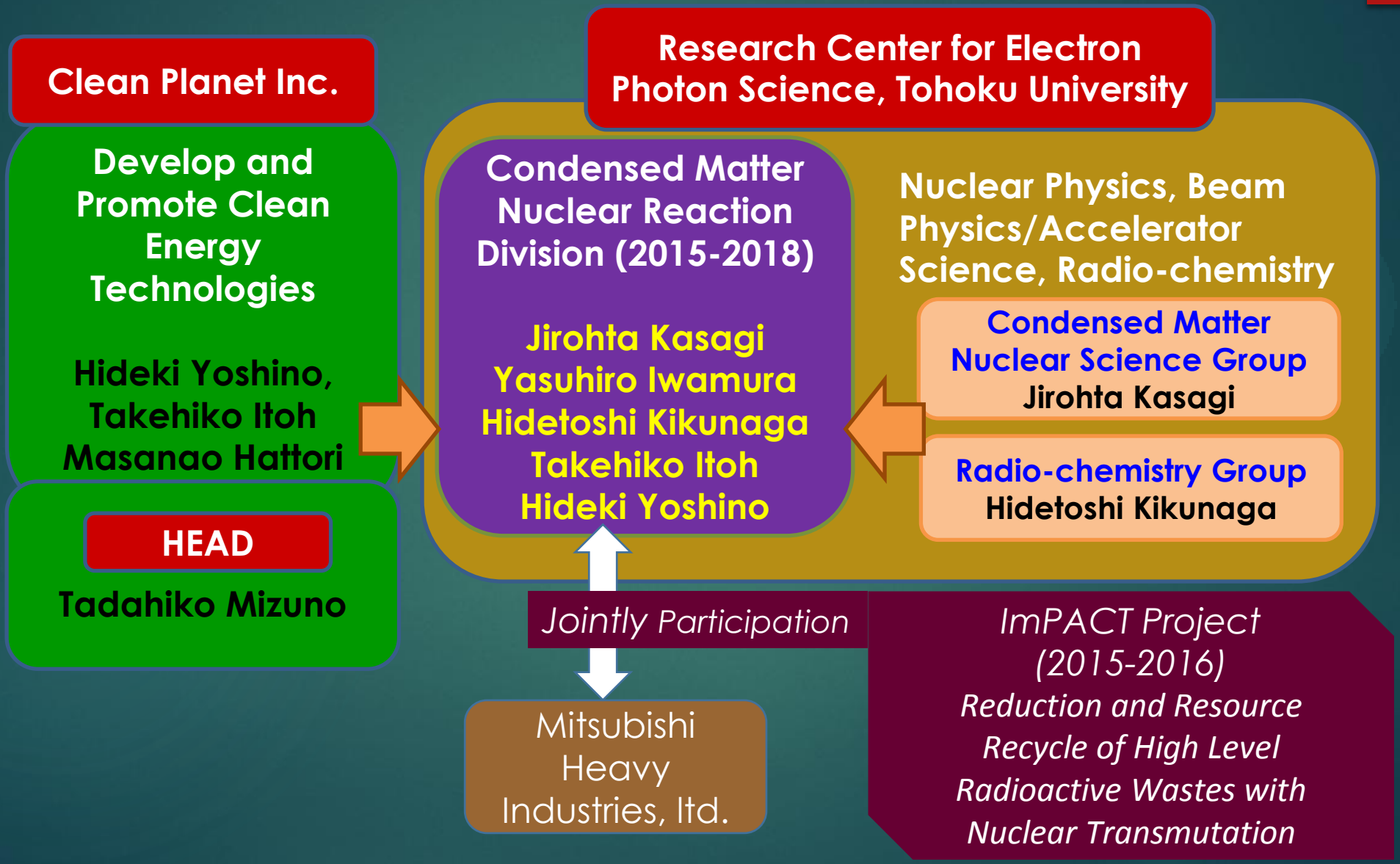
Tohoku University, Sendai, Japan

Research Center for Electron Photon Science

Outline of Research Plan



Organization of the Division



Merit of the Present Method

Conventional Transmutation

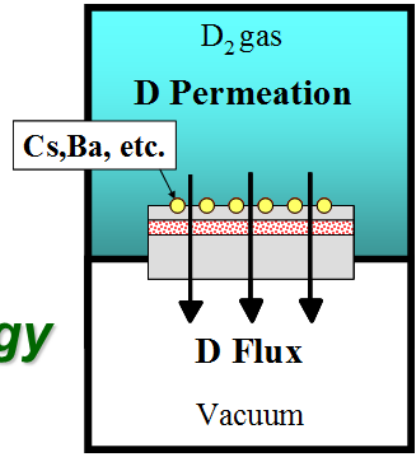
Requires a large apparatus such as an accelerator and a nuclear reactor

Permeation Induced Transmutation

Nuclear Transmutation can be induced only by deuterium permeation through our original nano-structured Pd multilayer film

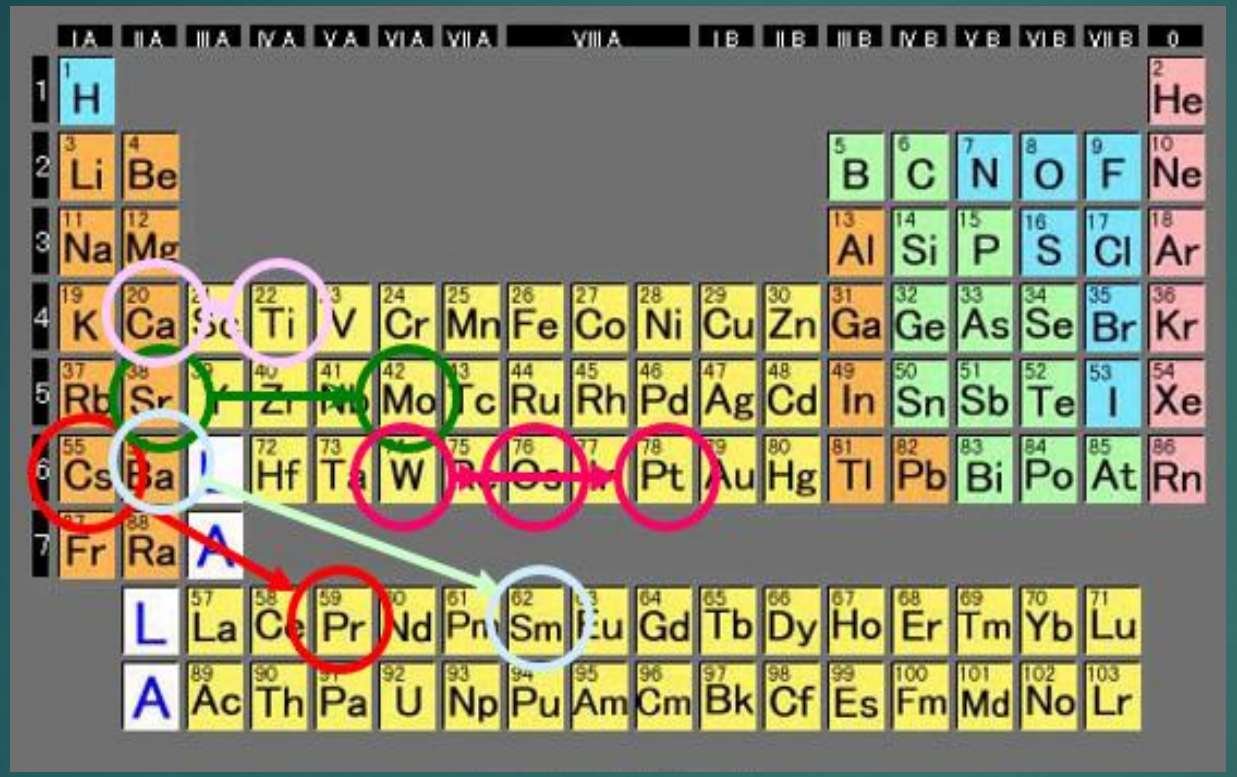
Compact

Low Energy



60-80 C
~1atm

Summary of Transmutation Reactions observed so far



1)Alkali metals; Electron Emitter
2)2d, 4d, 6d; α capture reactions

$$^{133}_{55}Cs \xrightarrow{4d\,(2\alpha)} {}^{141}_{59}\mathrm{Pr}$$

$$^{138}_{56}Ba \xrightarrow{6d\,(3\alpha)} {}^{150}_{62}Sm$$

$$^{137}_{56}Ba \xrightarrow{6d\,(3\alpha)} {}^{149}_{62}Sm$$

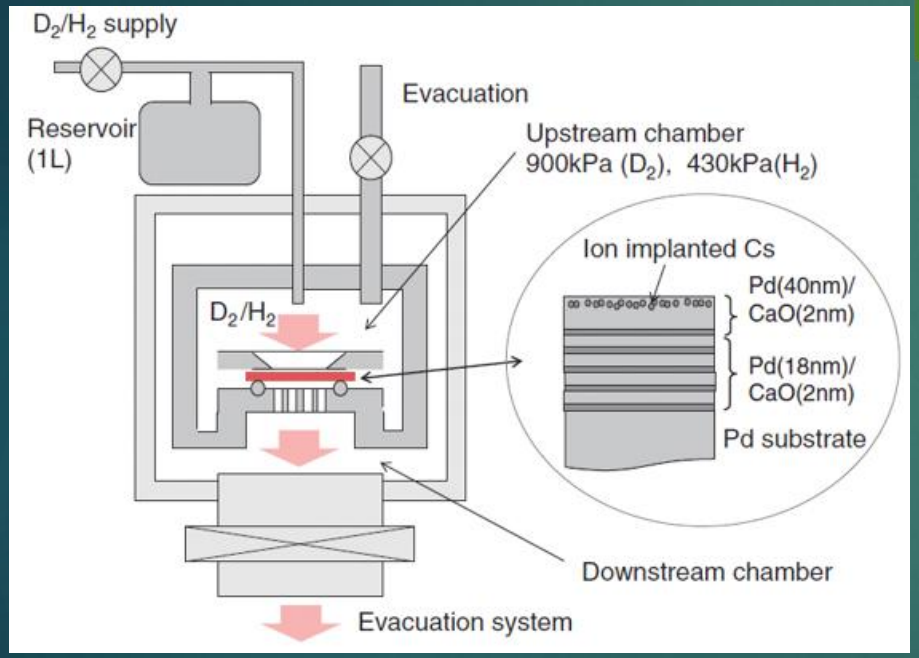
$$^{88}_{38}Sr \xrightarrow{4d\,(2\alpha)} {}^{96}_{42}Mo$$

$$^{44}_{20}Ca \xrightarrow{2d\,(\alpha)} {}^{48}_{22}Ti$$

$$^{182}_{74}W \xrightarrow{4d\,(2\alpha)} {}^{190}_{78}Pt$$

Y. Iwamura, T. Itoh and S.Tsuruga, *Current Science*, Vol. 108, NO. 4, p.628-632, 2015.

Independent Reproduction Experiments by Toyota Central R&D Labs



T. Hioki et.al, *Jpn. J. Appl. Phys.* **52**(2013) 107301

$2.5X10^{12}/cm^2$

Pr

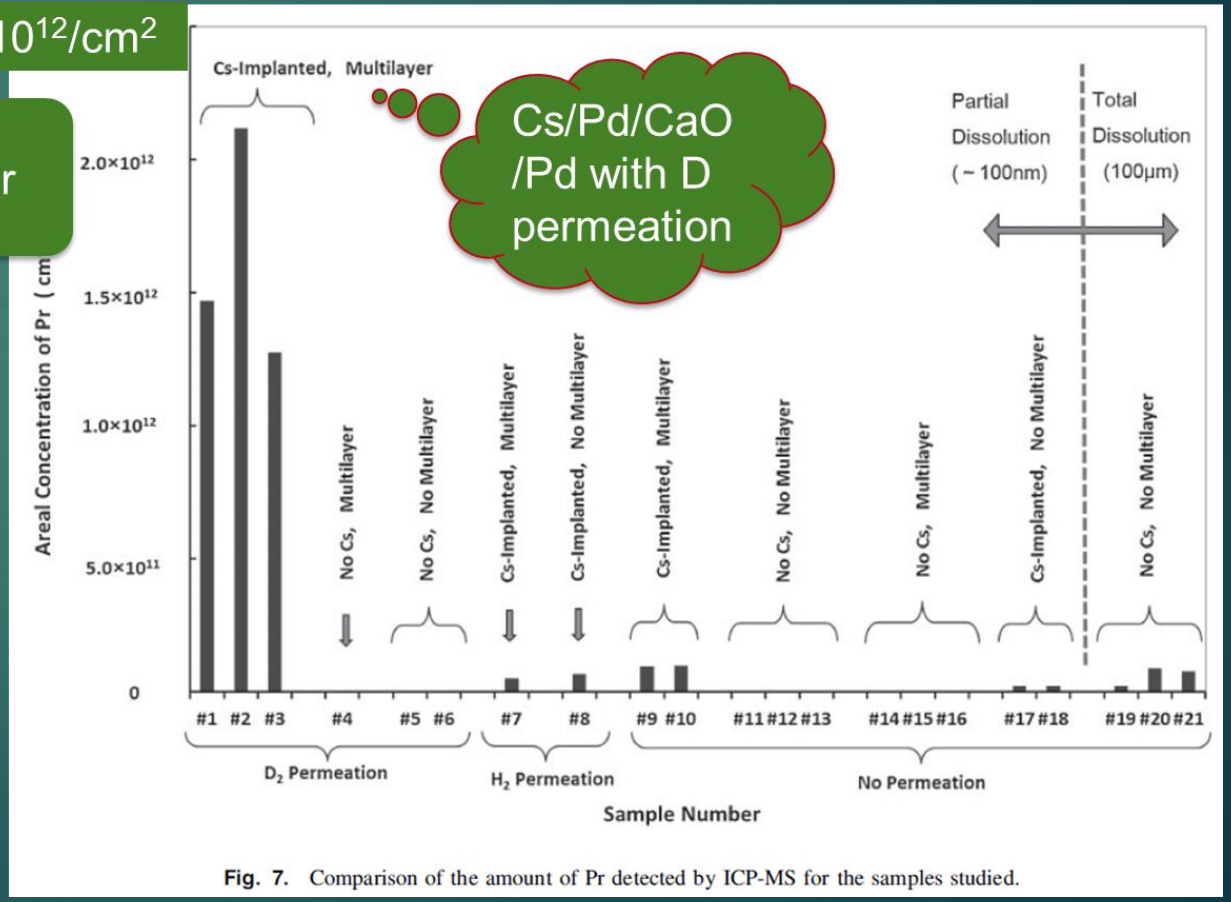
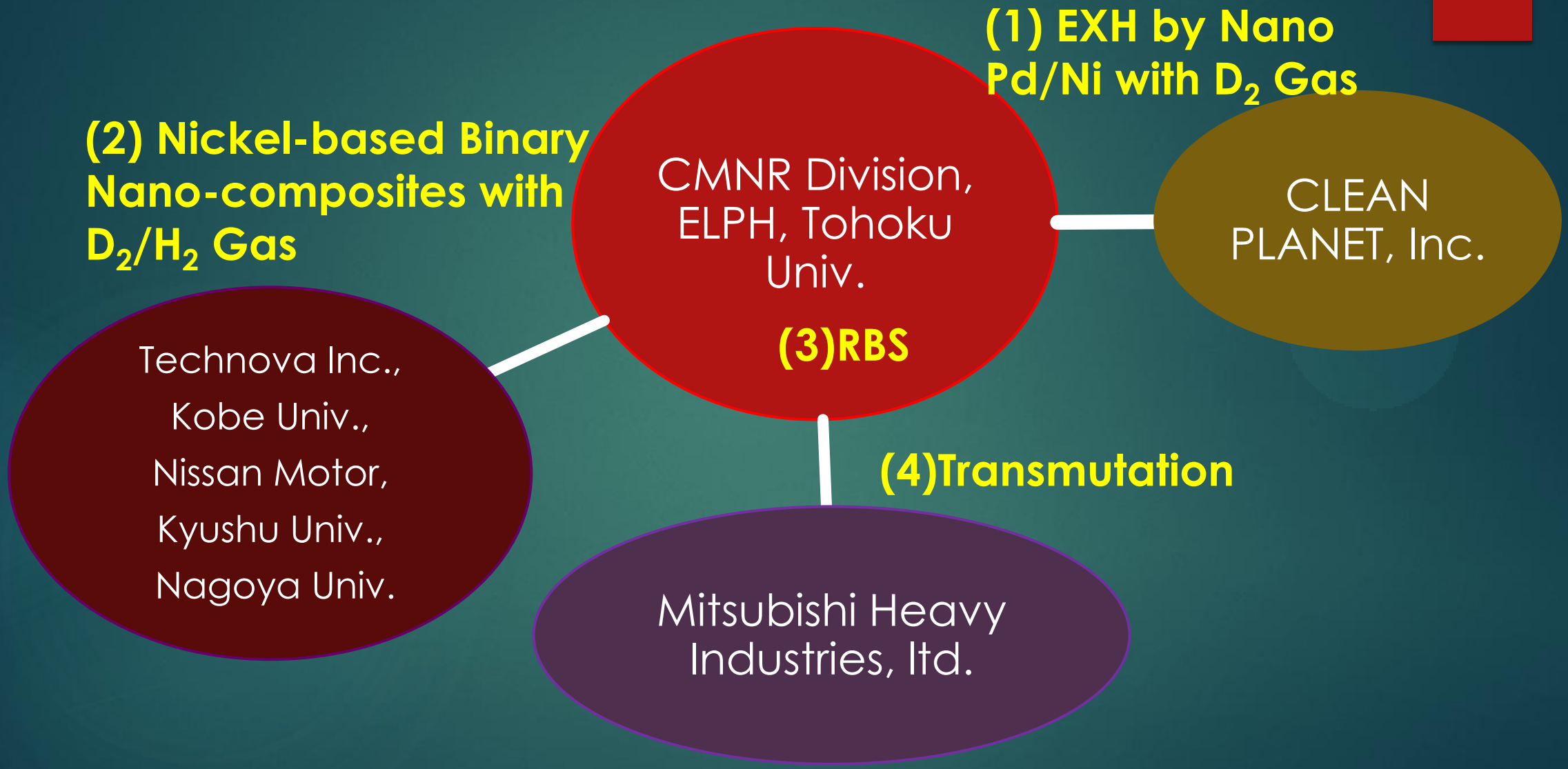
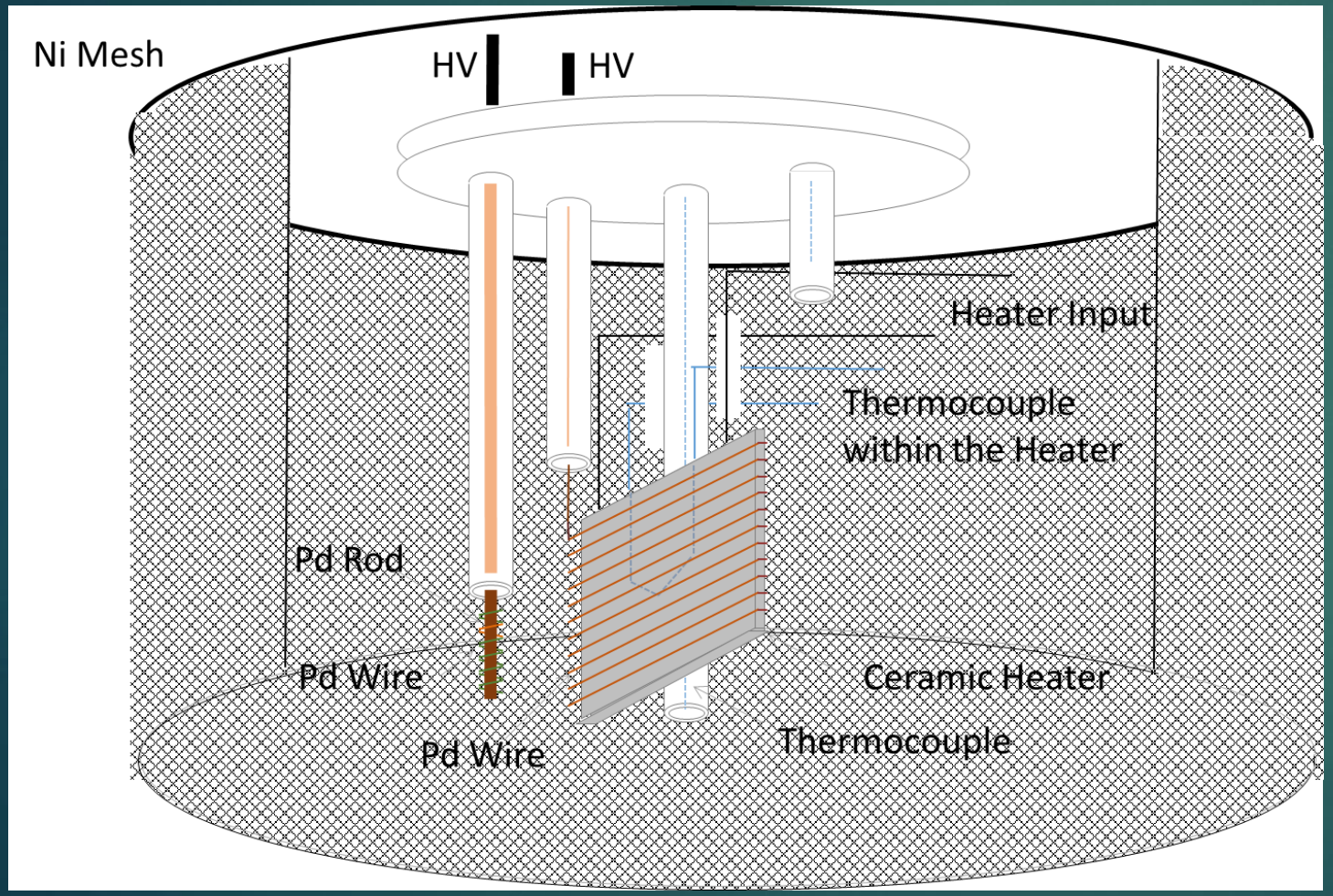


Fig. 7. Comparison of the amount of Pr detected by ICP-MS for the samples studied.

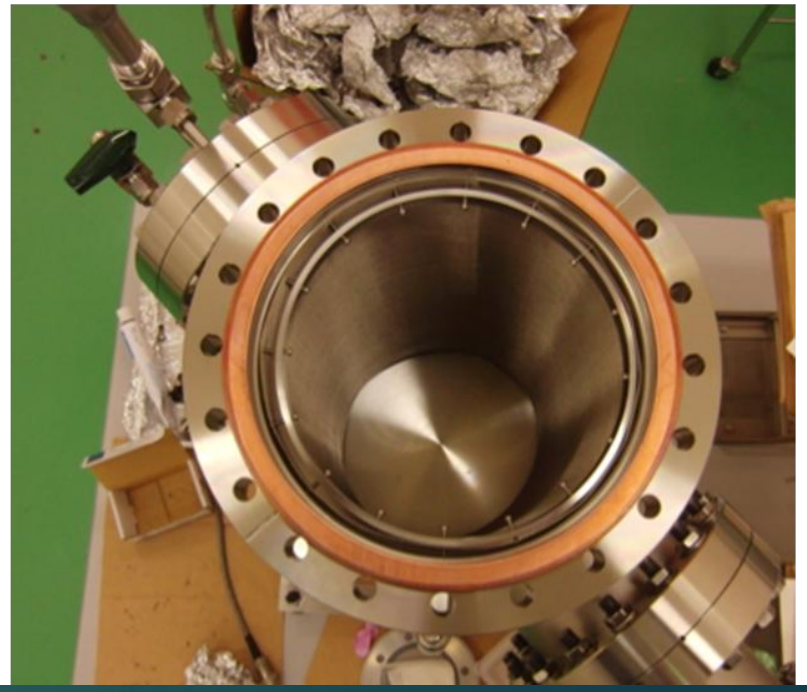
Today's Talk: Collaborative Relationship



Ni mesh



Inside of the Chamber
Ni Mesh located at the inner wall



Experimental Setup