Excess Heat Production During D_2 Diffusion Through Palladium

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Quote

A theoretician is the only one who believes in his theory. Everybody else doubts.

An experimentalist is the only one who doubts in his experiment. Everybody else believe.

Summary

1-Objective

2-First experimental set-up

3-Experimental results

4-Second experimental set-up

5-Experimental results

6-Model

7-Conclusion

Reproduce Arata's D2 gas/Pd nano-powder experiment :

1- Produces large excess heat, large COP, long duration.

2- Has been reproduced by SRI in the electrolytic design, and partly by Celani et al. in the gas phase design.

3- Better suited than electrolysis for potential applications.

Palladium nano-powder manufacturing recipe:

1- Produce a Pd-Zr alloy (arc melting).

2- Melt-spin the alloy to produce an amorphous film.

3- Oxidize the amorphous film and obtain Pd-ZrO_2 nano powder.

We do not have the capacity to do it in our lab

Previous work :

1- Fralick et al. NASA, 1989.

2- Li et al.

Our objective :

1- Test various surface treatments on the palladium tube

2- Test various materials inside the palladium tube

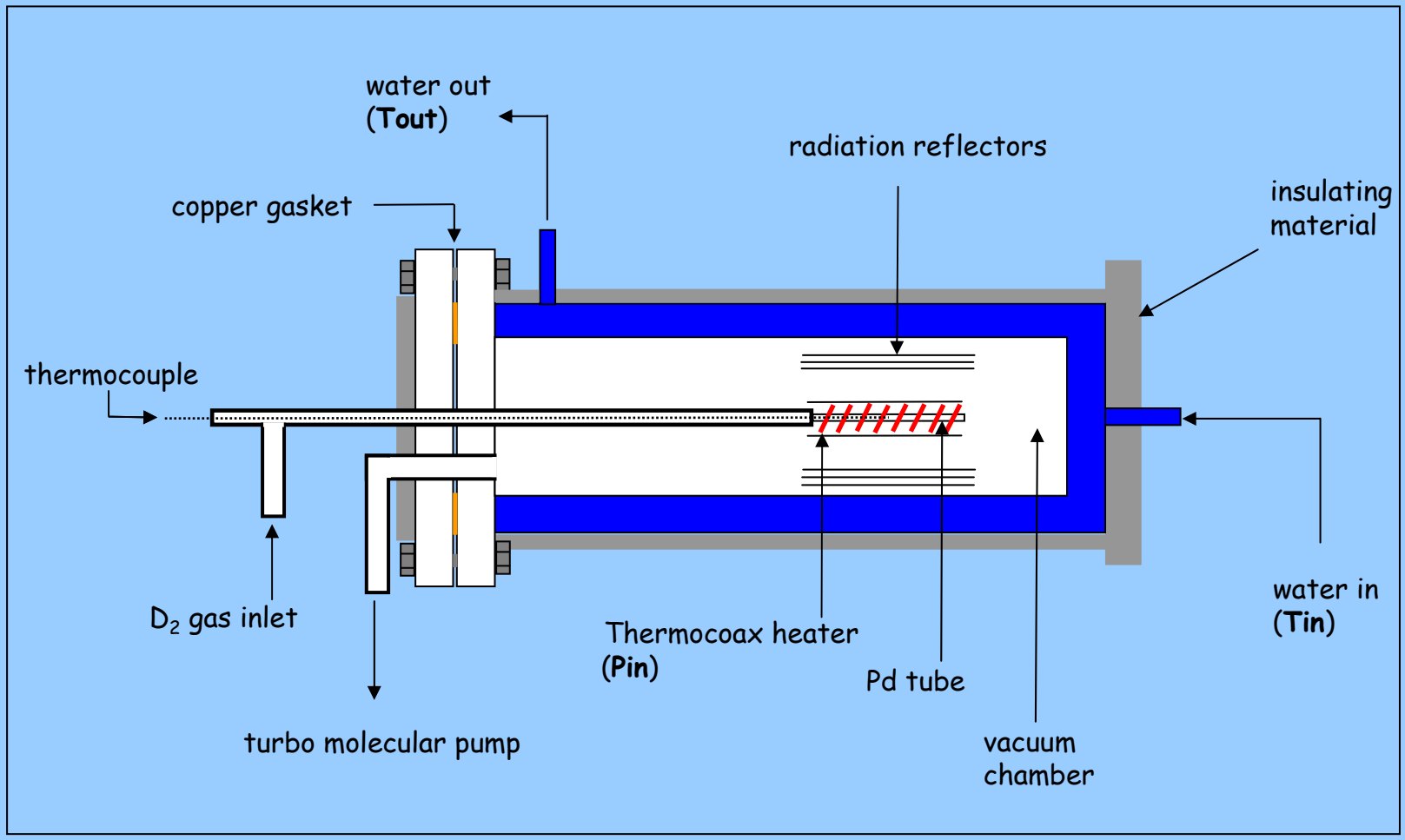
Mass flow calorimetry :

1- No calibration needed.

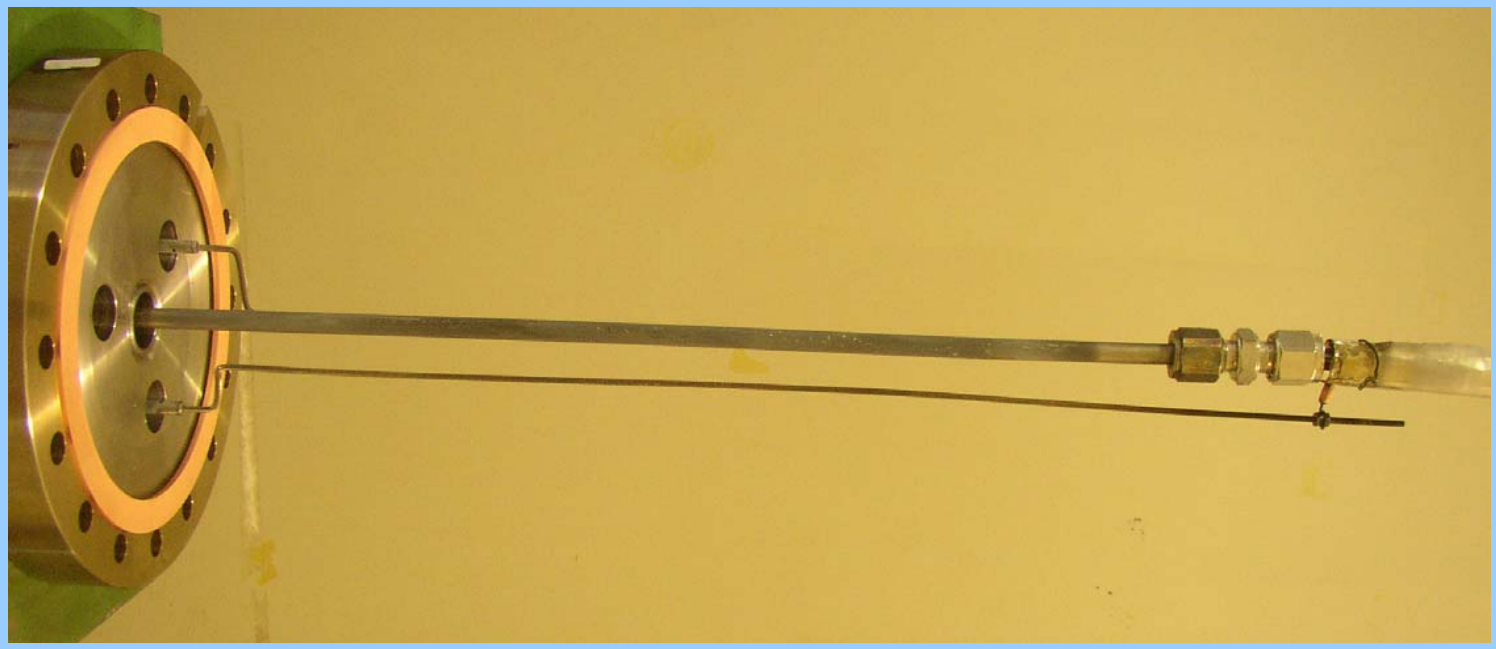
2- Simple to analyze for outsiders.

3- High temperature operation.

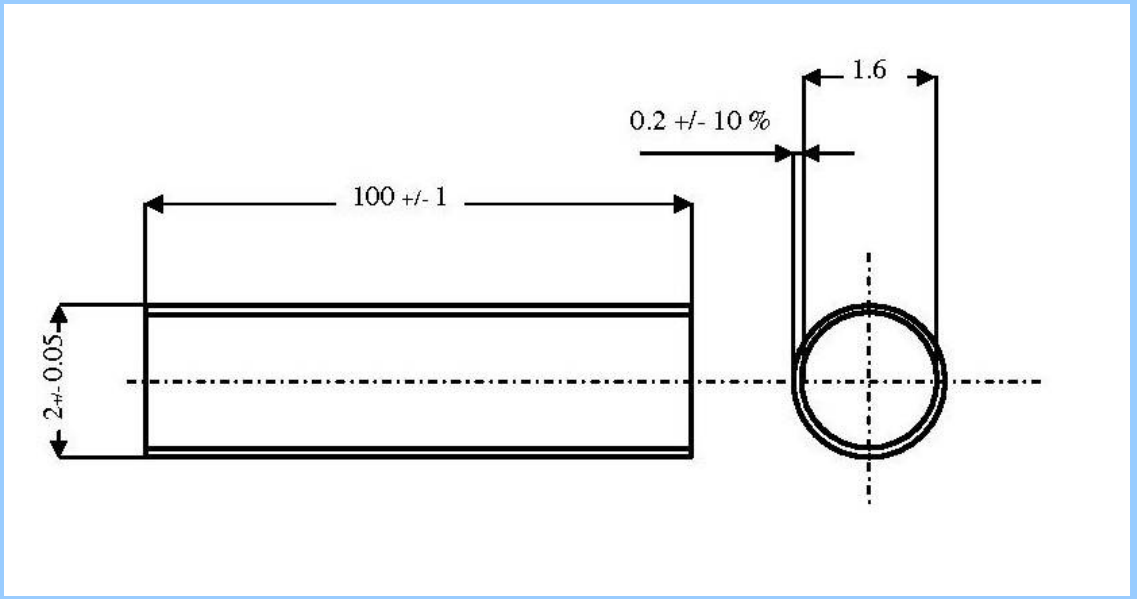
2 - First experimental Set-Up → Calorimeter design



2 – First experimental Set-Up → Flange and D_2 gas tubing



Dimensions



Closed at one end

2 – First experimental Set-Up → Overview

Mass flow : 180ml/min

Water temperature :30°C

Temperature measured with thermistors +/- 0.01°C

Yield :93 to 97%

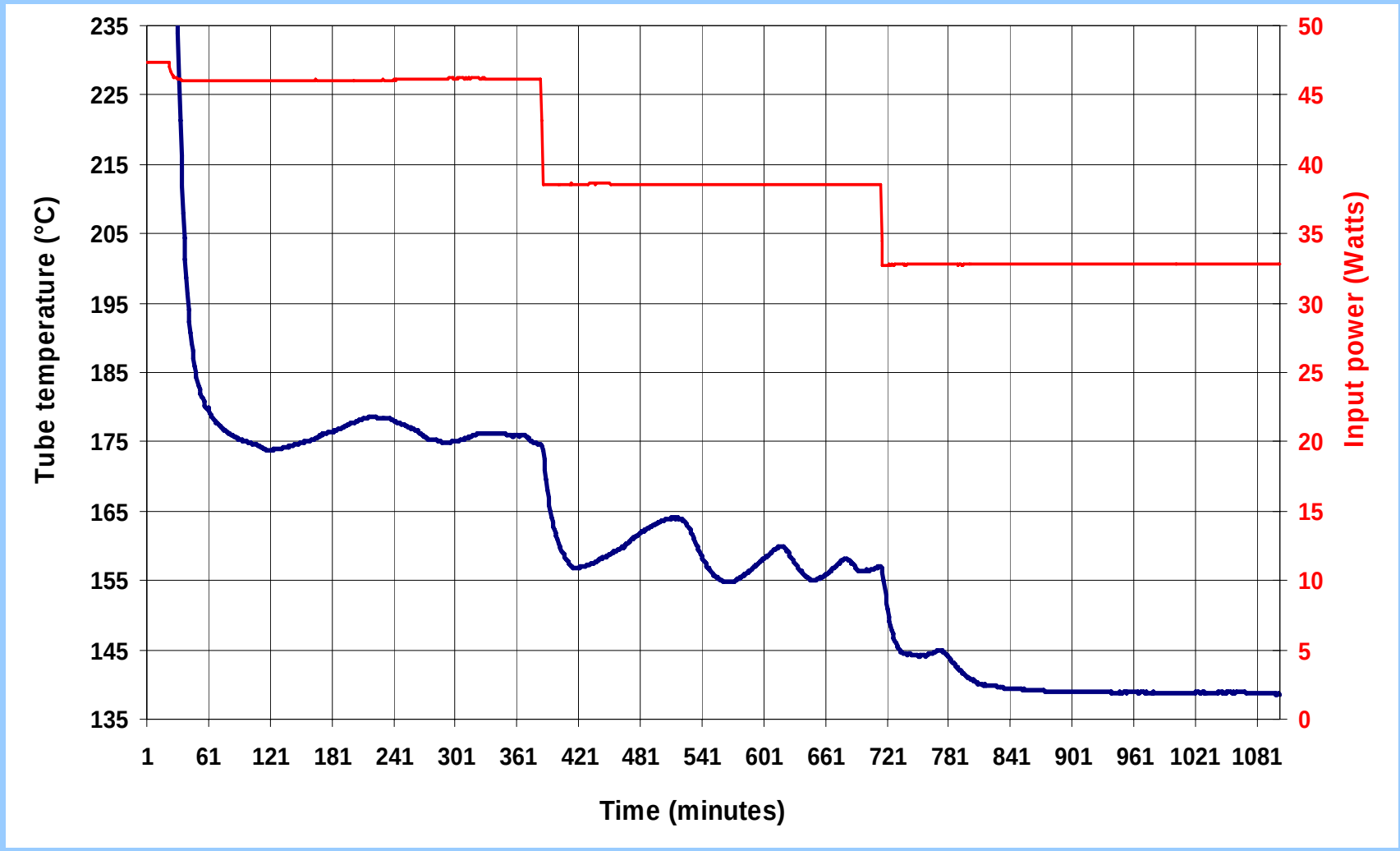
XSH precision:+/- 0.5 Watt

Conditions :

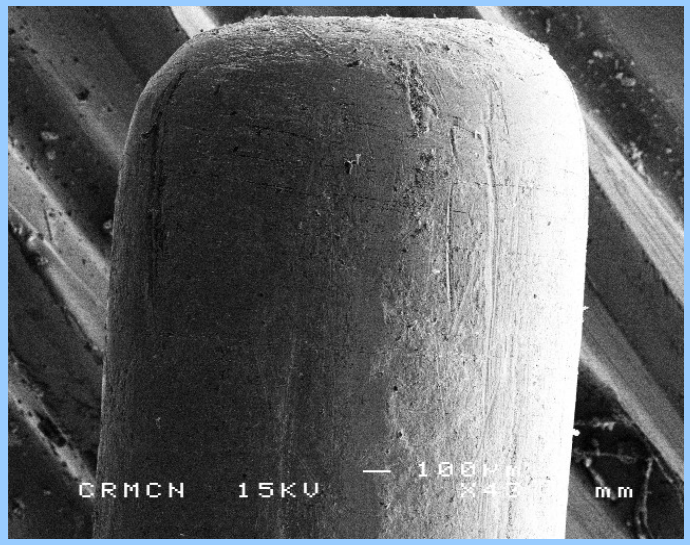
Palladium (purity 99.95%), 2mm diameter : no treatment.

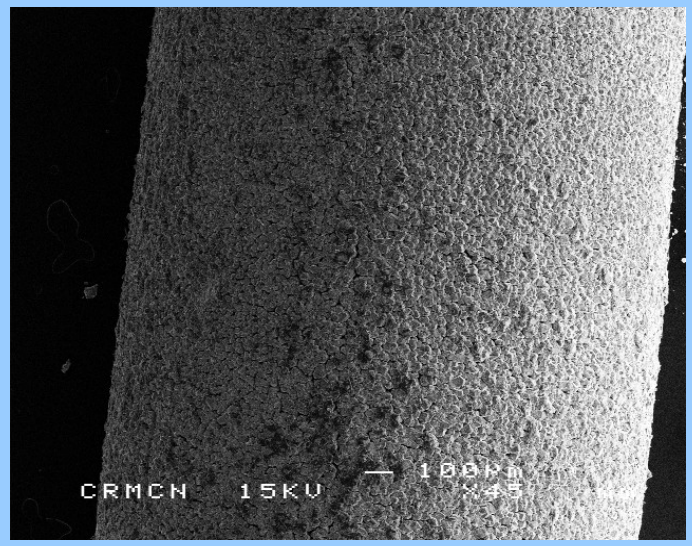
* Upstream D_2 pressure : 3 to 15 atm.
* Downstream D_2 flows /accumulates in reaction chamber.
* Temperature : 30°C to 300°C (max 550°C).

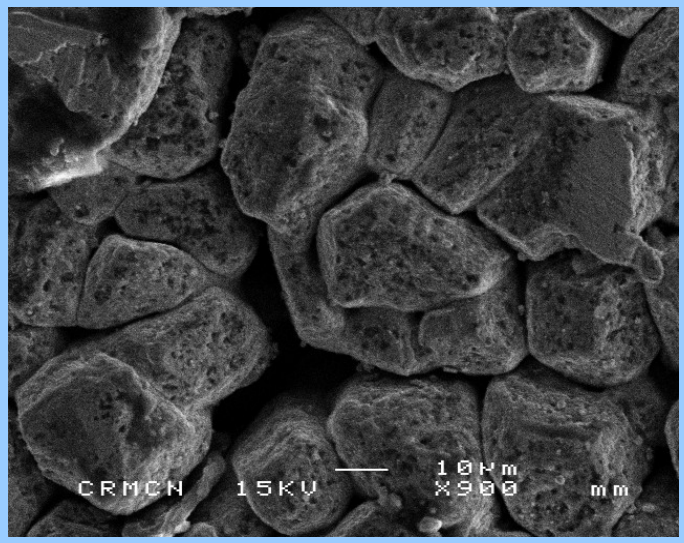
3 - Experimental results → Temperature oscillations run 6

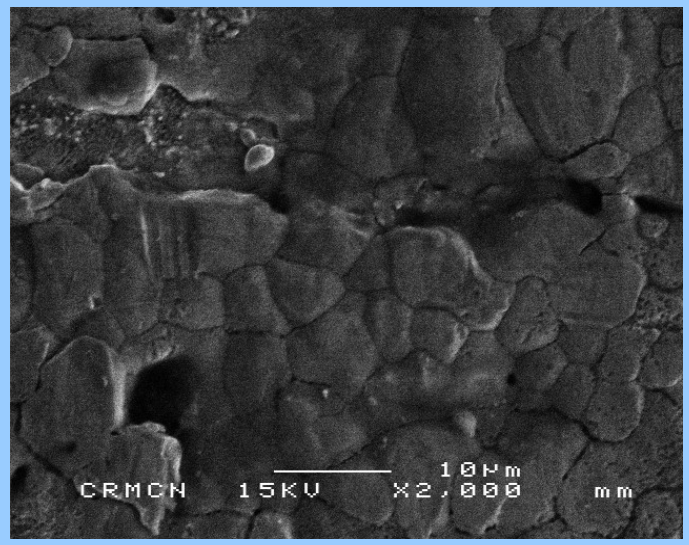


3 – Experimental results → Tube after run 6

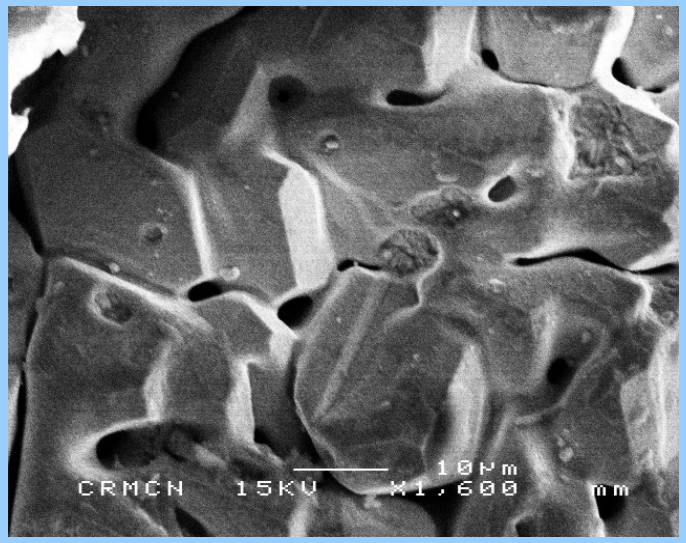


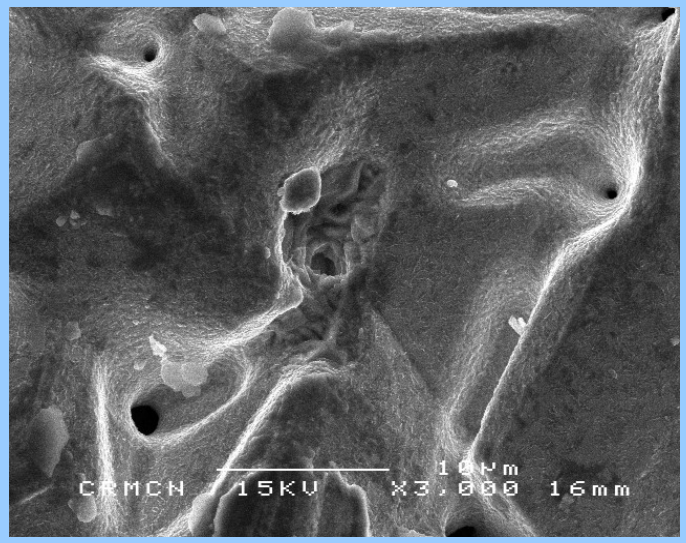


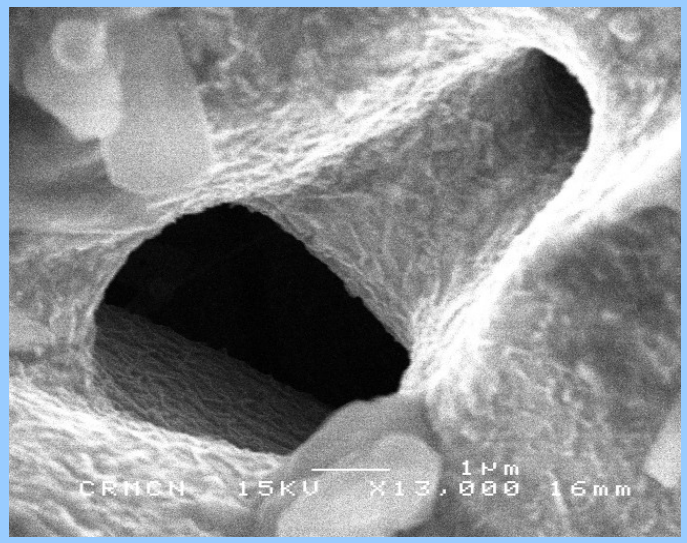




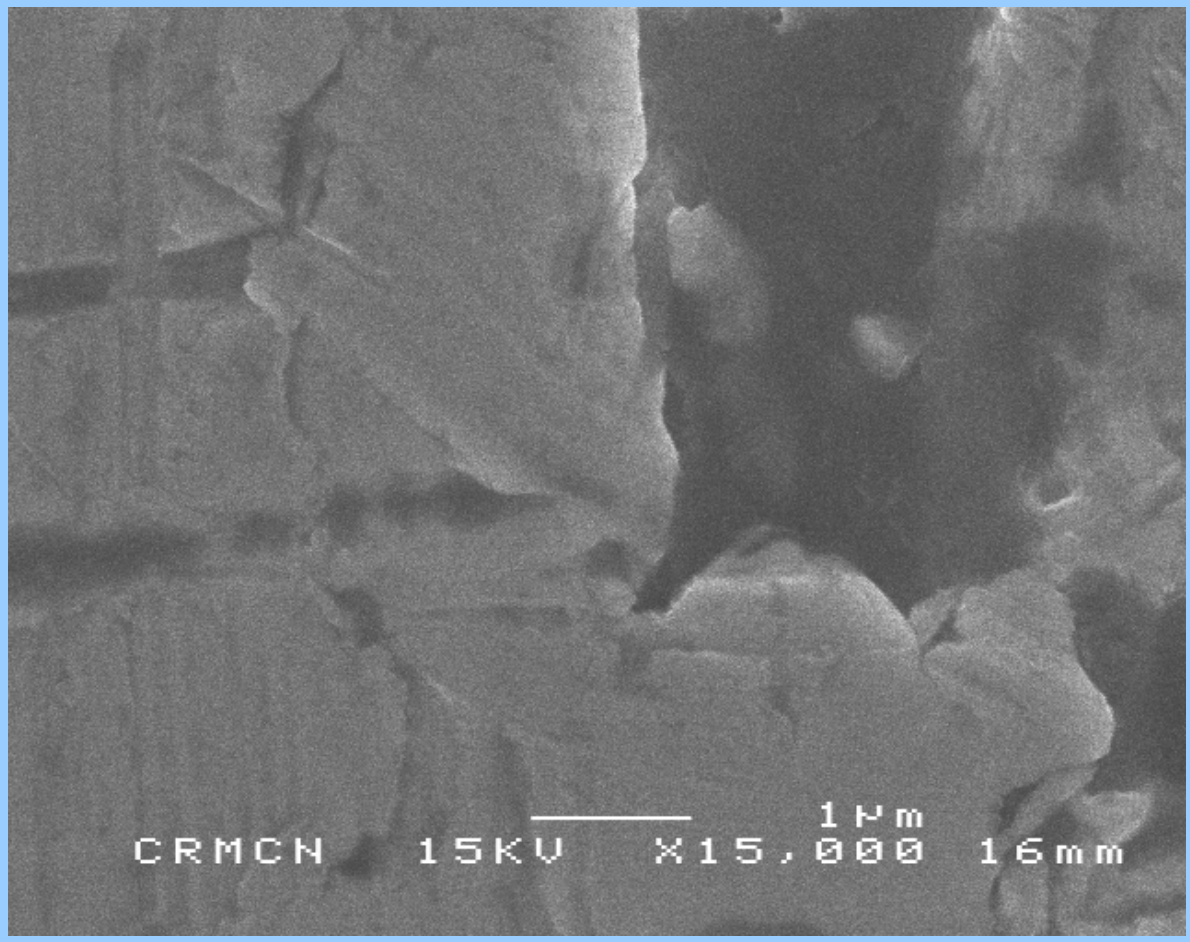
3 – Experimental results → Tube after run 6







3 – Experimental results → Virgin palladium tube

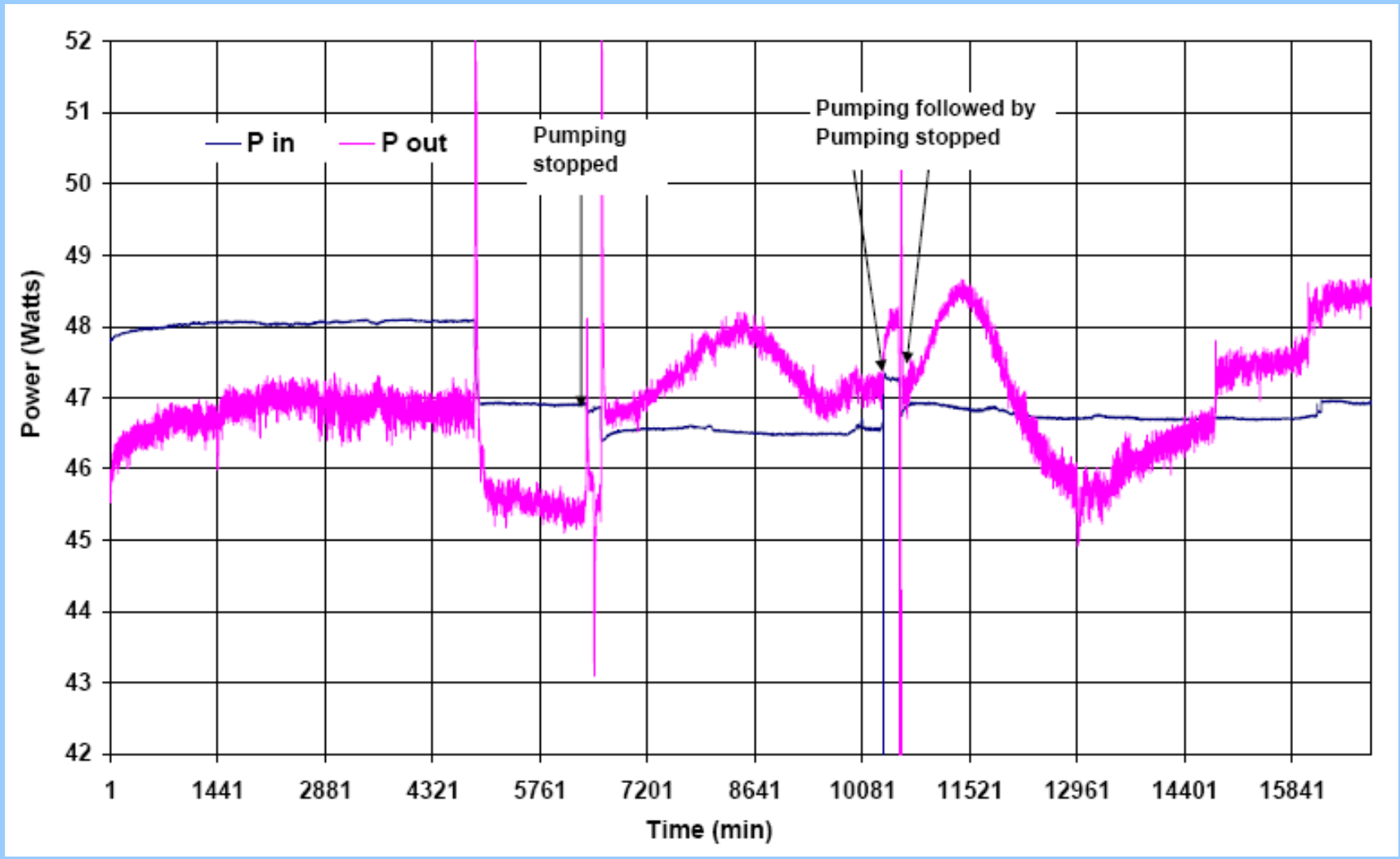


Conditions :

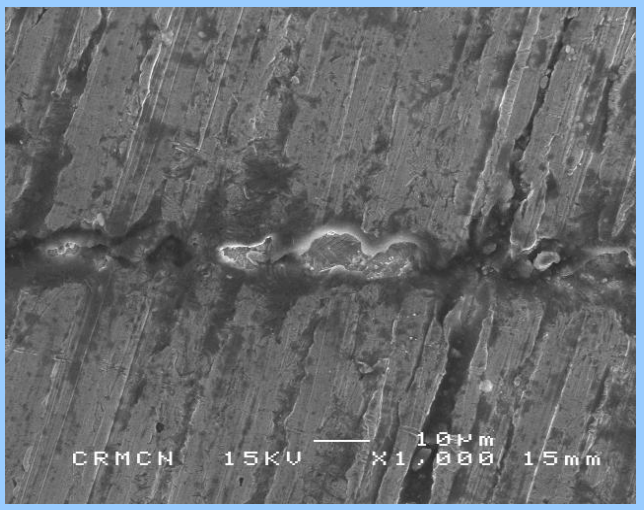
Palladium Tube : oxydized in air ~ 500°C during 2 hours (before filling the palladium powder).

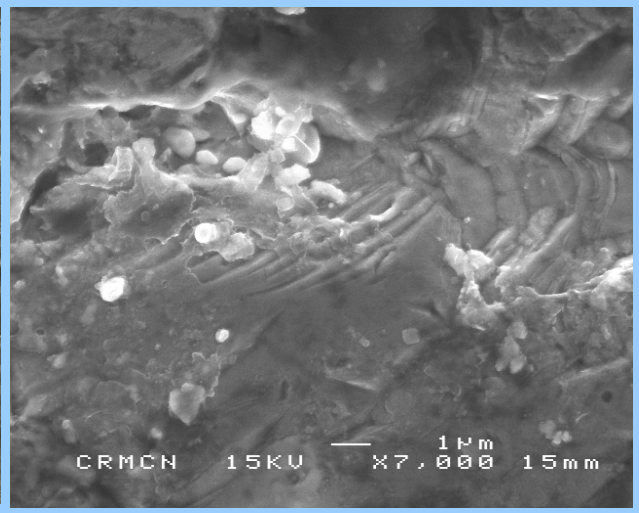
* Palladium powder : 80 – 180 nm Goodfellow (99.95 %) (~100 mg) .
* Upstream D_2 pressure 9 atm.
* Temperature : 80°C.

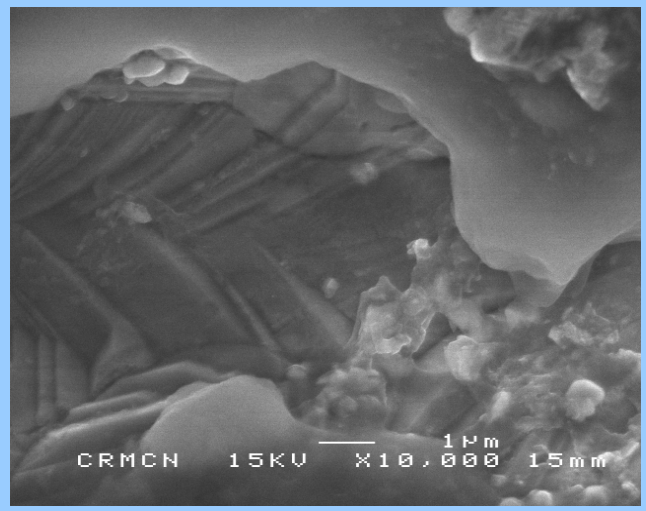
3 – Experimental results → Excess heat run 11

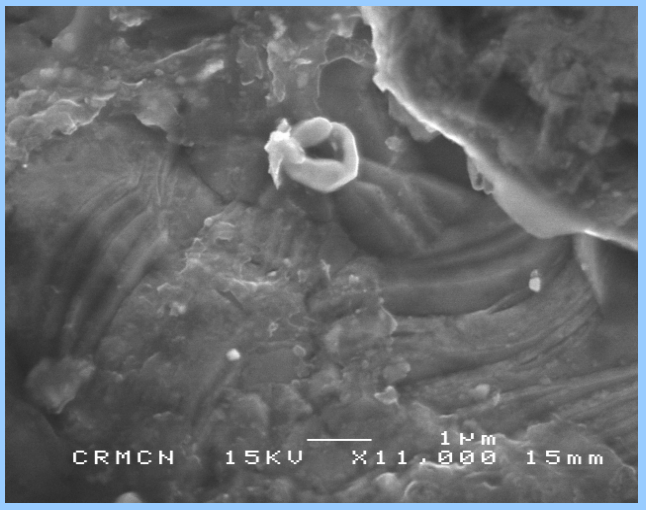


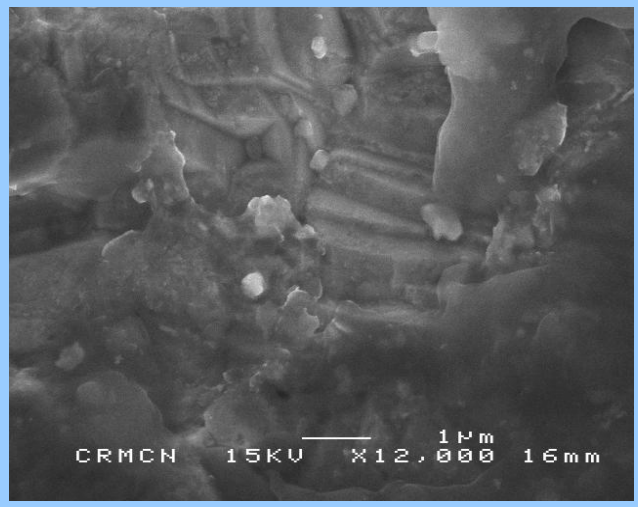
3 – Experimental results → Tube after run 11

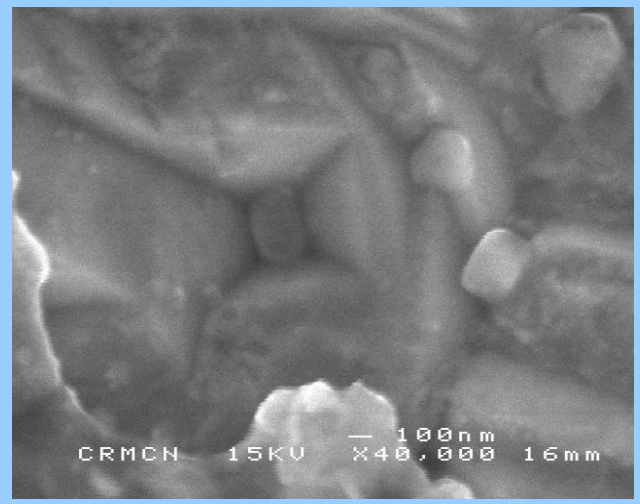




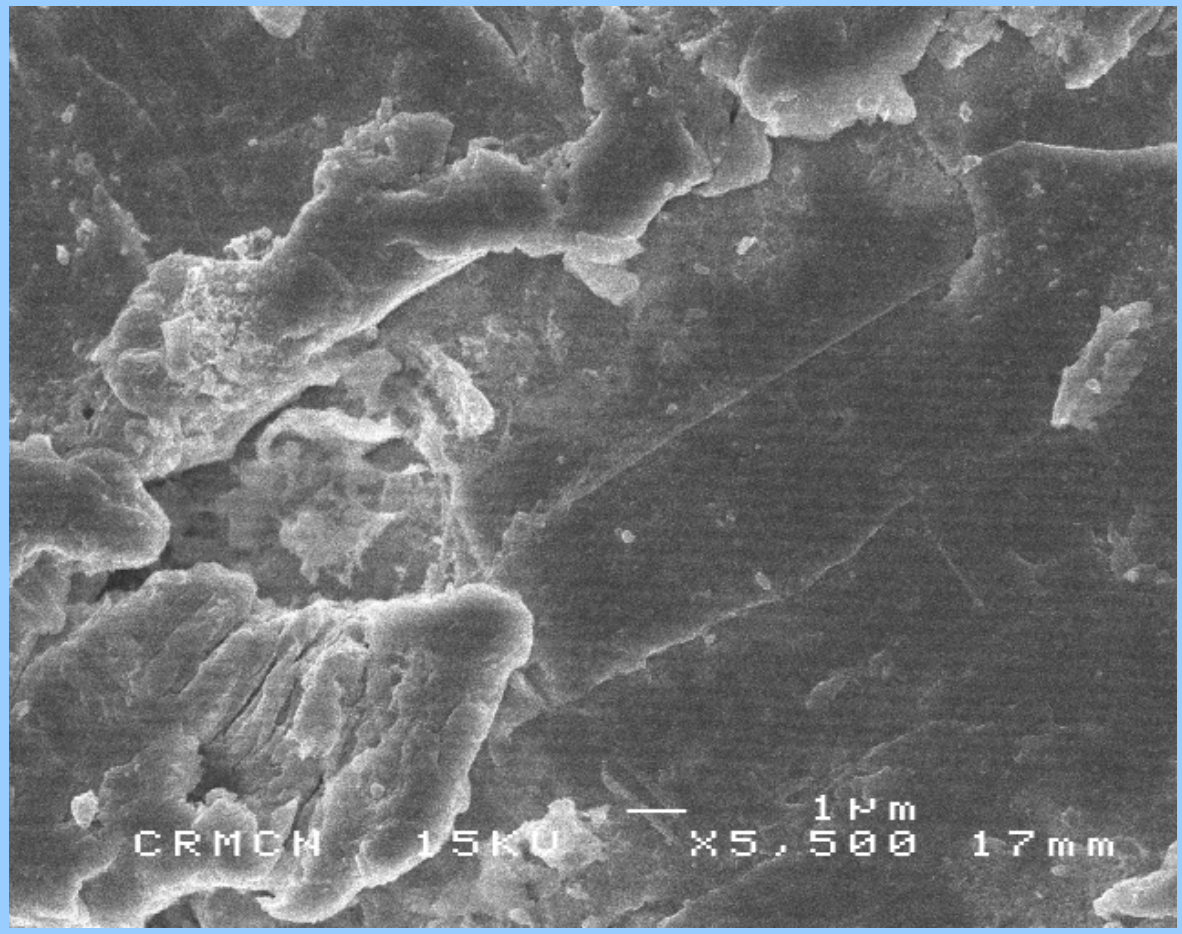




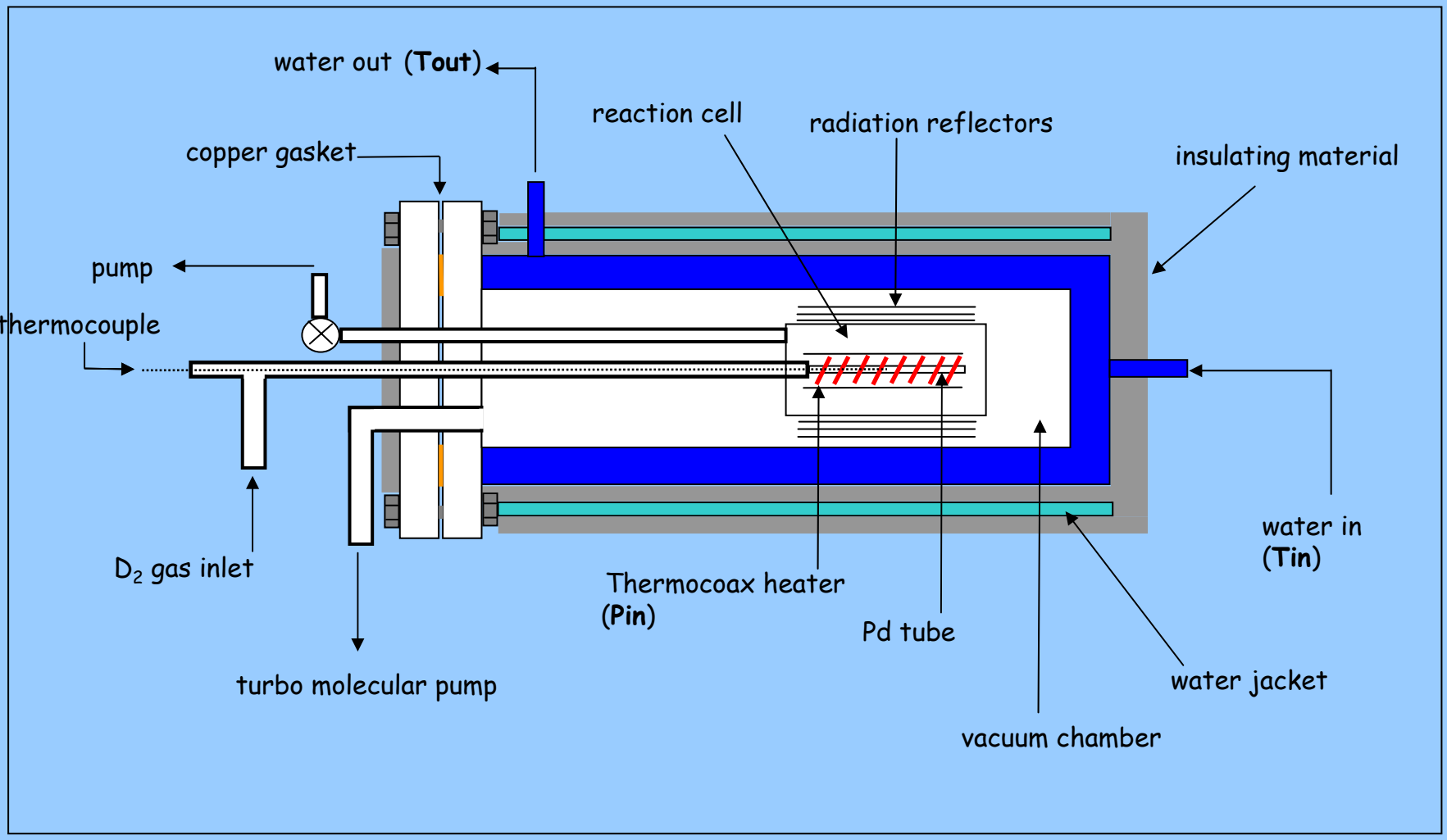




3 – Experimental results → Oxidized palladium tube

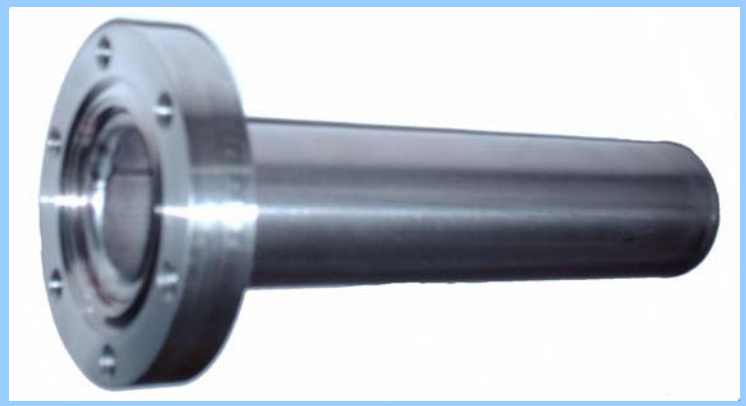


4 – Second experimental Set-Up → Calorimeter design

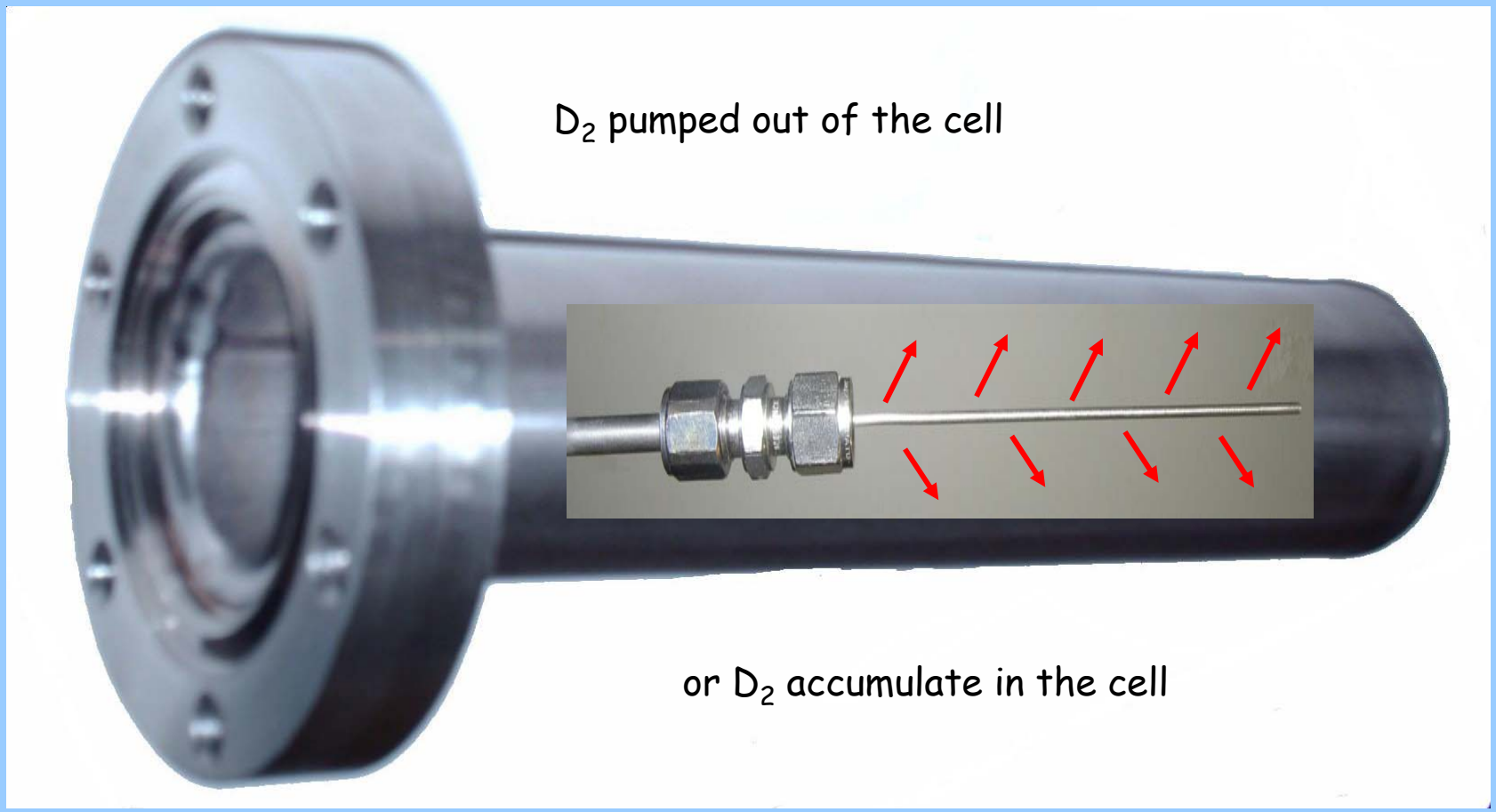


4 - Second experimental Set-Up → The reaction cell

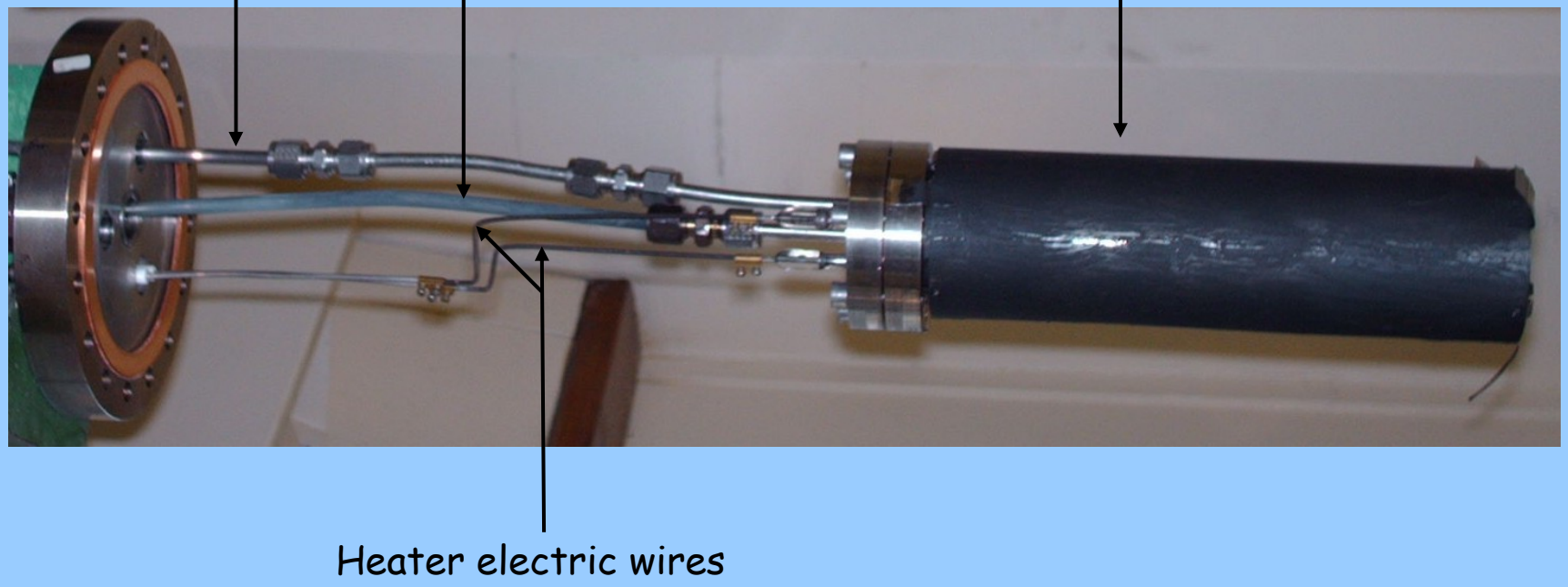
Reaction chamber : to eliminate conduction/convection heat losses



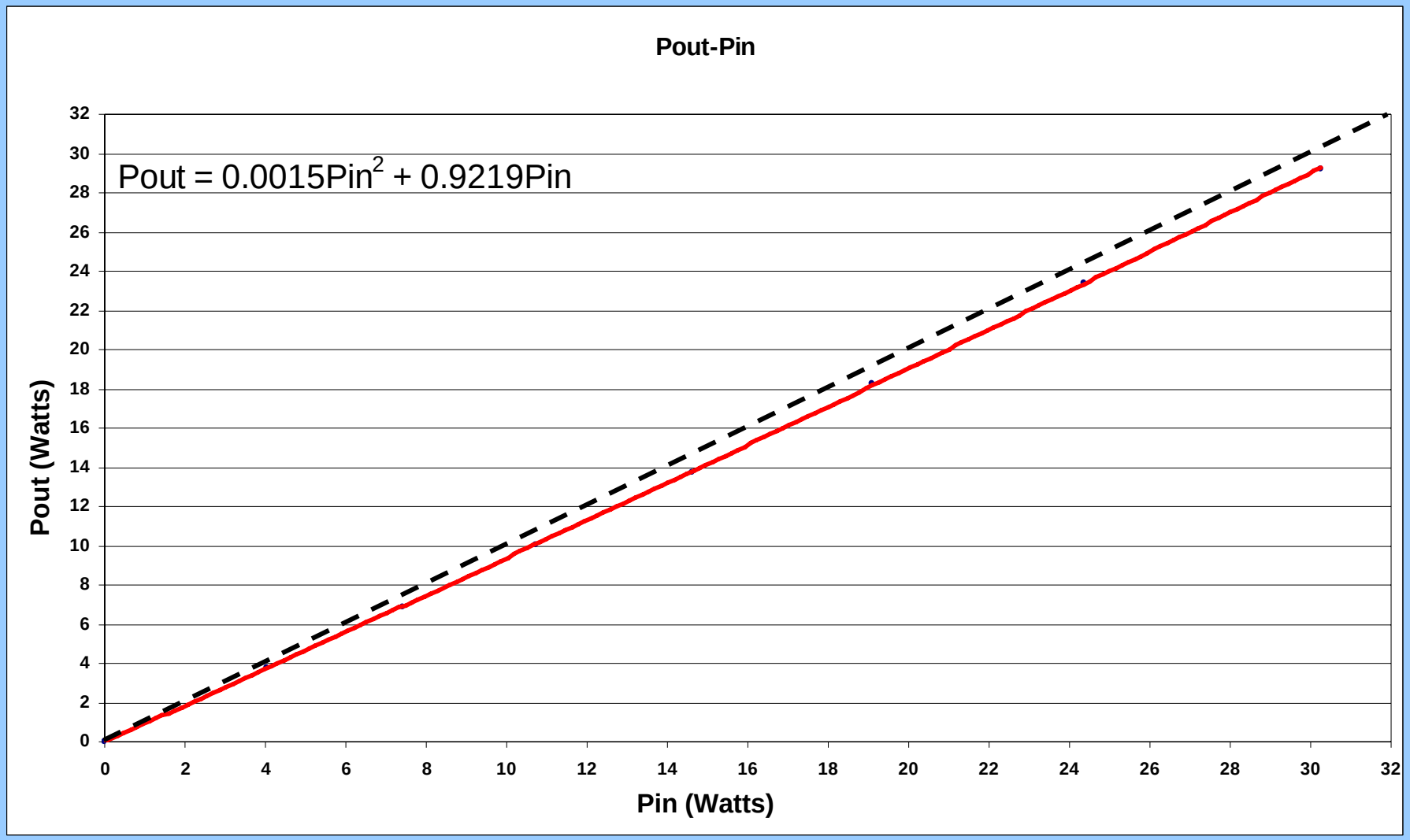
4 – Second experimental Set-Up → D_2 diffuses out of the tube



4 – Second experimental Set-Up → **Complete reaction cell**



4 – Second experimental Set-Up → Pout – Pin Calibration



Conditions :

Titanium was deposited in situ on the outer surface of the palladium tube.

Between the palladium tube and the resistor, a titanium foil was placed, and evaporated while heating with the resistor.

No Excess Heat

Conditions :

Catalyst : Pd 0.6 % on Carbon (from Les Case).

Inside a Palladium tube 2mm diameter 10 cm long (78 mg).

Inside a Stainless Steel tube 4mm id, 10 cm long (1 g).

No Excess Heat

Conditions :

Pd/Ag (30/70), 2mm diameter : no treatment.

* Temperature : 30°C to 300°C (max 550°C).
* Upstream D_2 pressure : 3 to 15 atm.
* Downstream D_2 flows/accumulates in reaction chamber.

No Excess Heat

5 – Experimental results → CETI type beads

Conditions :

Plastic beads similar to CETI beads :

with Cu/Ni/Pd/Ni thin film coatings.

Loaded inside a stainless steel tube 4mm id, 10 cm long (1 g).

No Excess Heat

Conditions :

Palladium powder from Goodfellow (80-180 nm).

Loaded inside a stainless steel tube 4mm id, 10 cm long (1.15 g).

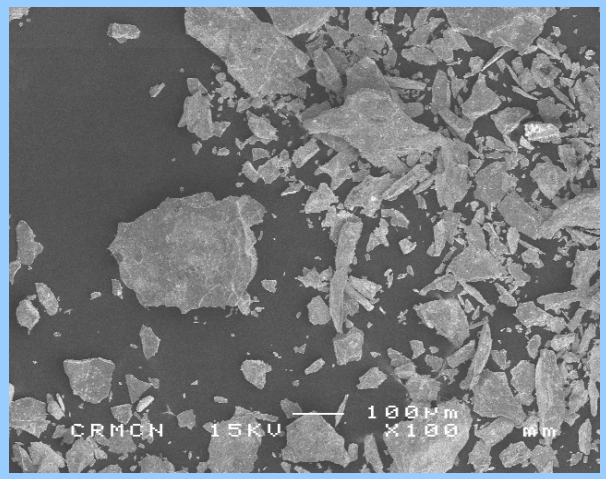
No Excess Heat

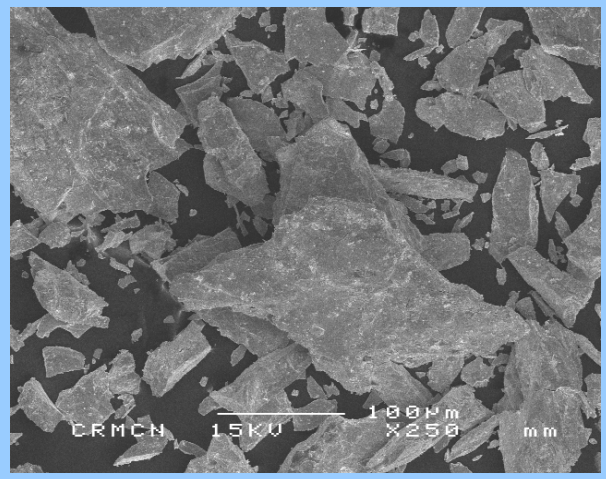
Homemade Palladium nano powder :

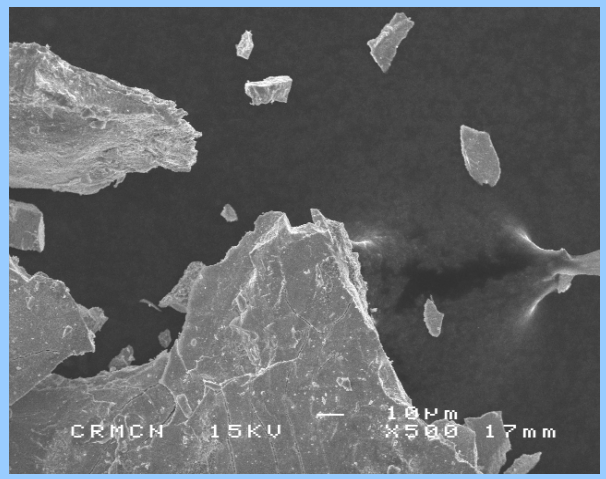
We tried to produce nano particles of palladium by oxidizing a PdZr alloy. So far our attempts have failed.

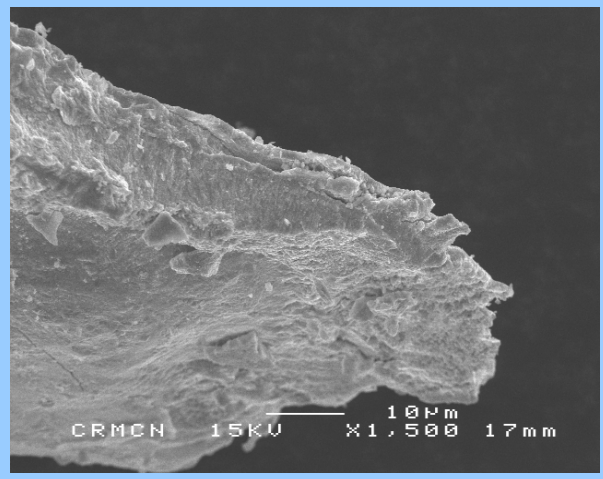
No Excess Heat

5 - Palladium nano powder → Attempt









Reproduce run 11 with second experimental set up :

Palladium Tube : oxydized in air ~ 500°C during 2 hours (before filling the palladium powder).

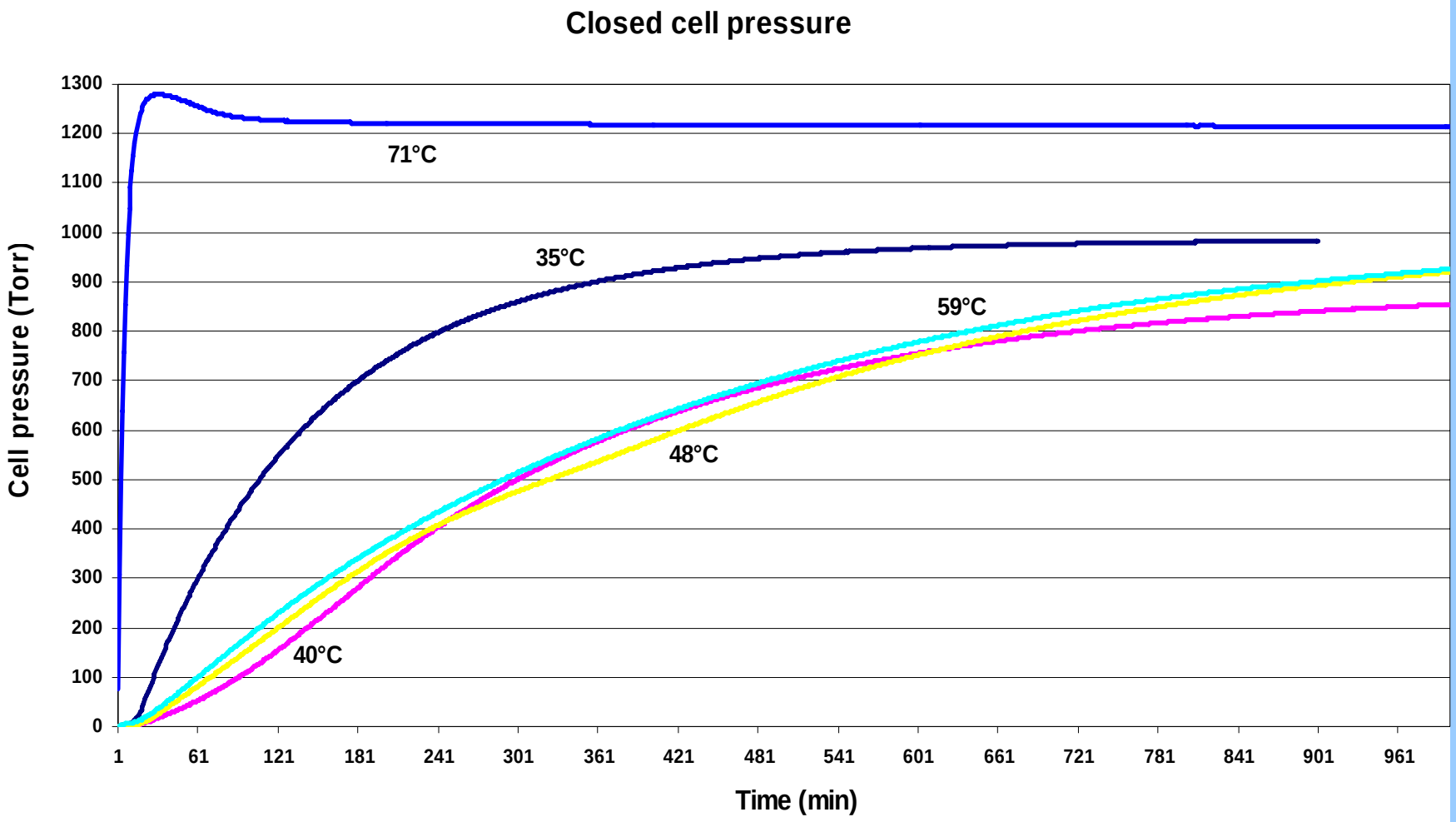
Palladium powder : 80 – 180 nm Goodfellow (~100 mg).

Upstream D_2 pressure 9 atm.

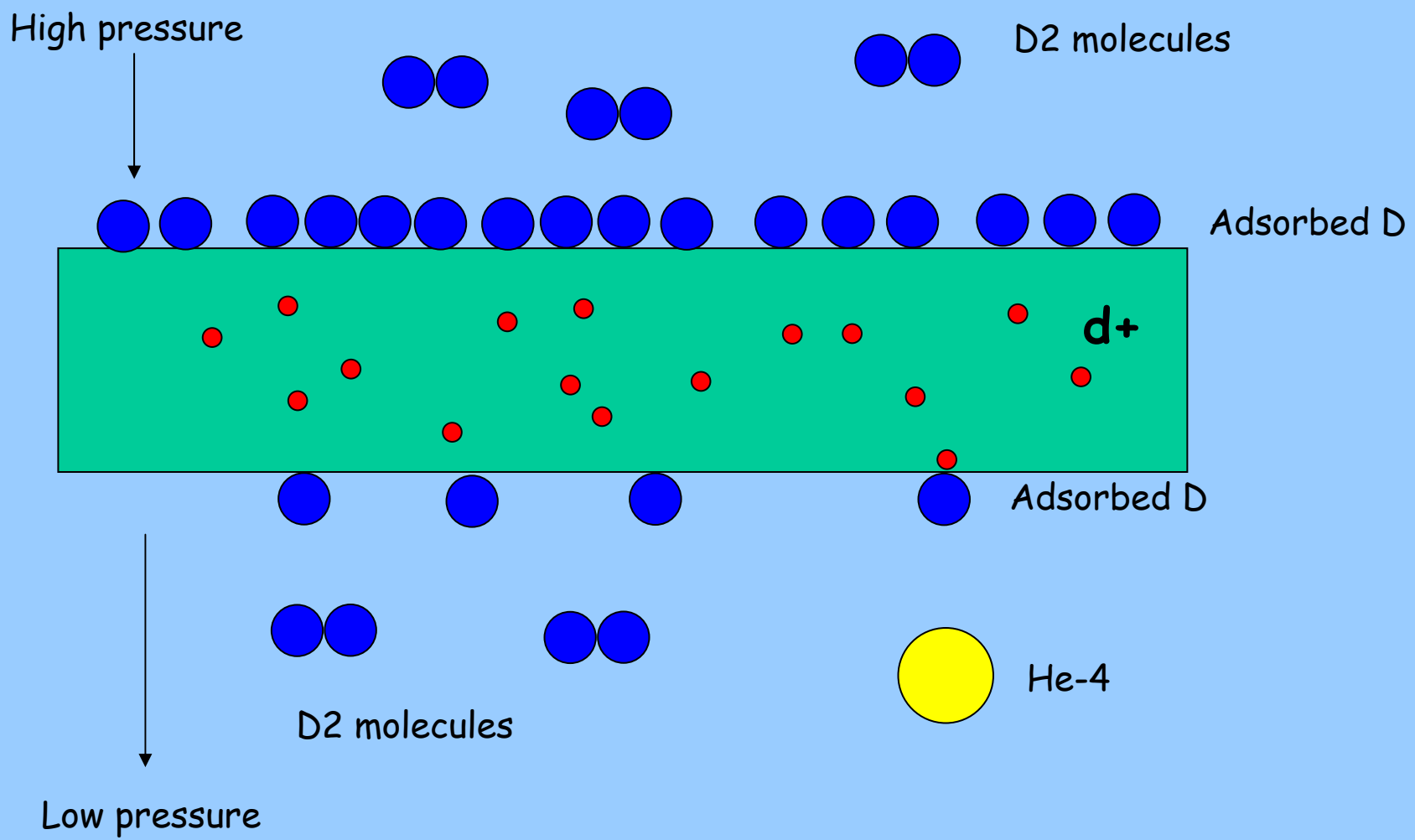
We had a leak, and experiment aborted.

No Excess Heat

5 - Experimental results → Pd tube + Pd powder run 24



6 – Model → d+D →He-4



The model:

1- D_2 molecules dissociate at the surface and forms D* adsorbed atoms.

2- Adsorbed D* atoms lose their electron and enters palladium as d+ ions.

3- d+ ions reach the other palladium surface and form D* adsorbed atoms.

4- Electrons of D* spend some of their time near the nucleus similar to a shrinked atom.

5- Sometimes a d+ gets near the nucleus of the D*.

6- By tunneling fusion occurs and He-4 is produced.

Mechanism:

1-The reaction between d+ and D* is in slow motion, therefore there is plenty of time to reach the lowest energy state, i.e. production of He-4.

2- In rare occasions He-3 and T are also produced.

3- Neutrons coming from the reaction can trigger transmutation.

Mechanism:
1- Reaction is first order in D*.
2- Reaction is first order in d+ flow rate.

Best conditions:
1- High D_2 pressure on the outer surface to increase D*coverage.
2- Work at high temperature to increase d+ flow rate.
3- Deposit electron donor materials on the outer surface to increase electron screening.

7 Conclusion

1- We have developed a reliable mass flow calorimeter.

2- We have tried various solutions with a number of variables without success.

3- We have observed excess heat using a palladium tube having been subject to oxydation filled with palladium powder.

4- We are at present trying to manufacture the palladium nano powder: Pd-ZrO_2.

5- A model has been developed that helps improve our experiments.

What's important is not what we want to do, but what we can do.

Margot Biberian (3 years)