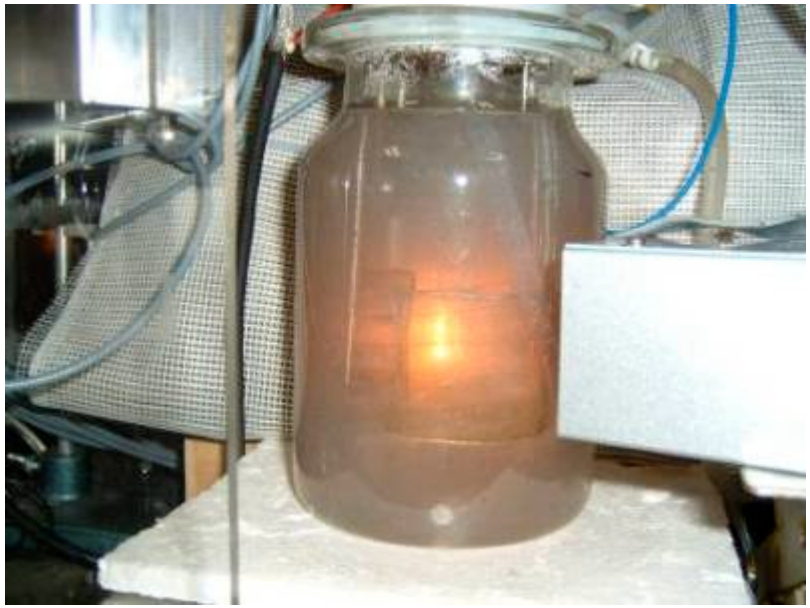
Experimental study of glow discharge in light water with W electrodes



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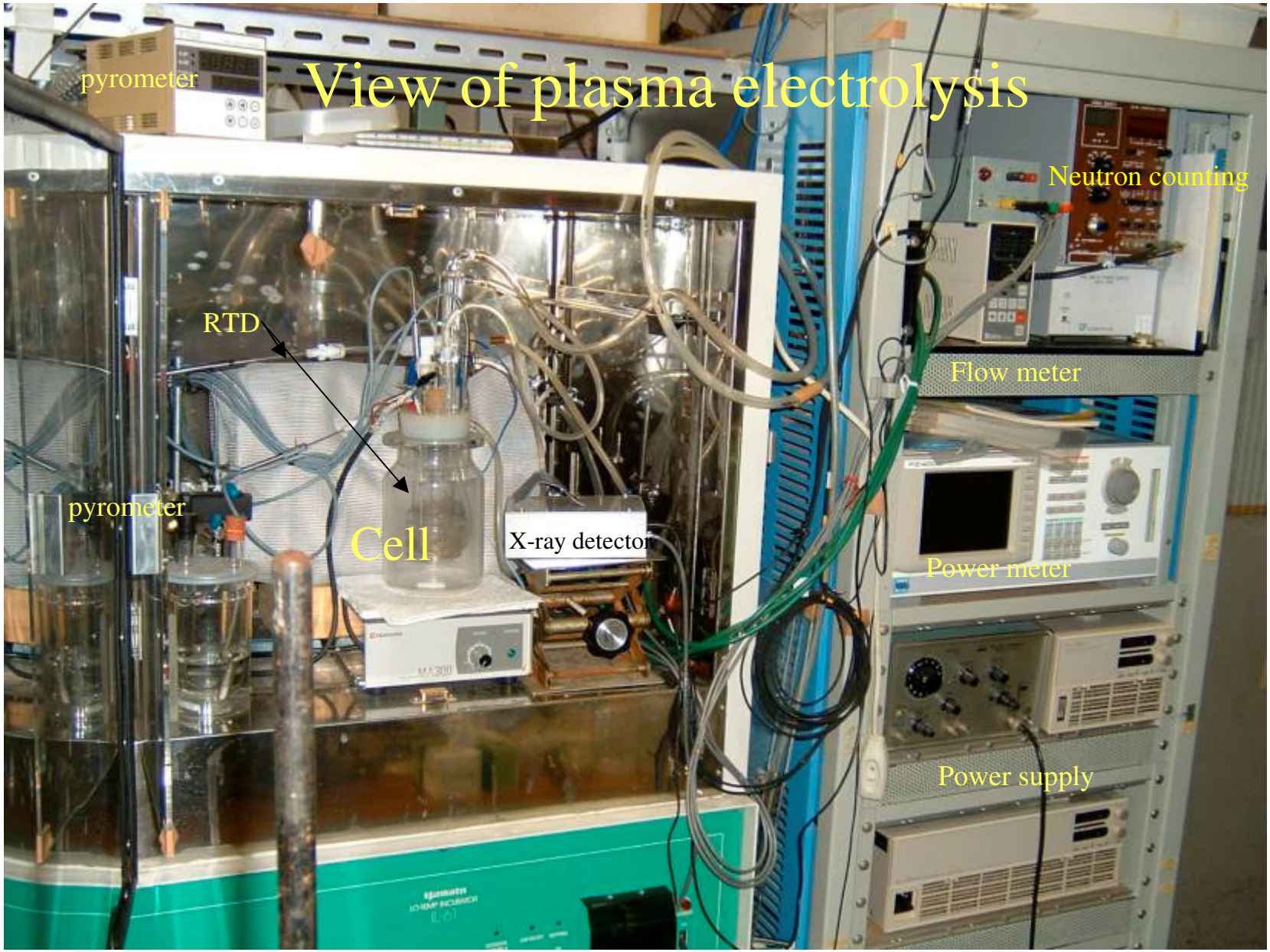
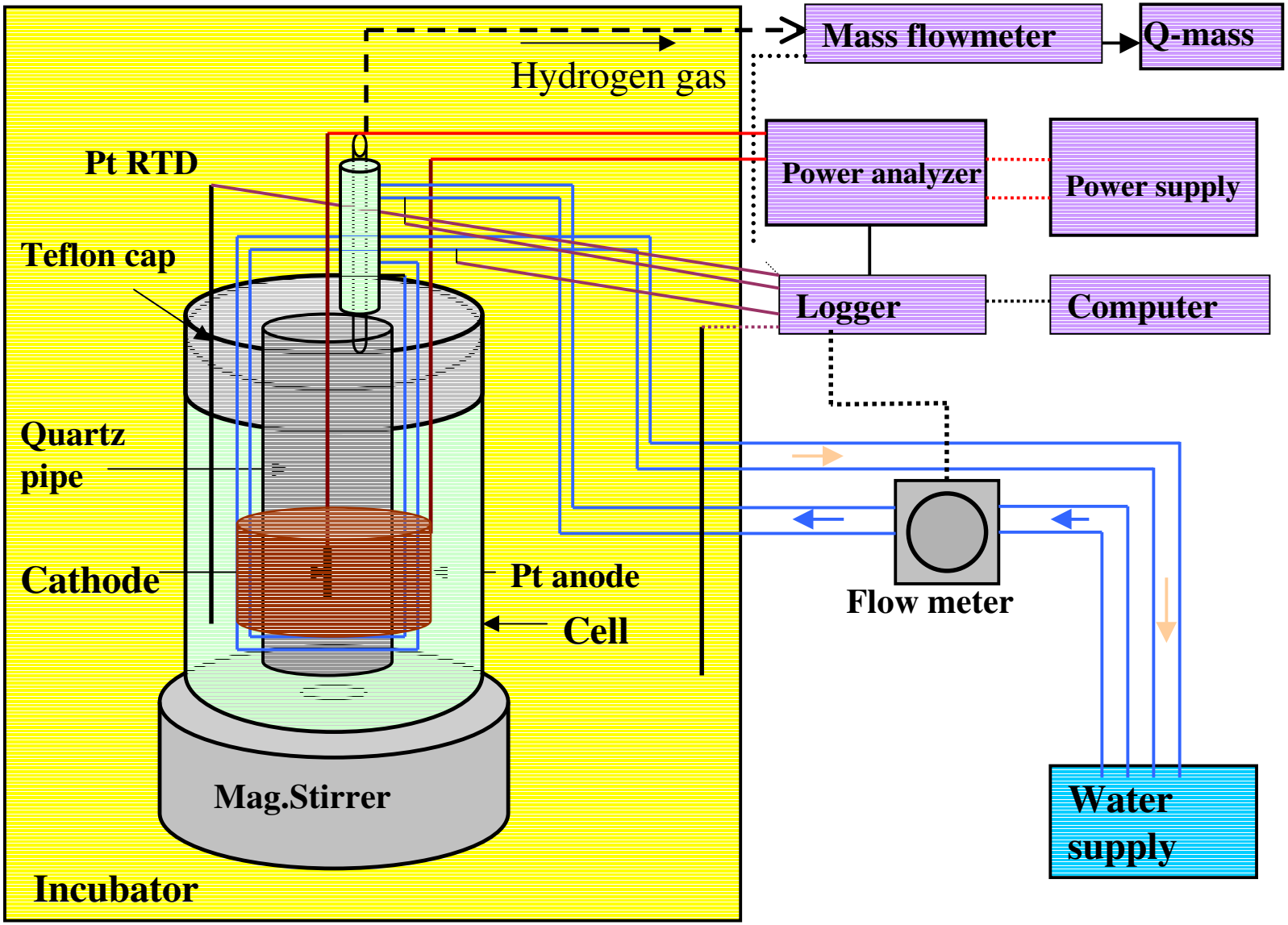
Content

- **Experimental**
- Measurement; heat, hydrogen, gas composition and element
- **Results**
- Heat and element


View of plasma electrolysis
pyrometer
Neutron counting
RTD
Flow meter
pyrometer
Cell
X-ray detector
Power meter
Power supply

Sketch of experimental set up



Detail of the gas measurement

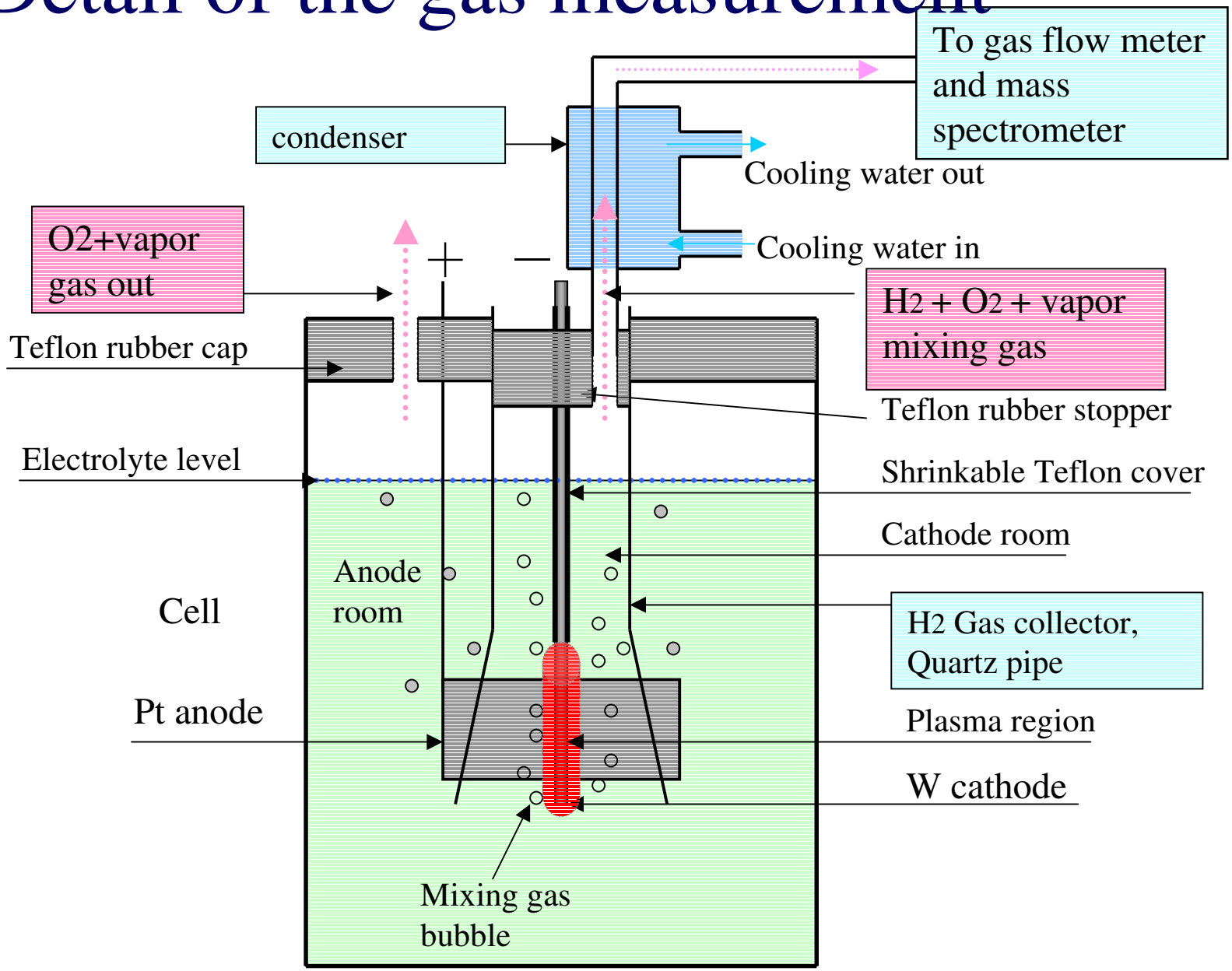


Photo of cell

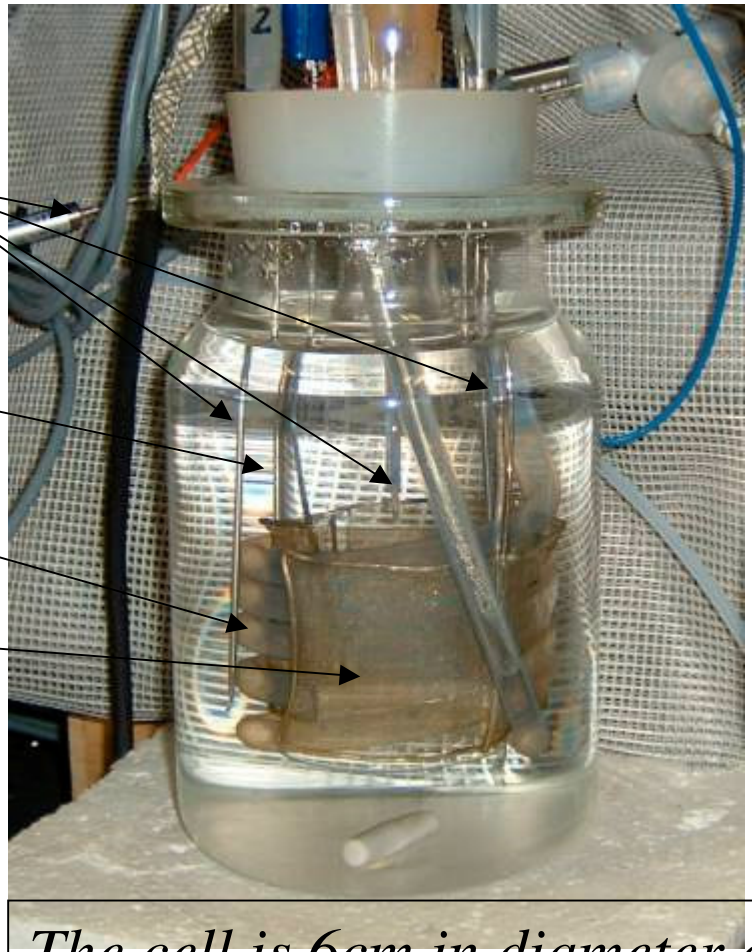
RTD: *Pt resistance thermometer, 0.001deg*

glass dome

coolant coil

Pt anode

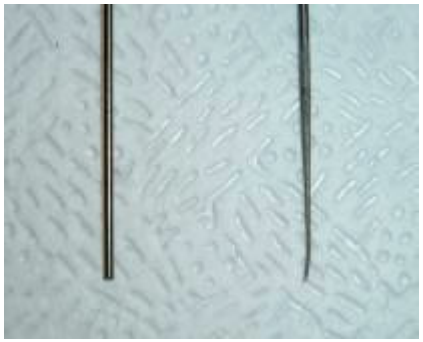
Rectangular Pt had an integral lattice constructed using a 15cm length of 0.1cm in diameter.



The cell is 6cm in diameter and 15cm in height.

Electrode

- The W wire; high purity (99.9%, Nilaco metals LTD).
- The cathode comprised a 1.5cm diameter and 15cm length of wire.



Before After

Electrolyte

- Light water; *purified through a milli-Q filter up to 18.3 Ohm-cm of resistively.*
- K_2CO_3 ; *Kanto Chem.CO., INC., 99.5%*

Input power supply

- Takasago Products LTD, EX-1500L and EX-750, 15A and 480v.
- Input power analyzer
- *Yokogawa-PZ4000, 50 μ sec sampling time, for 4s = 80000 data points*

Out put power measurement

- The logger converted input levels into a digital format acceptable to the computer software and the input voltage was directly measured between the two electrodes of the cell.

Coolant flow meter

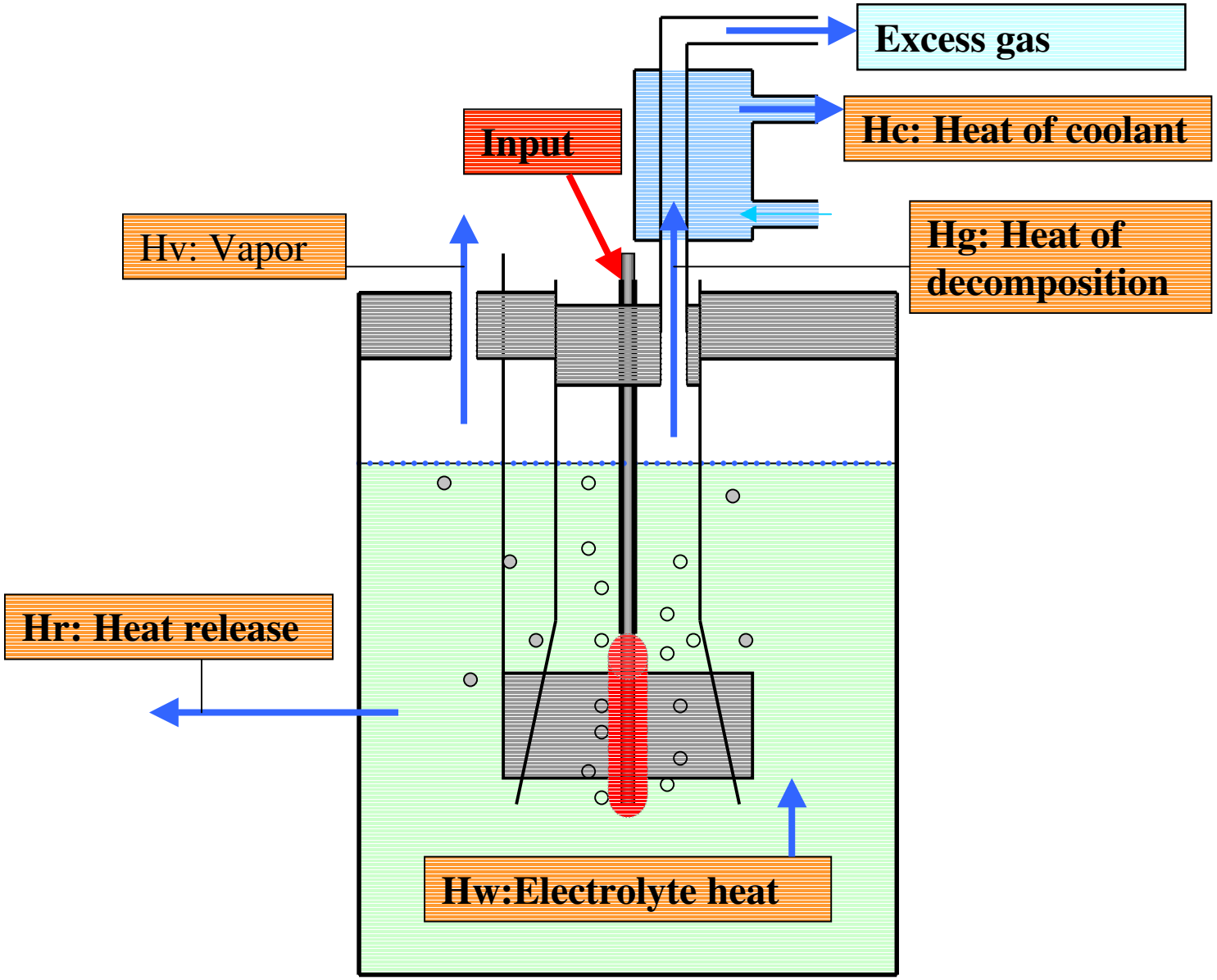
controller

Turbine meter:
0.0001g/s

Heat balance

- **Input** (J) = **I** (current) · **V**(Volt) · **t**
- **Out** = Hg + Hw + HC + Hr + Hv
- 1: Hg = Heat of decomposition $= \int 1.48 \cdot dI \cdot dt$
- 2: Hw = Electrolyte heat $= \int Ww \cdot Cw \cdot \delta T$
- Ww:electrolyte weight,Cw:heat capacity, δ T:temperature difference
- 3: Hc = Heat of coolant $= \int Wc \cdot Cc \cdot \delta T$
- Wc:coolant weight, Cc:heat capacity, δ T:temperature difference
- 4: Hr = Heat release $= \int (Ww \cdot Cw + Wc \cdot Cc)Tr$
- *Tr:temperature change*
- 5: Hv = vapor = $Wv \cdot Cc$

Heat balance



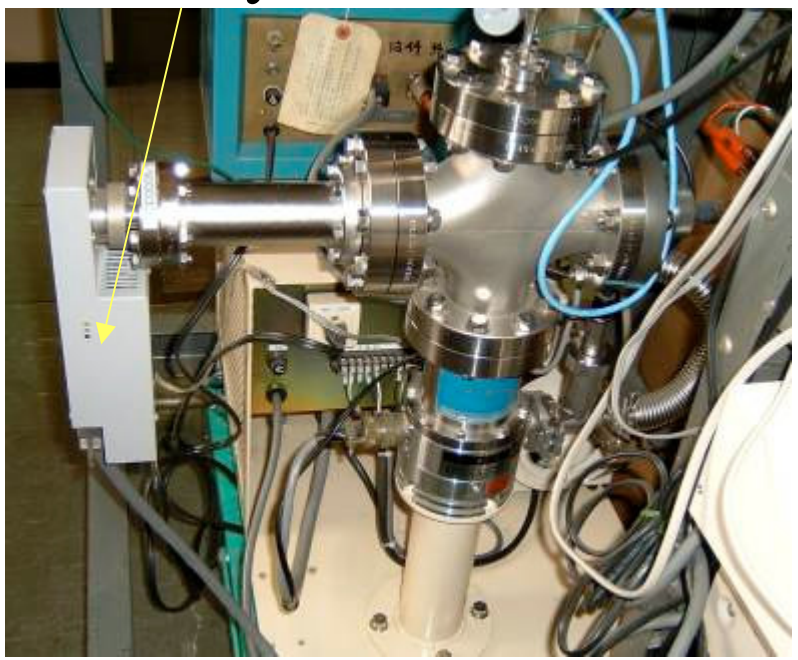
Photos of gas analysis equipment

Mass flow meter: model-3100 made by Kofloc Co

Mass flow controller:

CR-700 Kofloc

Q-mass spectrum analyzer



Elements Analysis

EDX analyzer

ICP mass analyzer

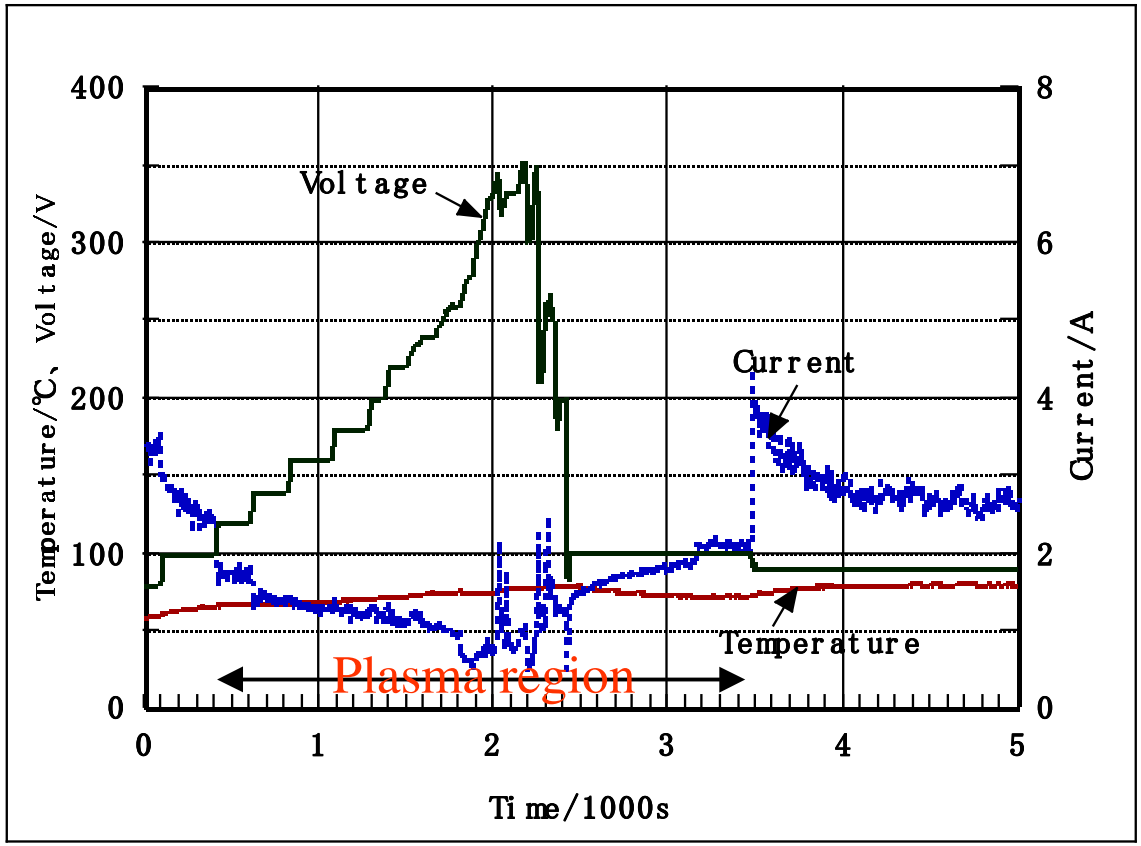
Plasma

W electrode 1.5 ϕ ,30mm

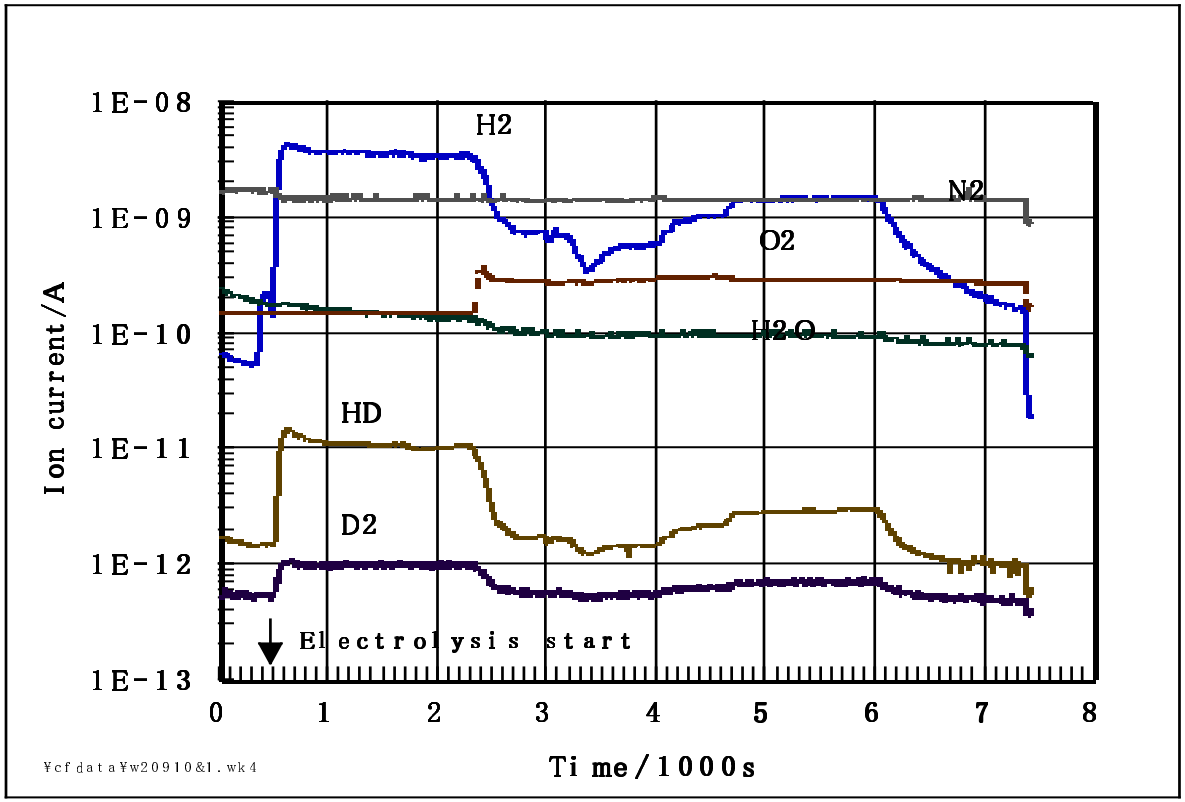
220V,1.2A,90C

Current efficiency;500%

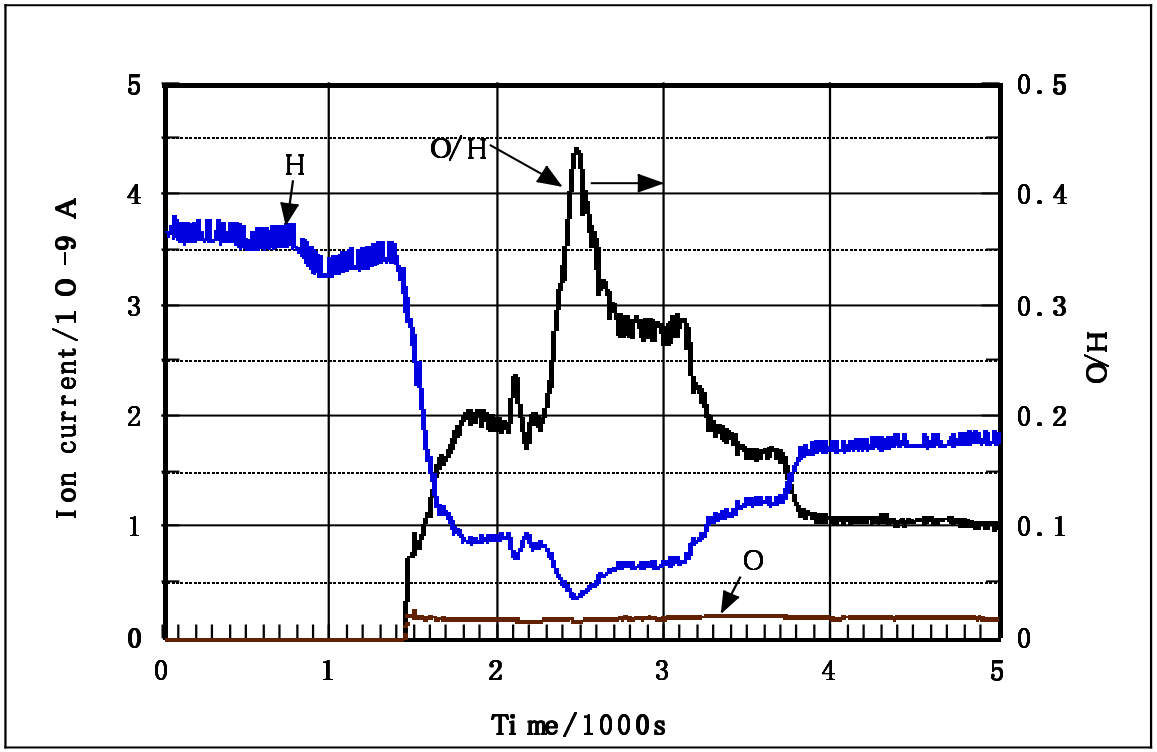
Time changes of input Voltage, current and solution temperature



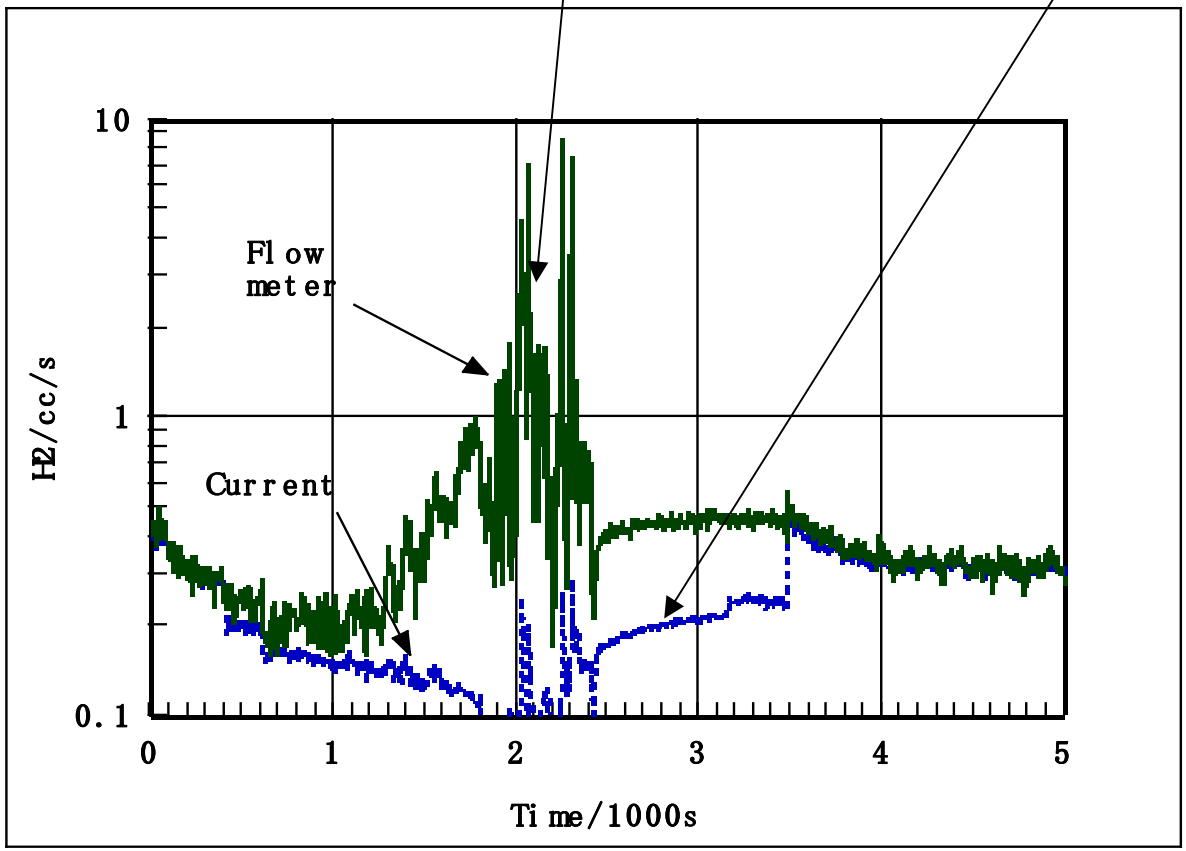
Time changes of various gas



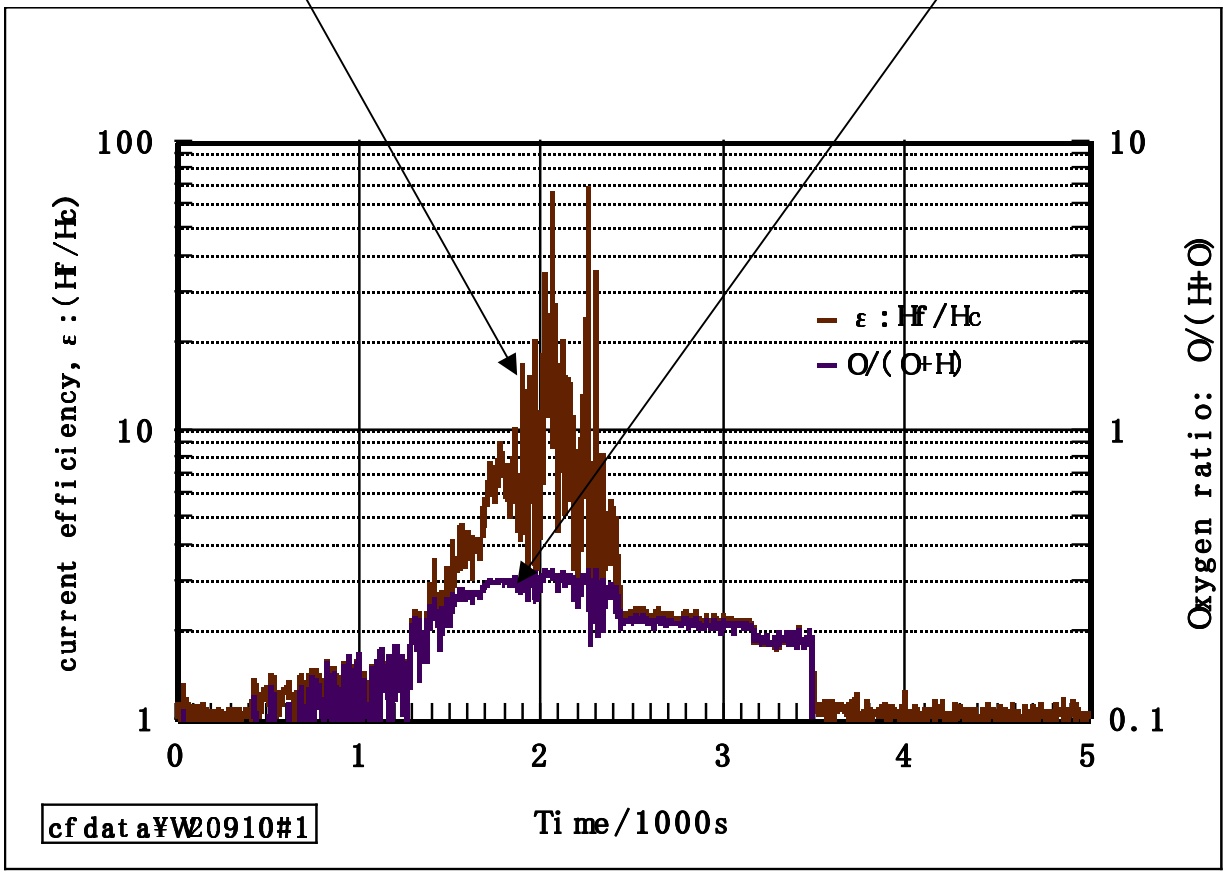
Time changes of H_2 and O_2



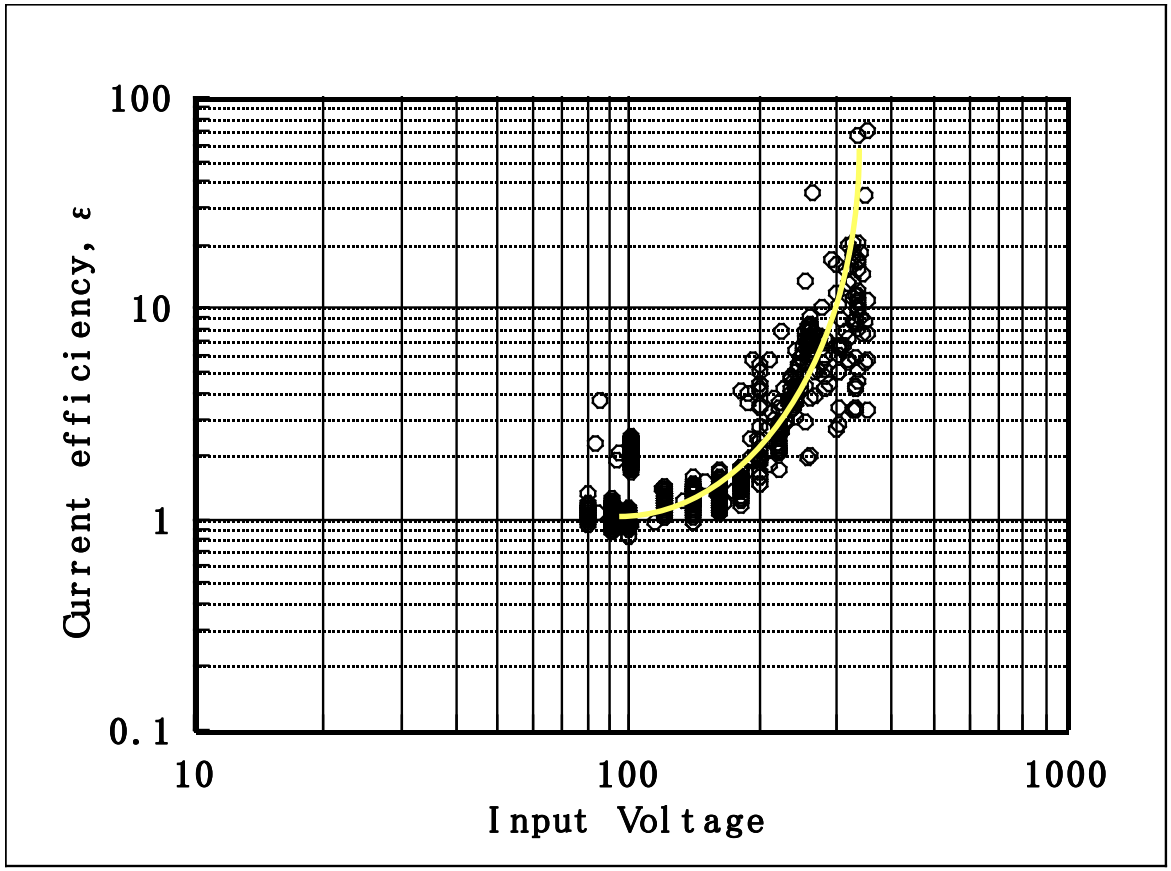
Time change of hydrogen generation; estimated by flow-meter and by current



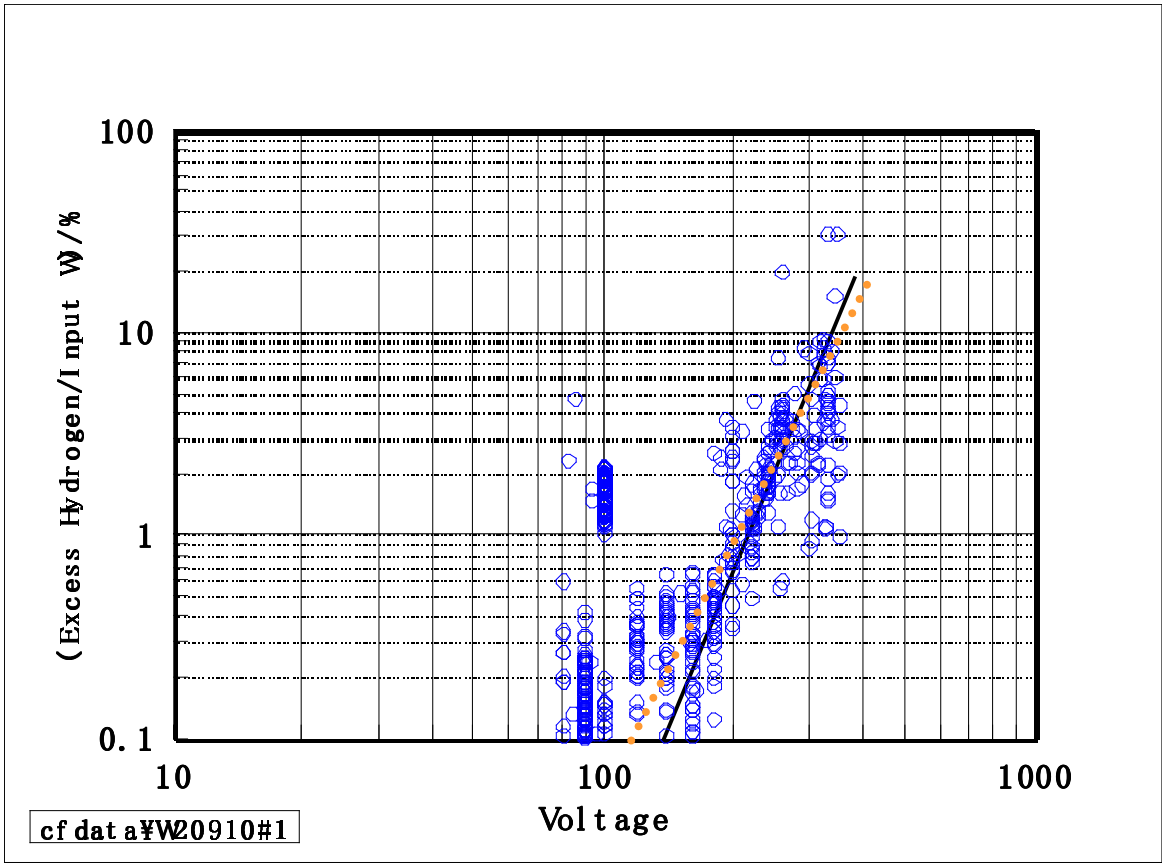
Time change of current efficiency and O_2 ratio



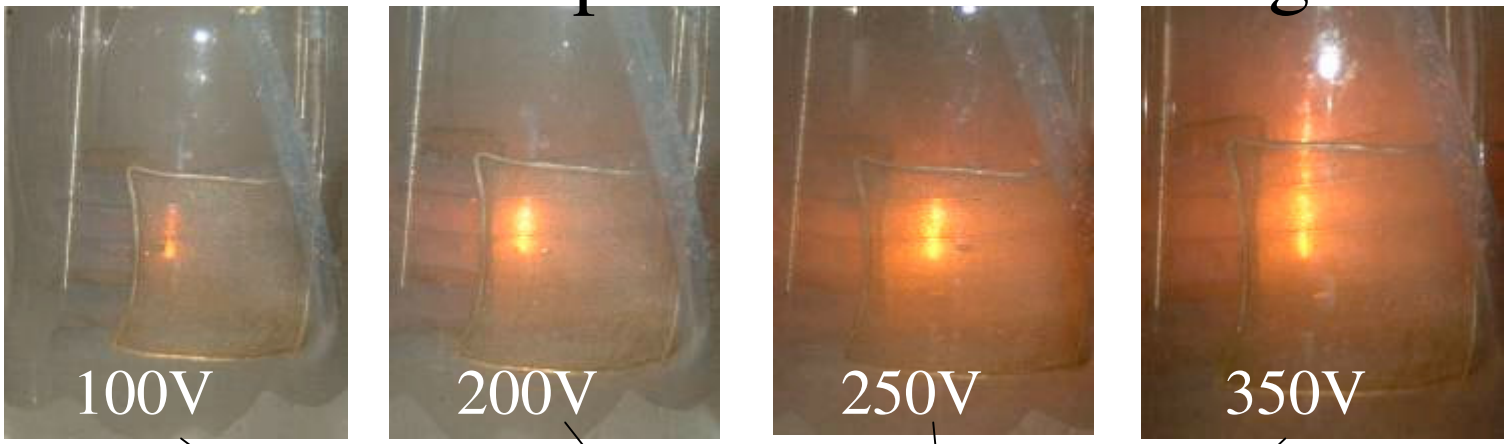
Dependence of current efficiency on input V

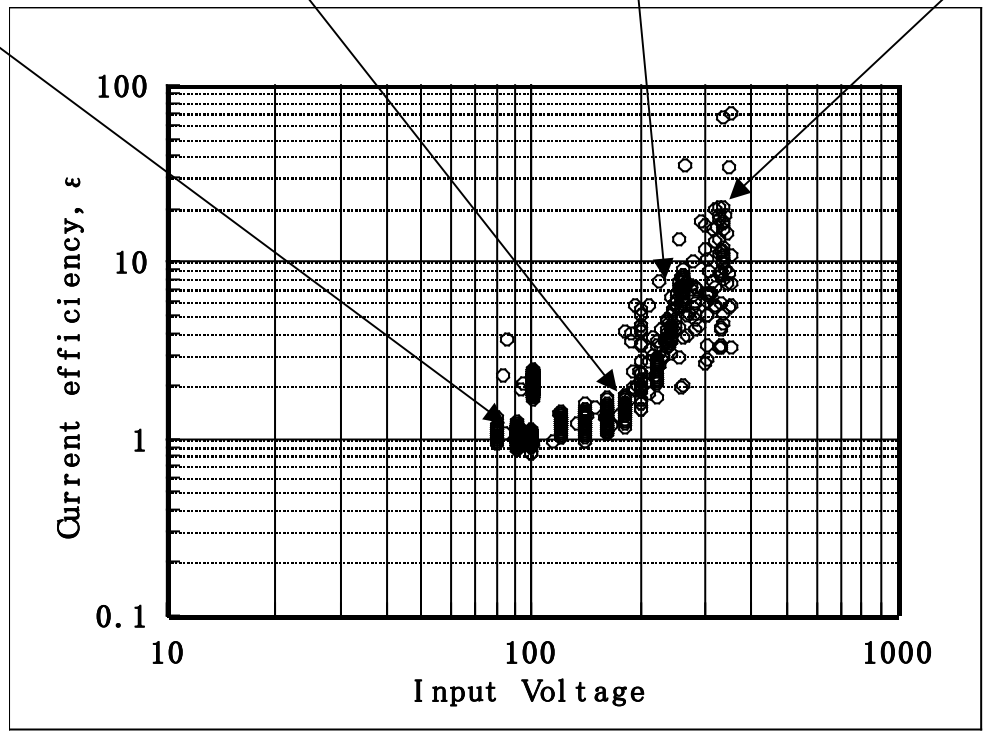


Voltage dependence of excess H2

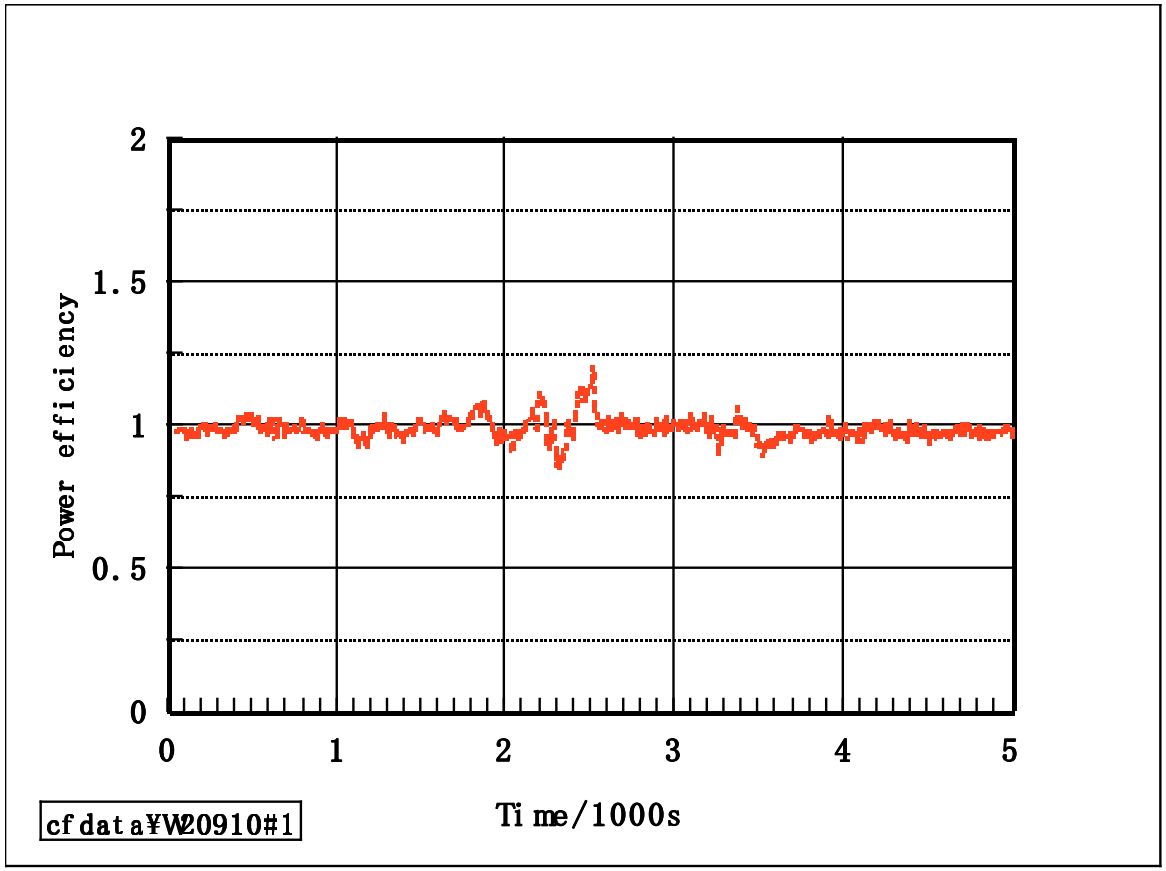


Photos of plasma at each voltages

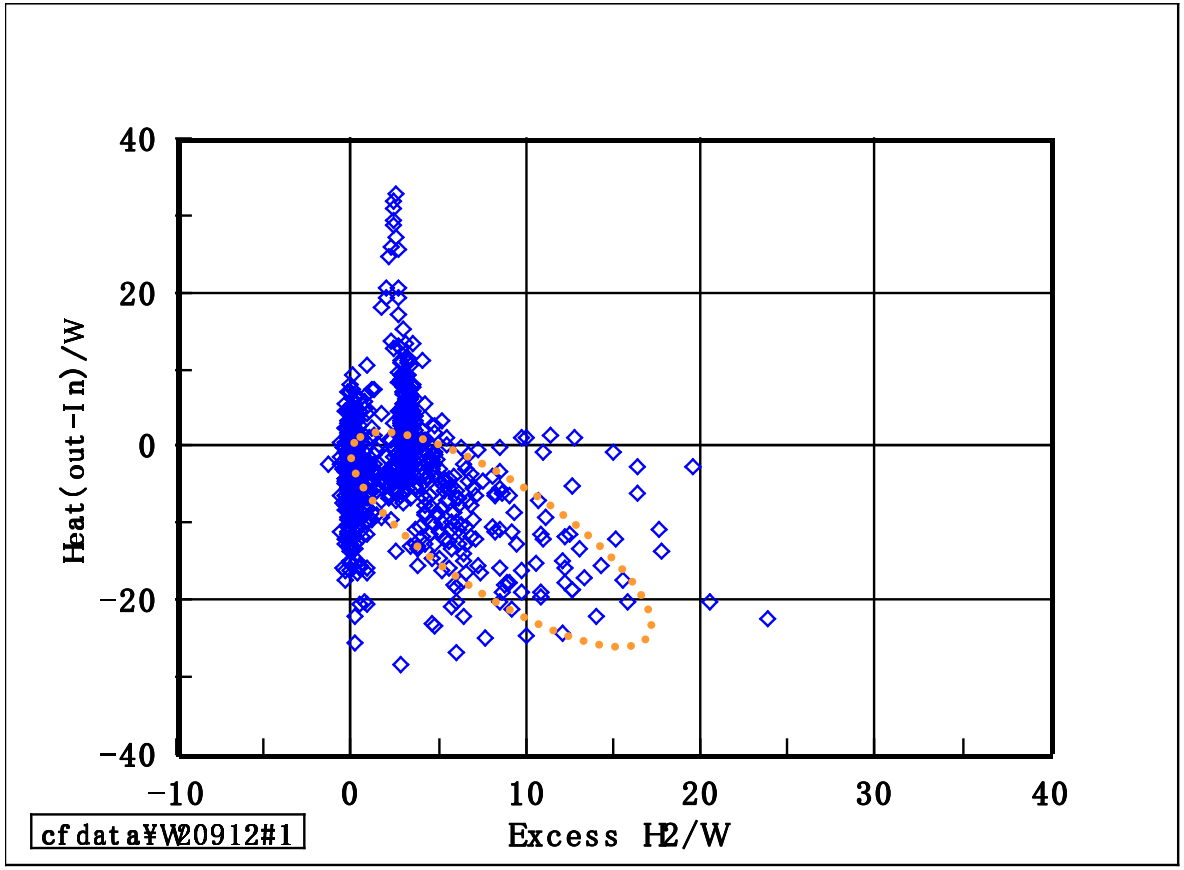




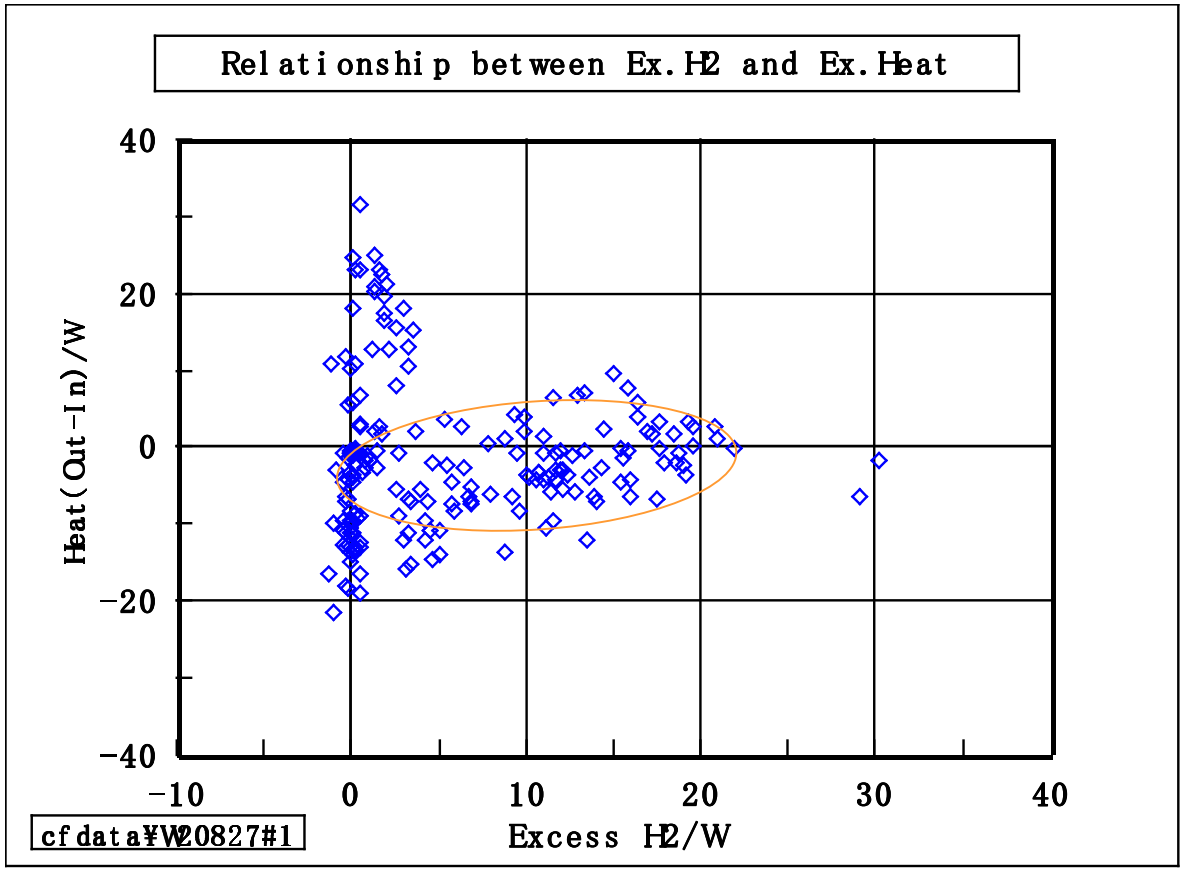
Time change of power efficiency



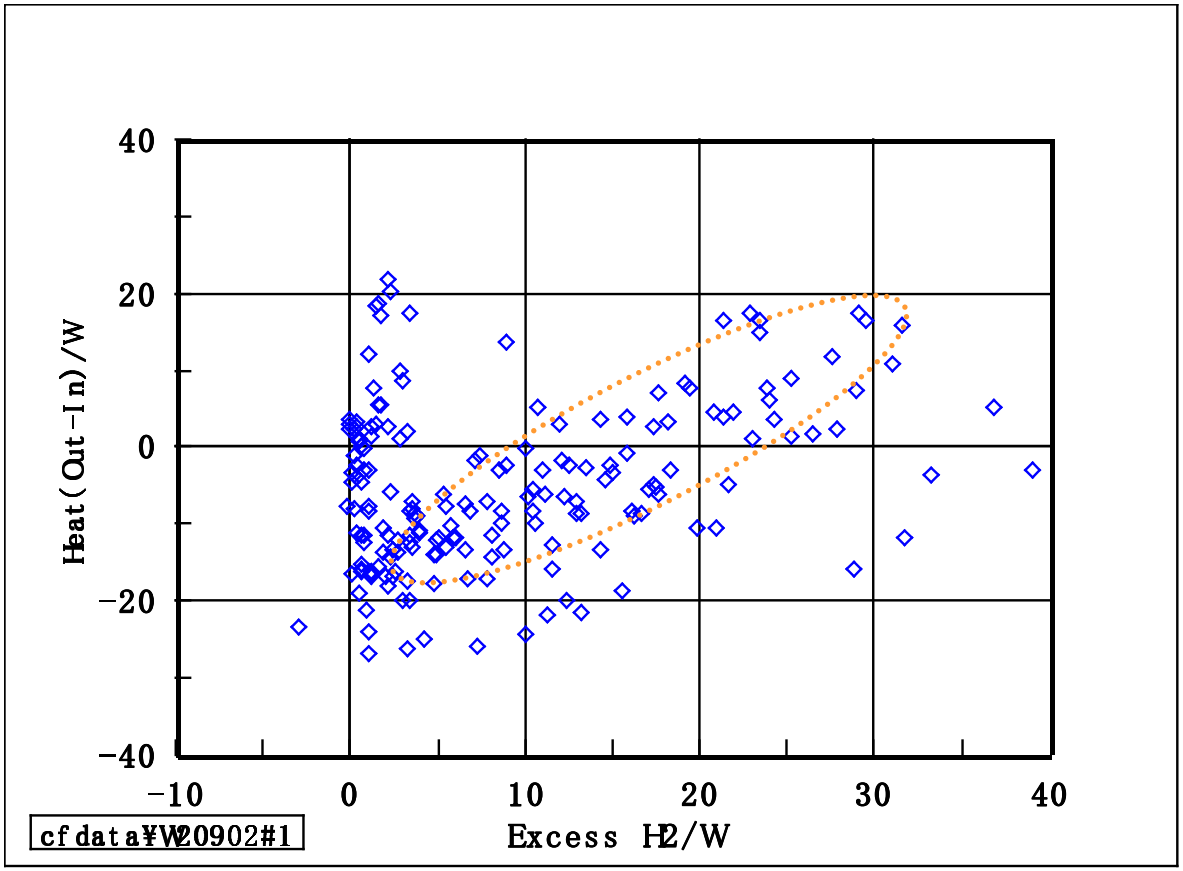
Endothermic result



No excess heat

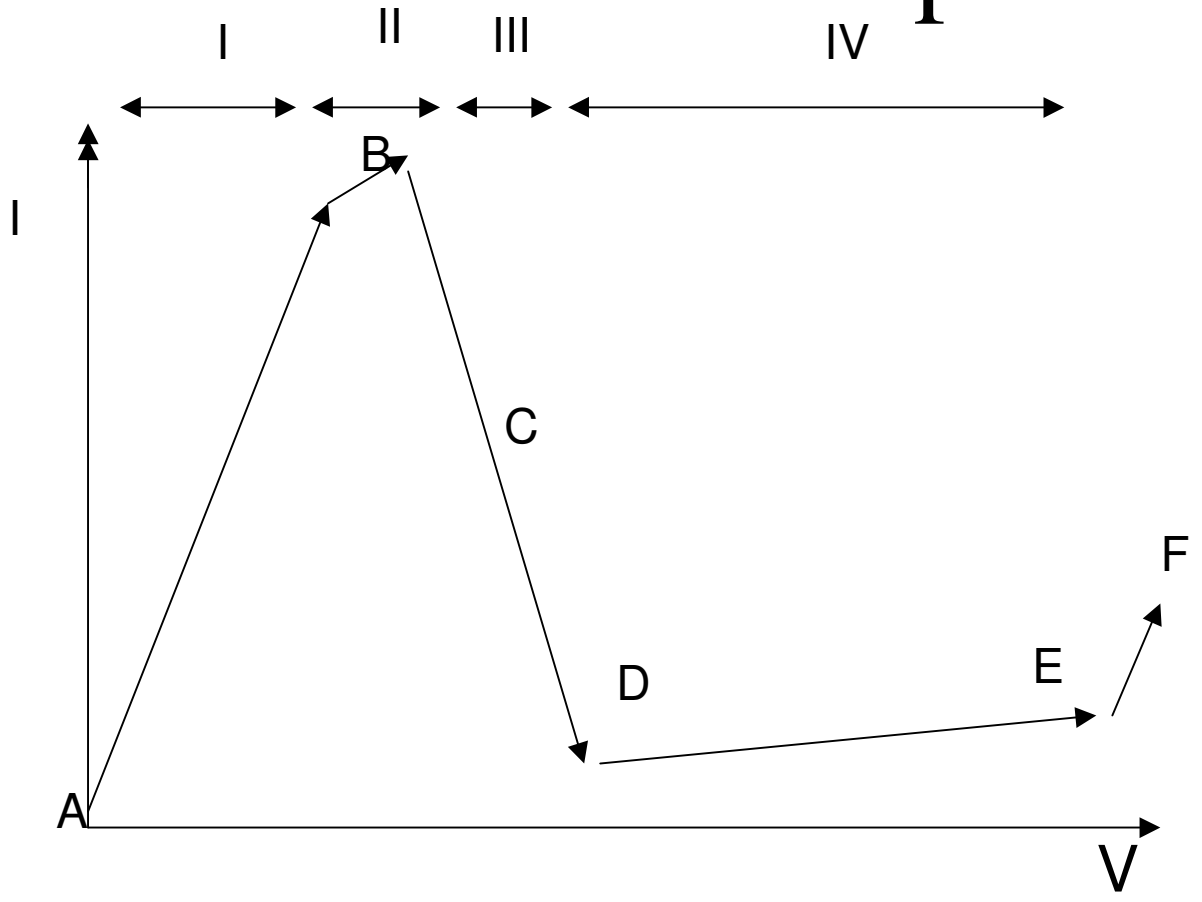


Excess heat generation



I-V relationship

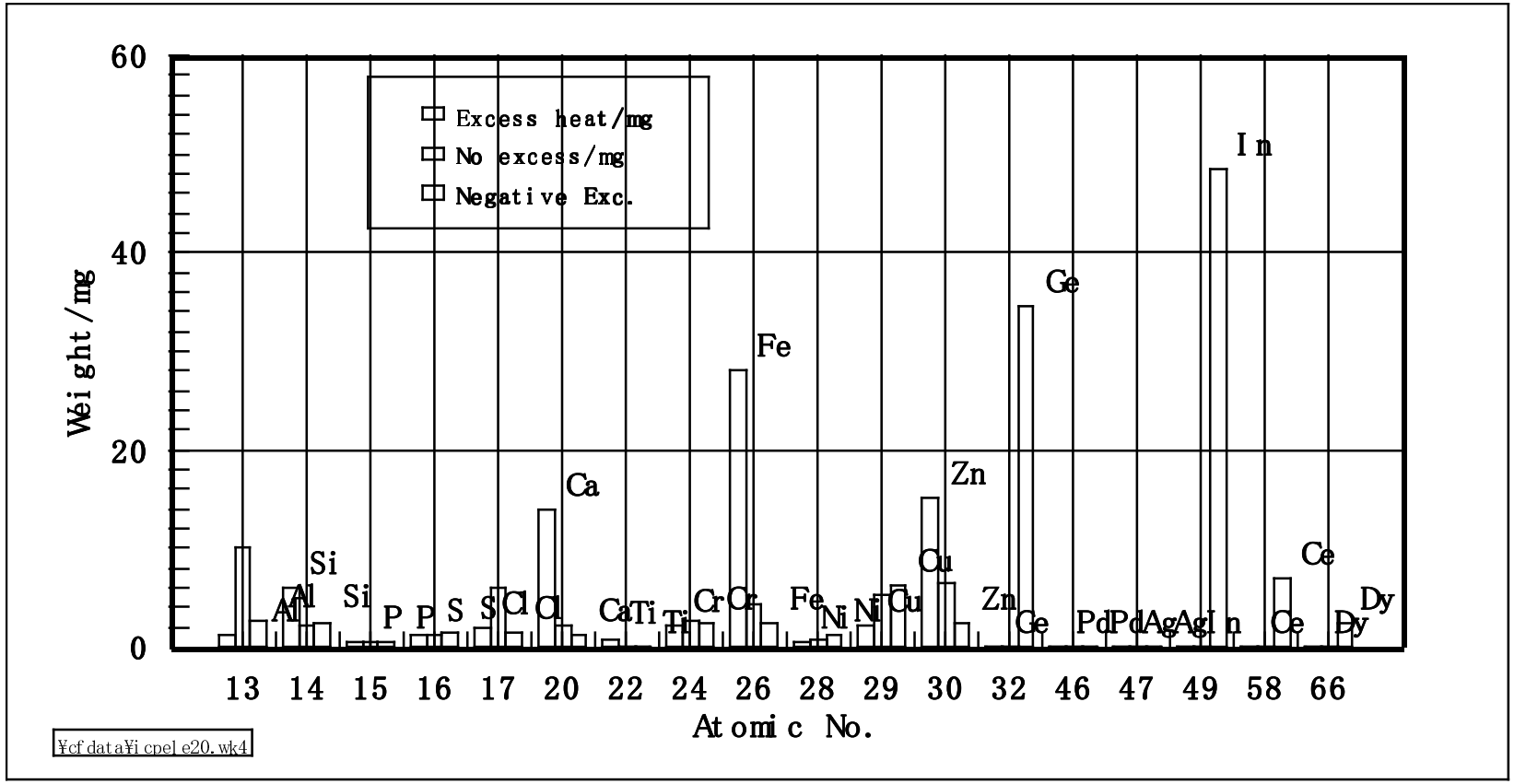
- E



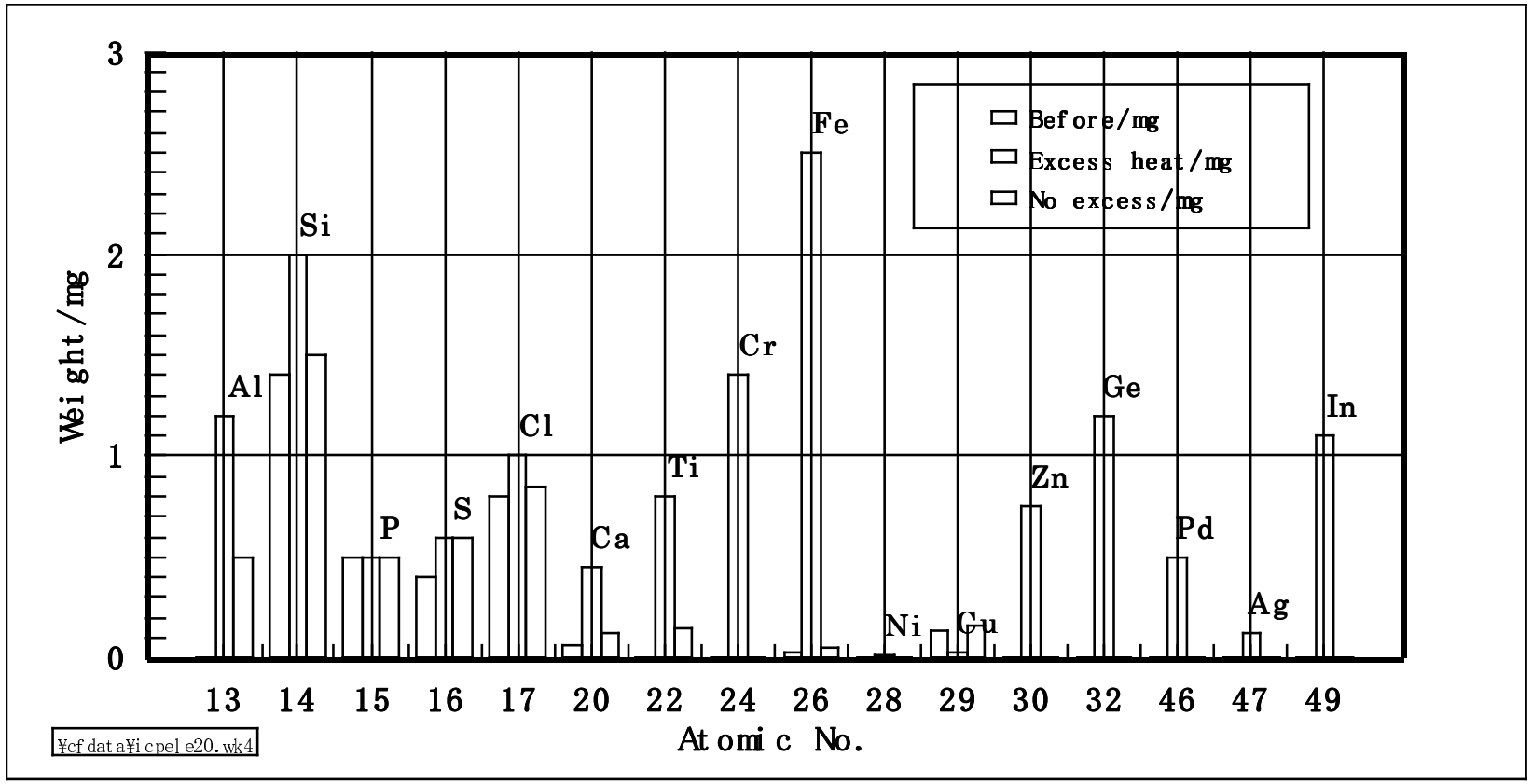
Characteristic element generation

- 1. Excess heat;
- Fe, Zn, Ca, Si: 2 --- 30 mg
- 2. No excess heat;
- Al, Cl, K, Cu: 2 --- 10mg
- 3. Endothermic;
- Ge, In, Ce, Dy: 5 --- 50mg

Difference of element distribution



Element distribution of Pd electrolyzed in D2O solution



Tetrahedral Symmetric Condensate: TSC

W186 (28.6%)

$$^{186}W + 4\,^{1}H \rightarrow$$

$$\rightarrow {}^{136}Xe + {}^{54}Cr + 129.5MeV$$

$$\rightarrow {}^{142}Ce + {}^{48}Ca + 114.6MeV$$

$$\rightarrow {}^{150}Nd + {}^{40}Ar + 95.1MeV$$

$$\rightarrow {}^{154}Sm + {}^{36}S + 89.5MeV$$

$$\rightarrow {}^{160}Gd + {}^{30}Si + 78.3MeV$$

TSC for W184

$$^{184}\mathrm{W} + 4\,^{1}\mathrm{H} \rightarrow {}^{124}\mathrm{Sn} + {}^{64}\mathrm{Ni} + 138.9\mathrm{MeV}$$

$$\rightarrow {}^{130}\mathrm{Te} + {}^{58}\mathrm{Fe} + 133.3\mathrm{MeV}$$

$$\rightarrow {}^{136}\mathrm{Xe} + {}^{52}\mathrm{Cr} + 124.9\mathrm{MeV}$$

$$\rightarrow {}^{138}\mathrm{Ba} + {}^{50}\mathrm{Ti} + 123.0\mathrm{MeV}$$

$$\rightarrow {}^{142}\mathrm{Ce} + {}^{46}\mathrm{Ca} + 110.9\mathrm{MeV}$$

$$\rightarrow {}^{150}\mathrm{Nd} + {}^{38}\mathrm{Ar} + 91.3\mathrm{MeV}$$

$$\rightarrow {}^{154}\mathrm{Sm} + {}^{34}\mathrm{S} + 85.7\mathrm{MeV}$$

$$\rightarrow {}^{160}\mathrm{Gd} + {}^{28}\mathrm{Si} + 72.7\mathrm{MeV}$$

Results

- 1. Current efficiency for the H2 generation reached 8000% to the input current.
- 2. Power efficiency for the plasma electrolysis reached 20% to the input V.
- 3. In some cases, excess heat was observed.
- 4. In other cases, no and endothermic heat were confirmed.
- 5. The reaction products after electrolysis were changed with the heat balance.