Heat and other products induced by plasma electrolysis

Tadahiko Mizuno, Tadayoshi Ohmori,
Tadashi Akimoto, Kazuhisa Azumi
Hokkaido University, JAPAN
Akito Takahashi, Masayuki Ohta
Osaka University, JAPAN

Contents

- 1) Experimental procedures;

  Material, Electrolyte, Heat calibration method and Element analysis methods.

- 2) Results;

  Excess heat and Products.

- 3) Theoretical explanation;

  Photo fission mechanism.

Electrode and Electrolyte

- Electrode;

  highest quality W,(99.95% pure, supplied by High Metals Co. LTD.), dimension;5 ×10 ×0.3mm

- Reagent:ultra high purity;

  K_2CO_3, Merck Co. Ltd.,metal impurity max 1ppm

- Electrolyte;

  light water, purified through a milli-Q filter up to 18.3 Ohm-cm of resistively

Cell and Electrode

- Cell dimension;

  8 cm in diameter and 20 cm in height of Pyrex cell,

- Cathode;

  W plate (1.0 cm x 0.5 cm) and incorporated a 1.5 ∅,15-cm length of W wire.

- Anode;

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

Power supply and Data sampling

- DC power supply;

  Takasago Products LTD, EX-1500L , 25A and 240V.

- Data processing;

  Temperatures, Volt,Current→logger →computer

Electrolysis condition

- Electrolyte;

  0.2 mol of K_2CO_3 solution.

- Voltage;

  60～220V (plasma electrolysis)

- Current density;

  0.3～10A/cm^2

- Electrolyte temperature;

  60～100℃

Elements analysis

- Sample surface;

  EDX analysis.

- Total amount;

  ICP analysis.

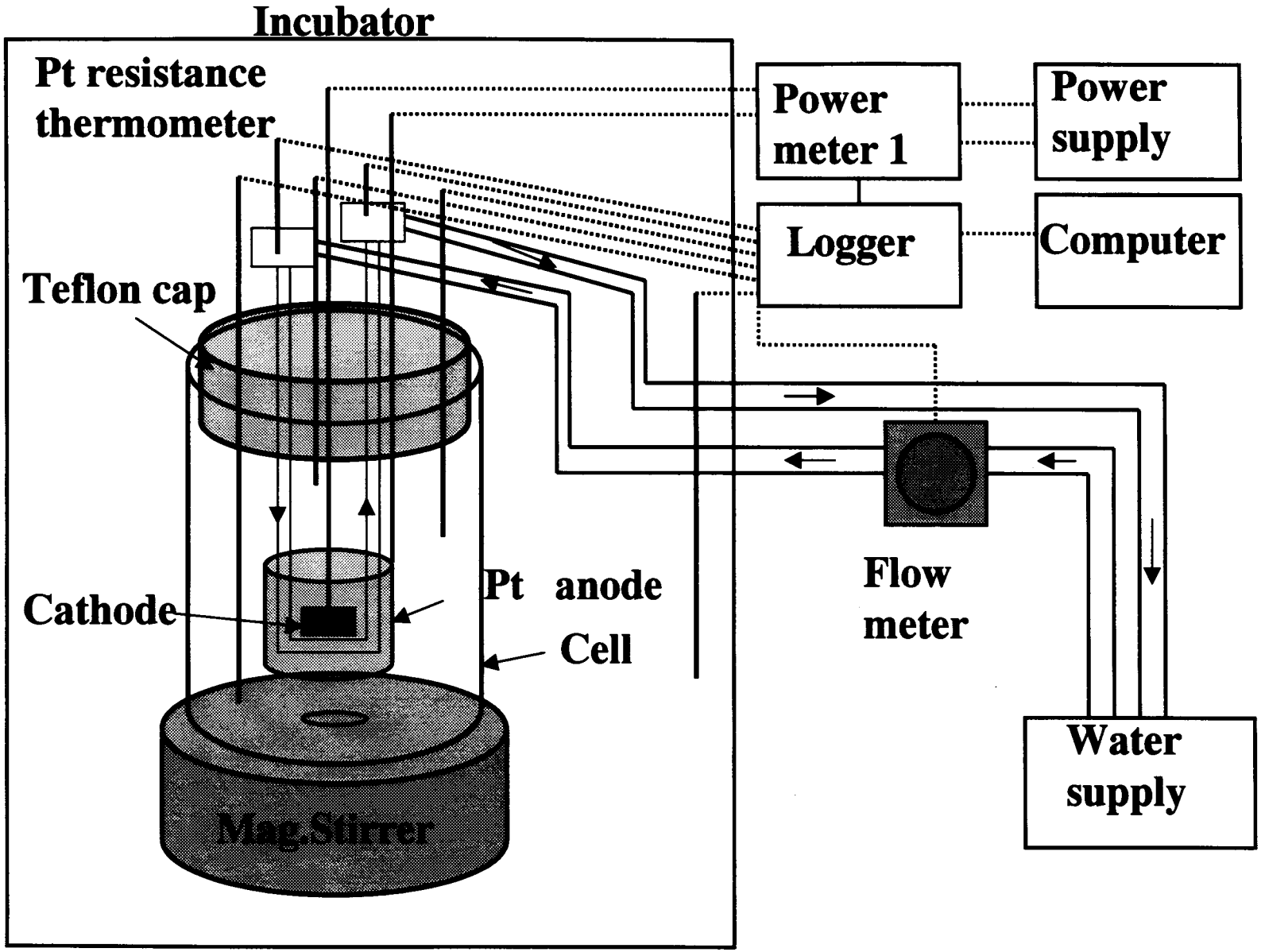
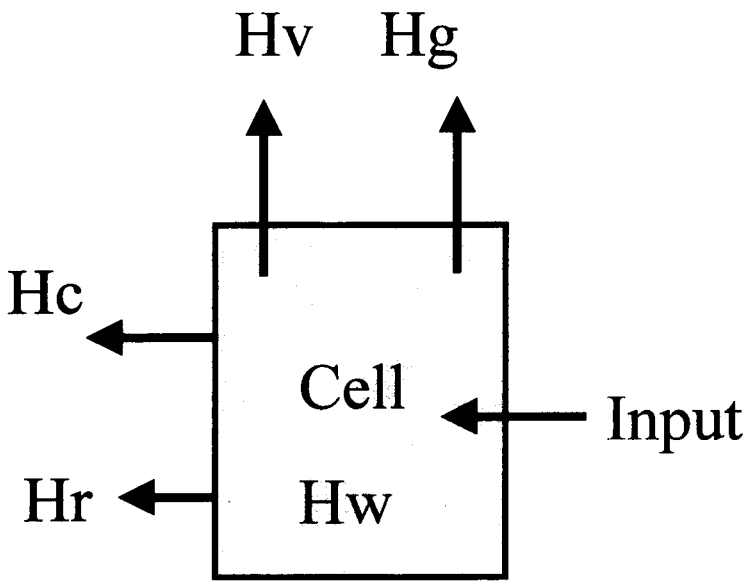


Fig.1 Experimental arrangement



Heat balance

Heat balance

Input (W) = **I** · **V**

Out = Hg+Hw+HC+Hr+Hv

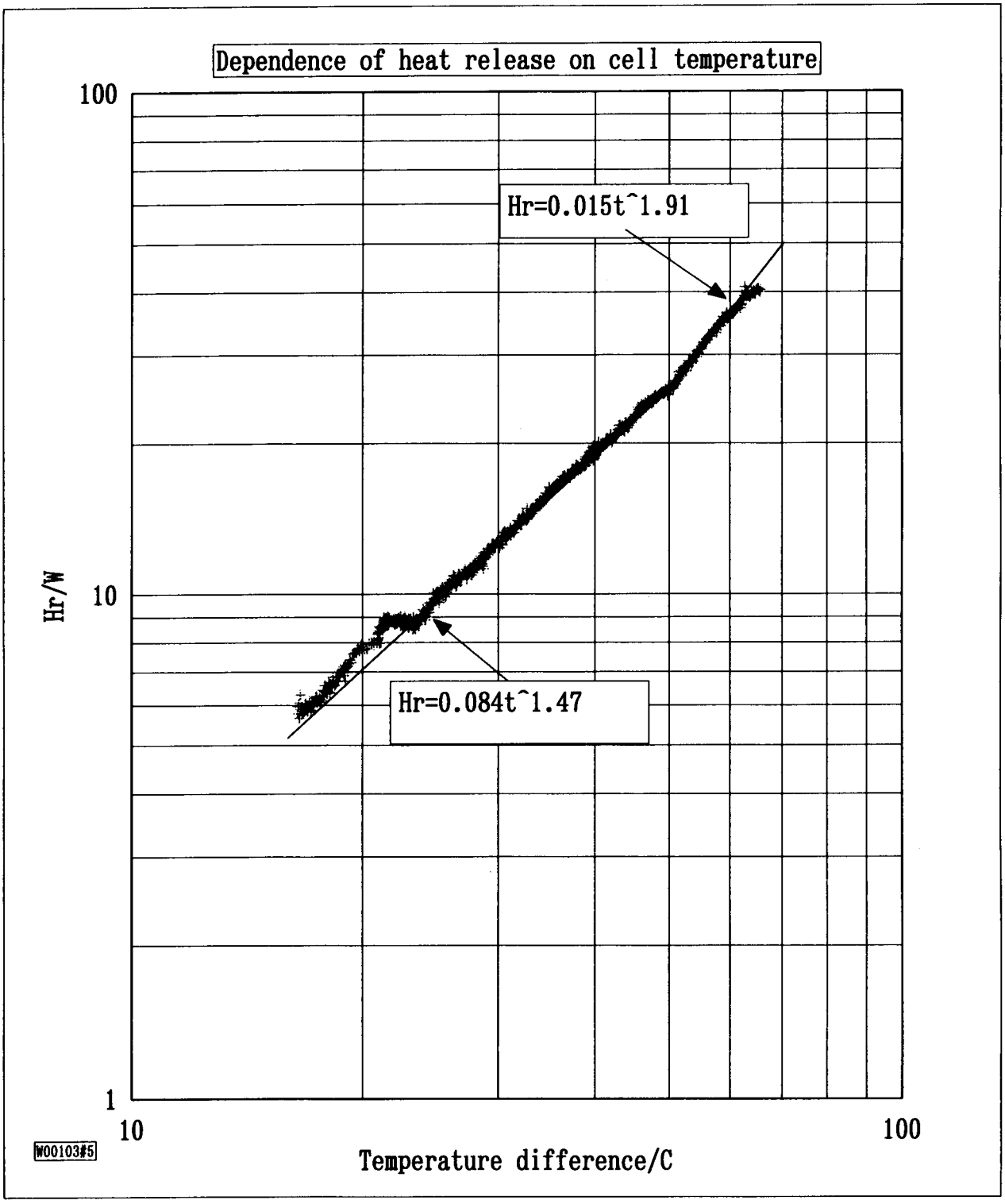
- Hg=Heat of decomposition=1.48 ·I
- Hw=Electrolyte heat =Ww · Cw ·d T/t

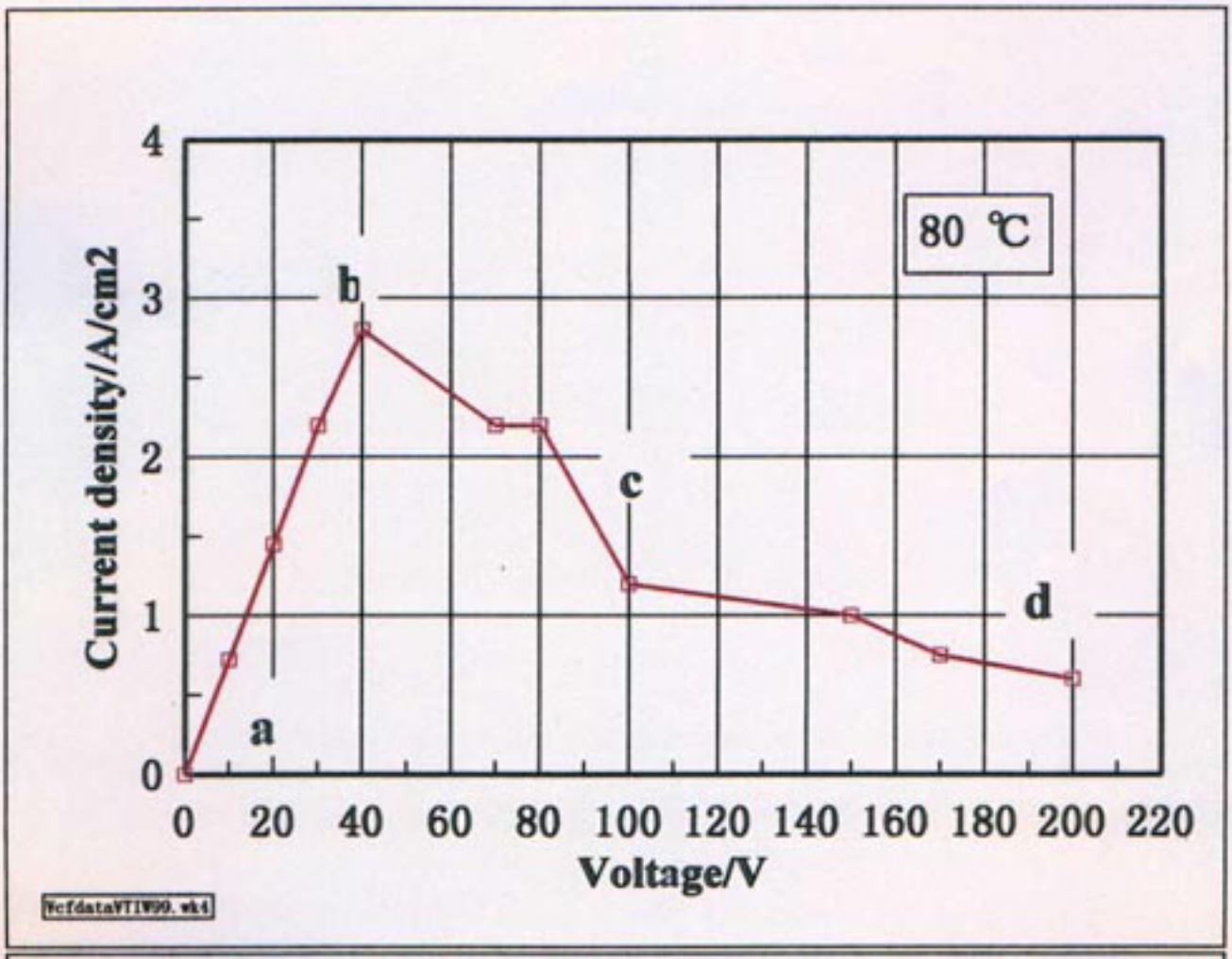
  Ww:electrolyte weight,Cw:heat capacity,dT:temperature difference

  t:interval time of data sampling
- Hc=Heat of coolant = Wc · Cc ·dT

  Wc:coolant weight, Cc:heat capacity,dT:temperature difference
- Hr=Heat release = Ww ·Cw · Tr

  Tr:temperature change
- Hv=vapor= Wv · Cc


Dependence of heat release on cell temperature
100
10
1
Hr/W
Hr=0.015t^1.91
Hr=0.084t^1.47
10
100
Temperature difference/C
W00103#5



Current and Volt relation for plasma electrolysis

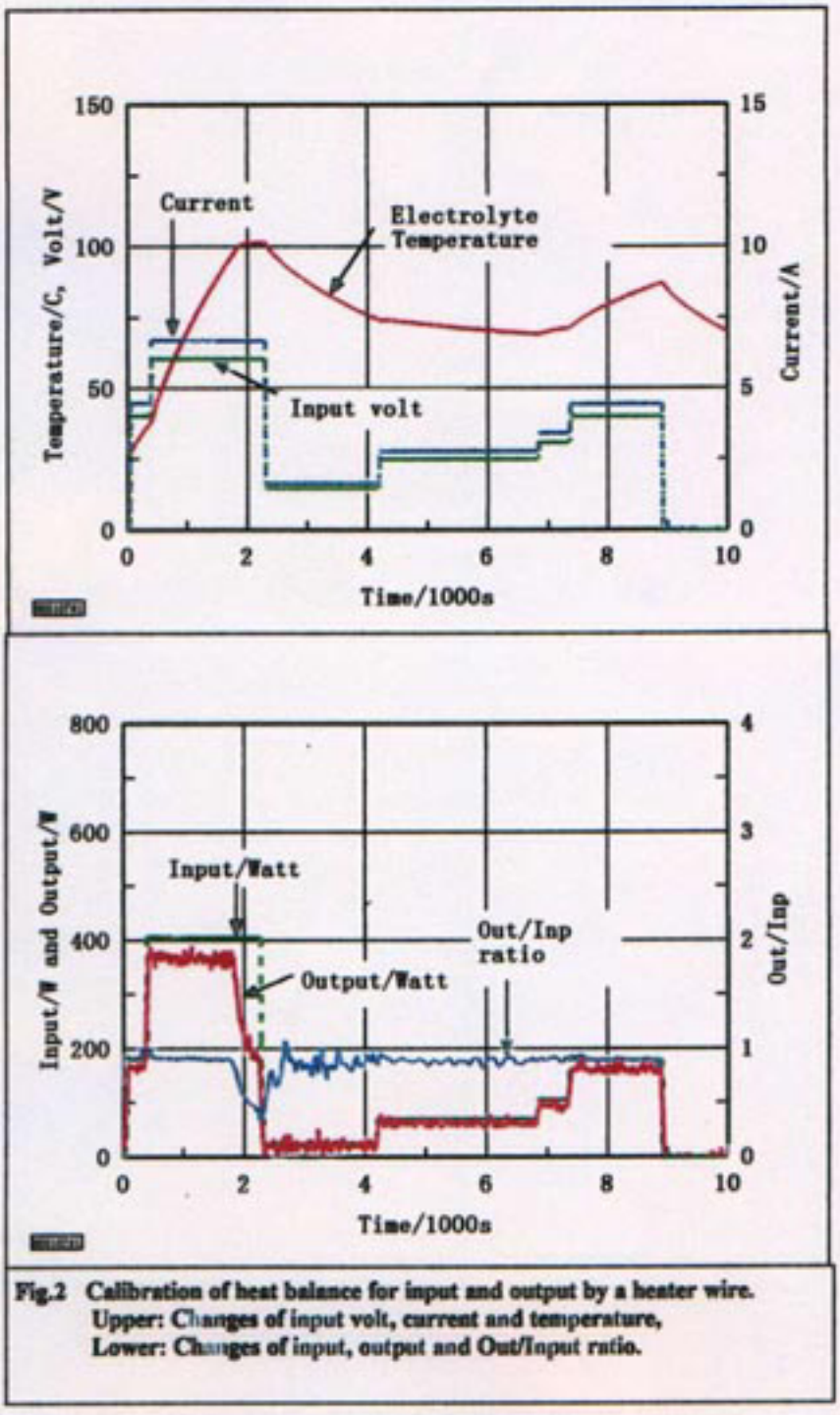
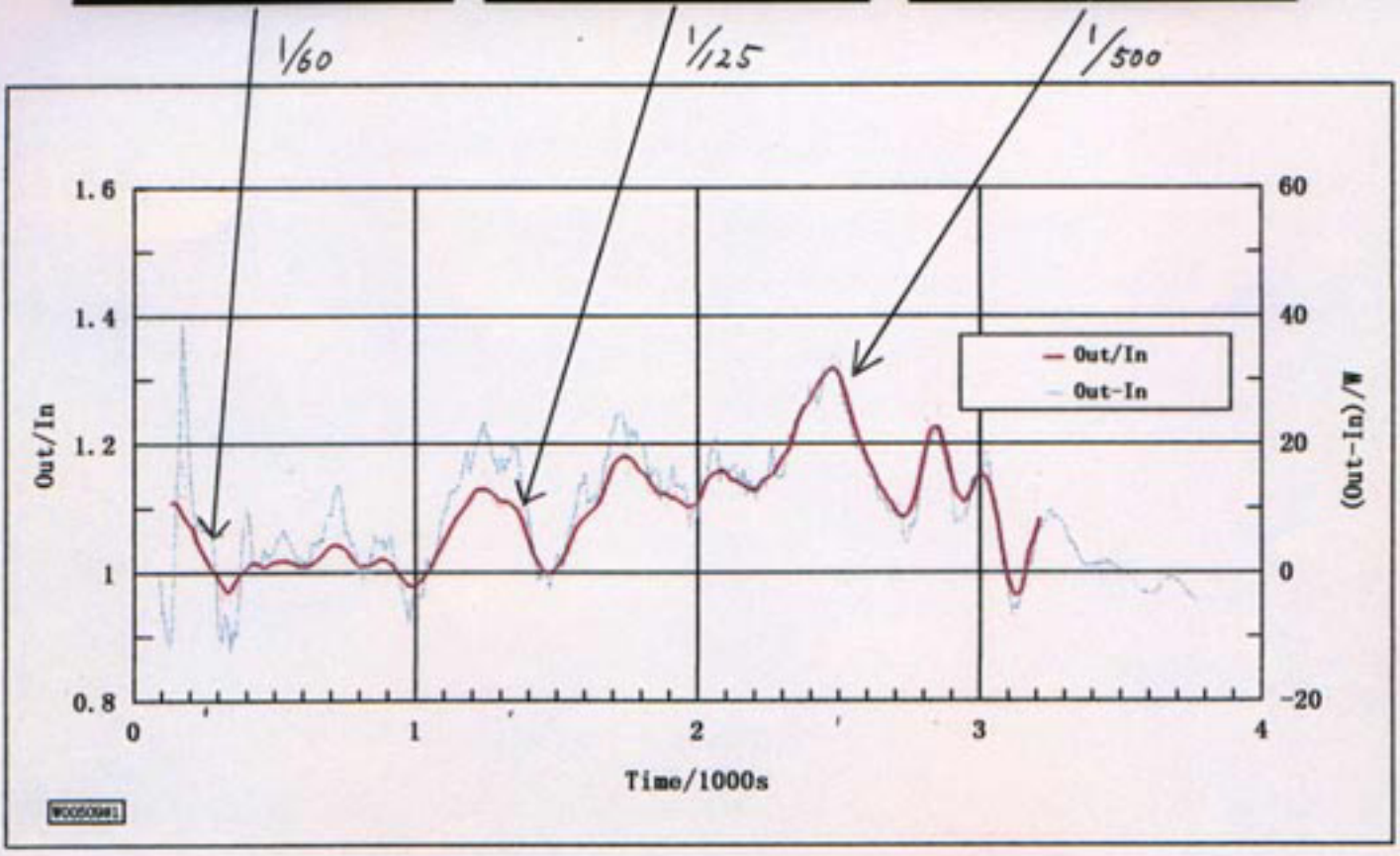
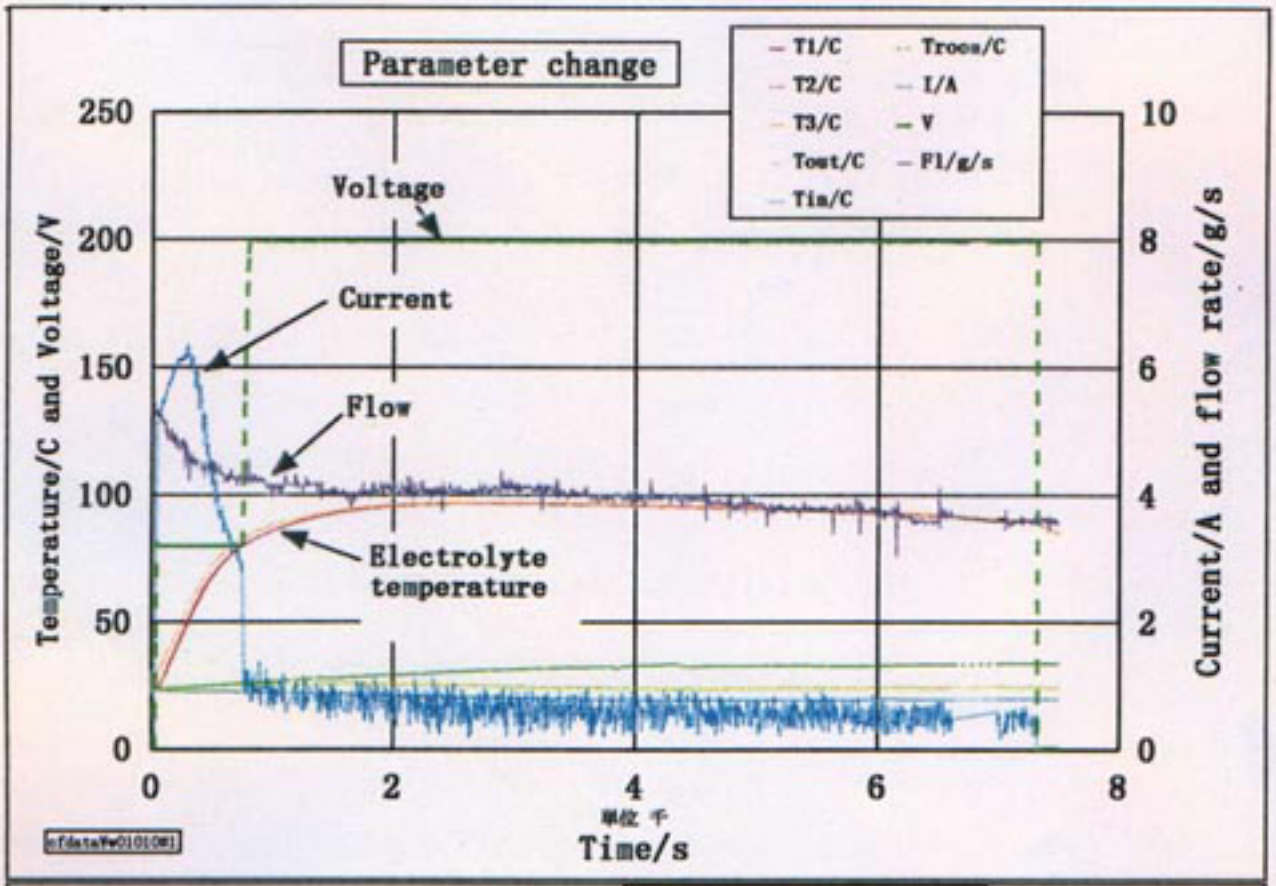
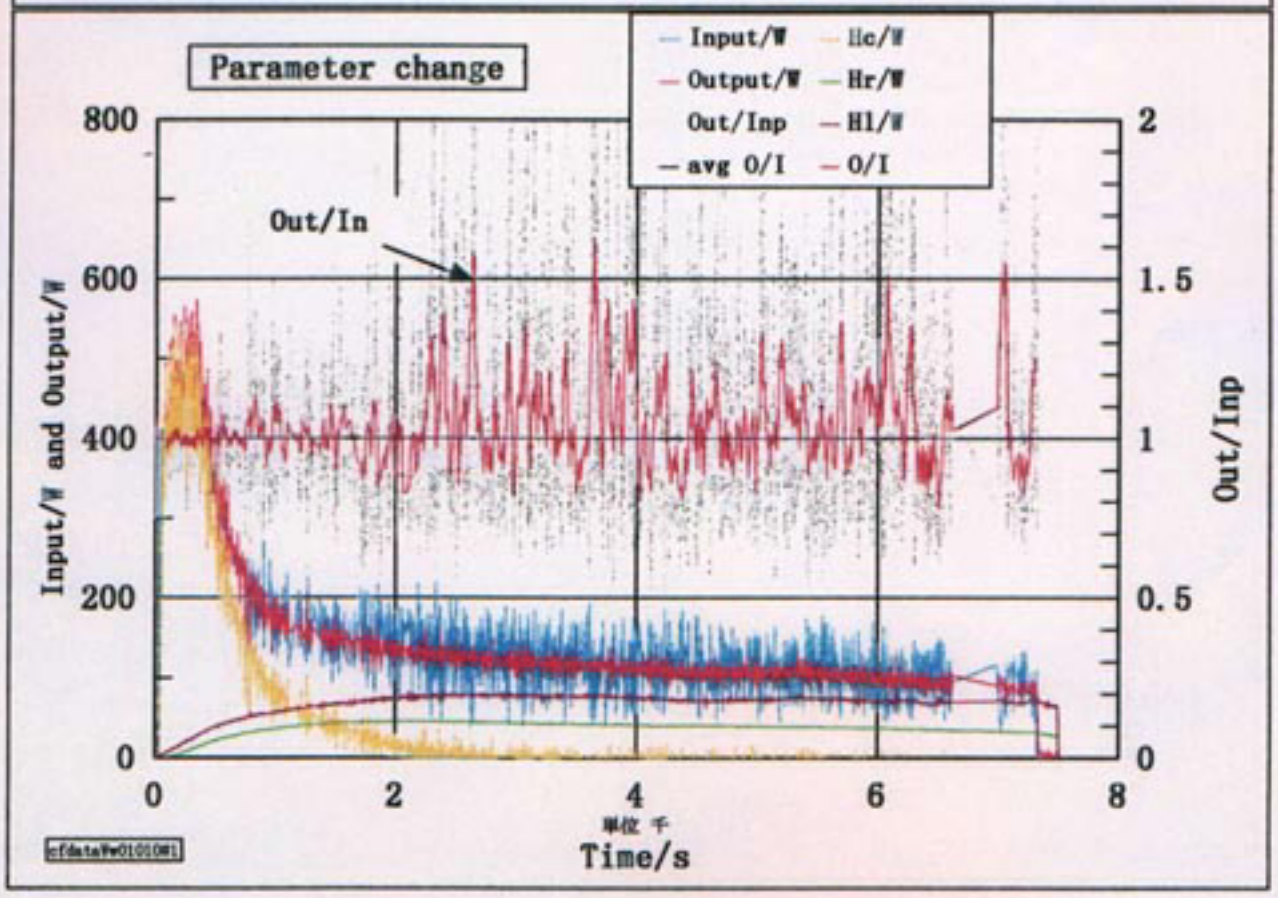


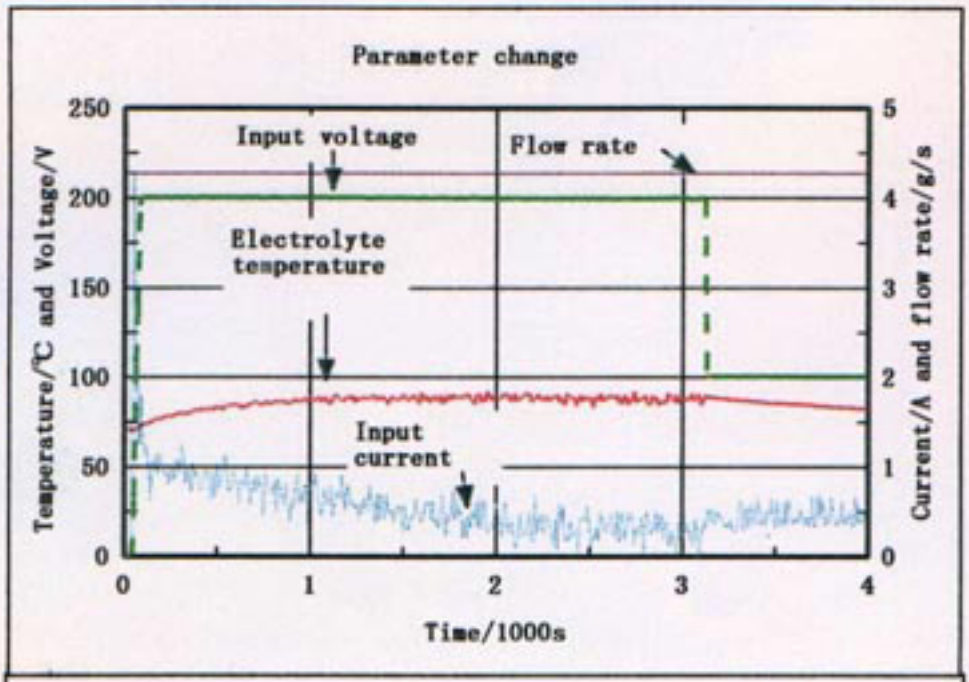
Fig.2 Calibration of heat balance for input and output by a heater wire.
Upper: Changes of input volt, current and temperature,
Lower: Changes of input, output and Out/Input ratio.

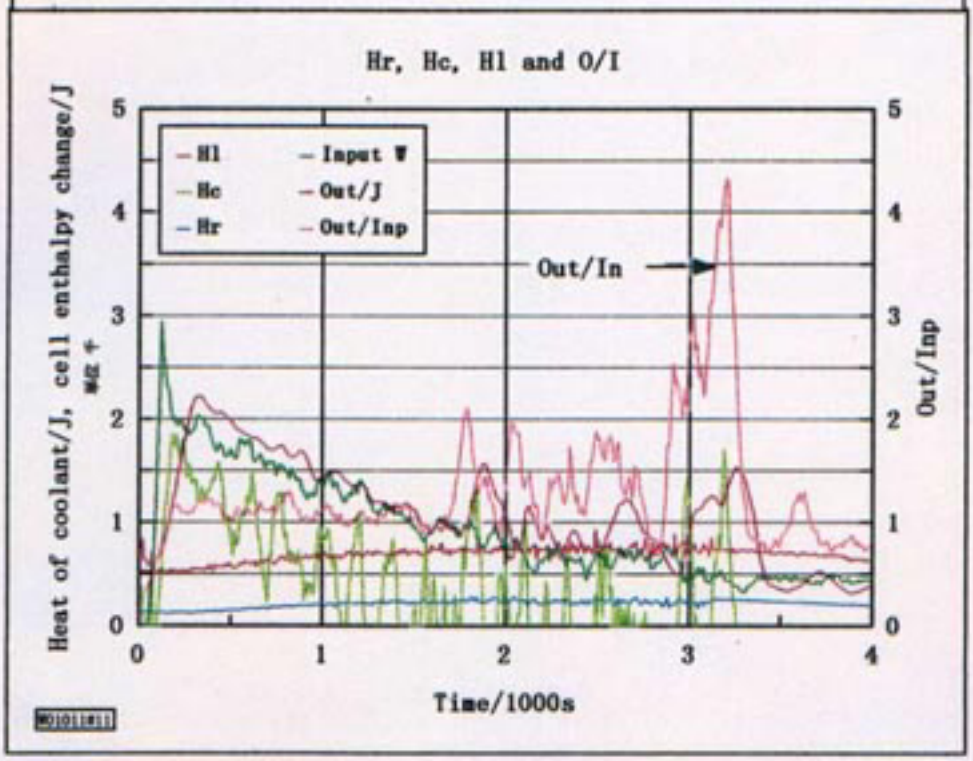
Changes of plasma discharge



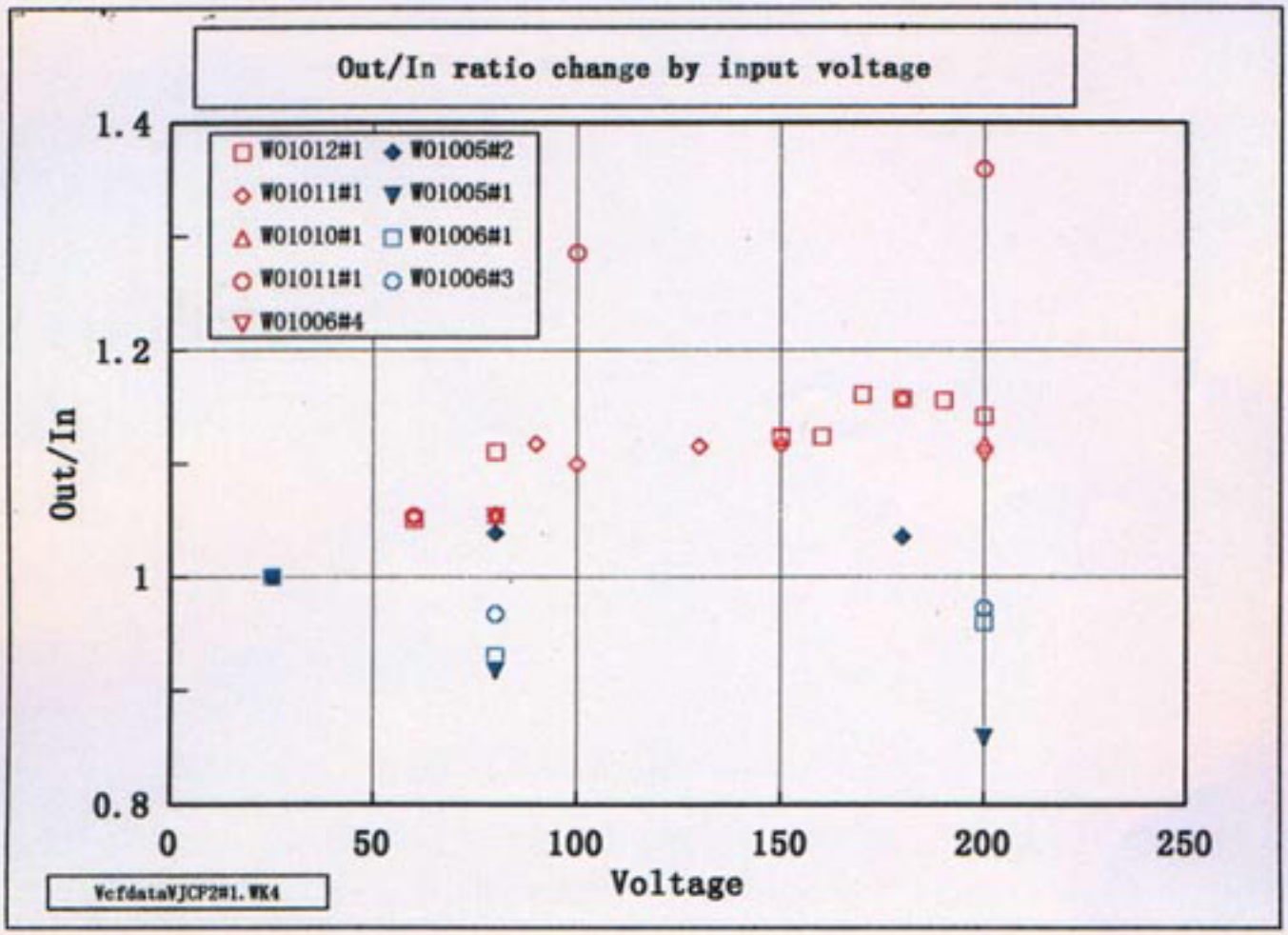

Parameter change
T1/C
T2/C
T3/C
Tout/C
Tin/C
Troom/C
I/A
V
Fl/g/s
Voltage
Current
Flow
Electrolyte temperature
Temperature/C and Voltage/V
Current/A and flow rate/g/s
250
200
150
100
50
0
10
8
6
4
2
0
0
2
4
6
8
单位 千
Time/s


Parameter change
Input/W
Output/W
Out/Inp
avg O/I
Hc/W
Hr/W
Hl/W
O/I
Out/In
Input/W and Output/W
Out/Inp
800
600
400
200
0
2
1.5
1
0.5
0
0
2
4
6
8
单位 千
Time/s



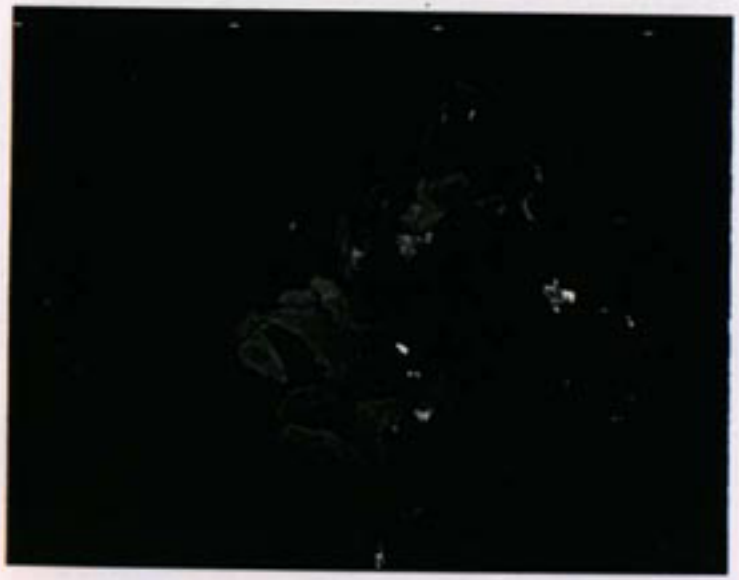


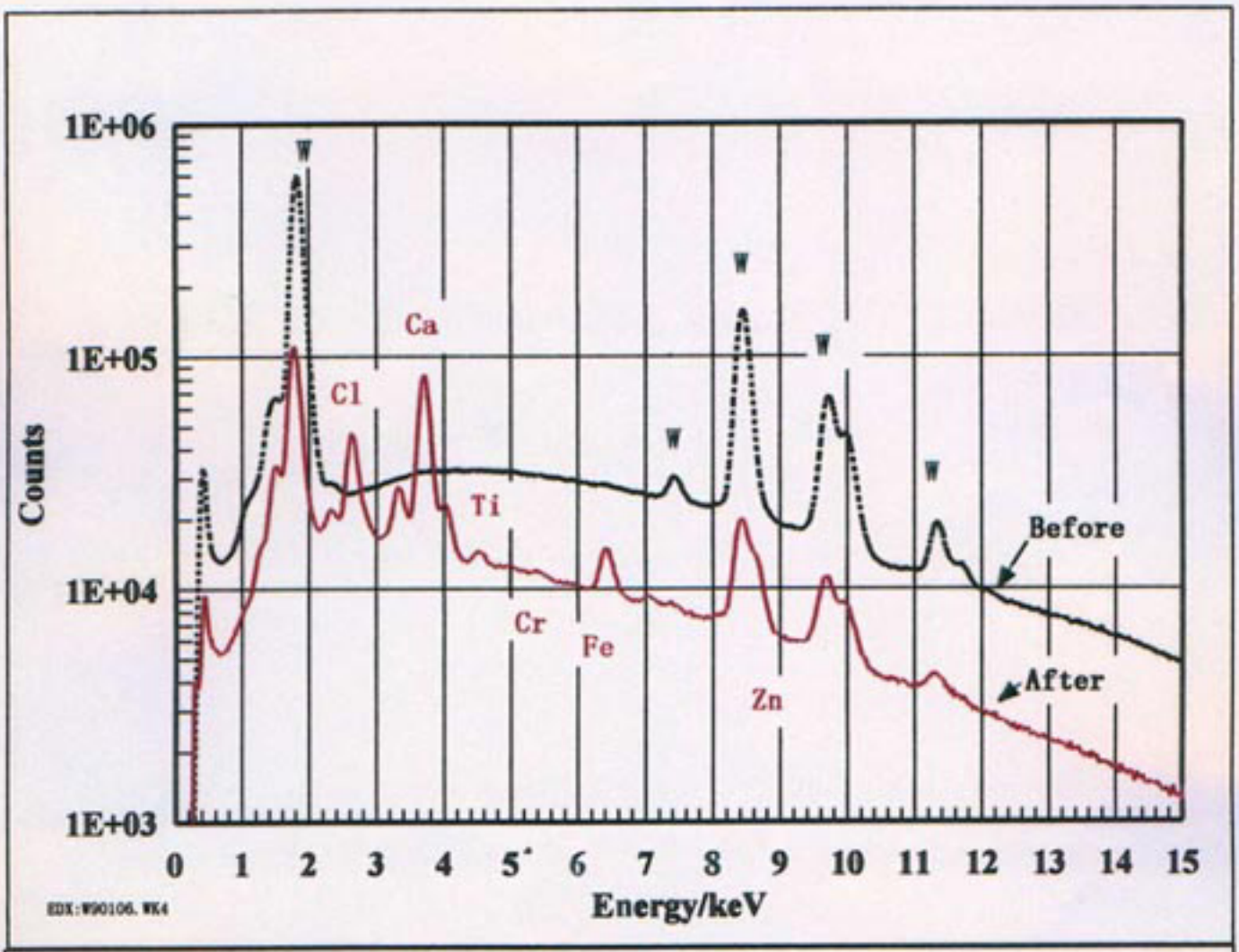
200V 1.29
150V 1.22
60V 1.00


Out/In ratio change by input voltage
W01012#1
W01005#2
W01011#1
W01005#1
W01010#1
W01006#1
W01011#1
W01006#3
W01006#4
1.4
1.2
1
0.8
Out/In
0
50
100
150
200
250
Voltage
VcfdataVJCP2#1.WK4

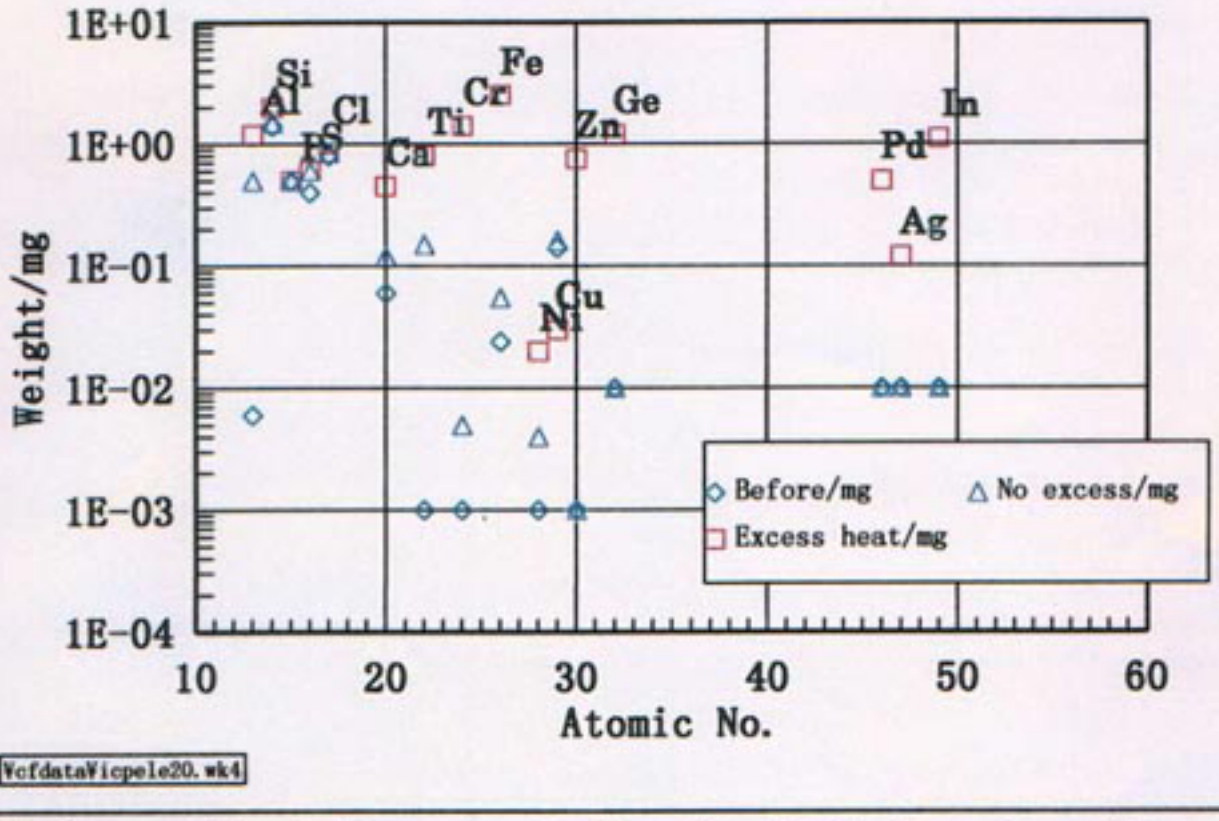
SEM image

1mm





Energy spectra of EDX analysis for W electrode surfaces; before and the after plasma electrolysis.



Total amount of elements in the electrolyte and on the electrode for the case of before, excess heat and no excess heat evolved.

Summary

- Excess heat was confirmed during the plasma electrolysis of tungsten electrode.
- Many elements were detected on the electrode and in the electrolyte for the case of excess heat generated experiment.
- Experimental results can be well explained by the photo fission mechanism.