Ion Sensors for Explosions

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Introduction

- Previous work with individual or multiple discrete electrodes allowed detection of the ions flame front of a butane air explosion
- Electrochem 2007 discussion with Darren Carruana suggested the consideration of the Langmuir probe approach to the explosion measurement

Introduction

- The Langmuir probe is used in plasmas and is essentially a voltage scan technique during which the current is measured (voltages typically -100V to +100V).
- It allows the identification of plasma parameters such as the electron temperature of the plasma and the ion saturation current.

Voltammetry in flames

Investigation of Butane/air explosions

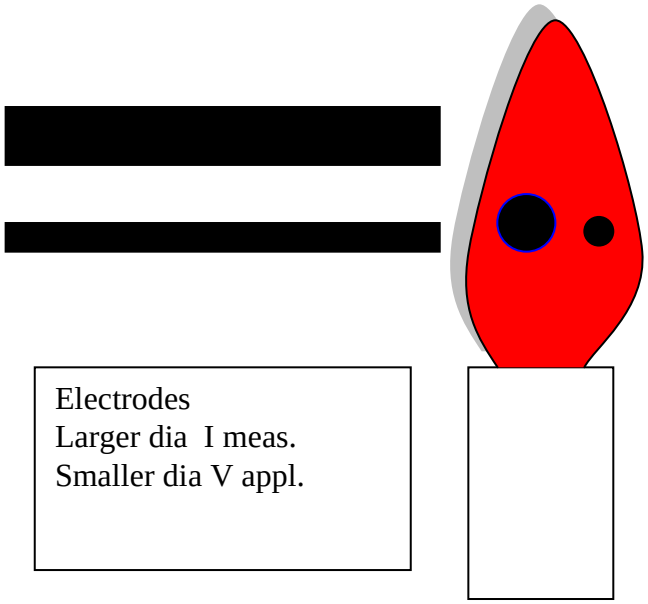
Electrochemical- Voltammetry

Evidence from flames

Attempts at voltammetry in the explosion

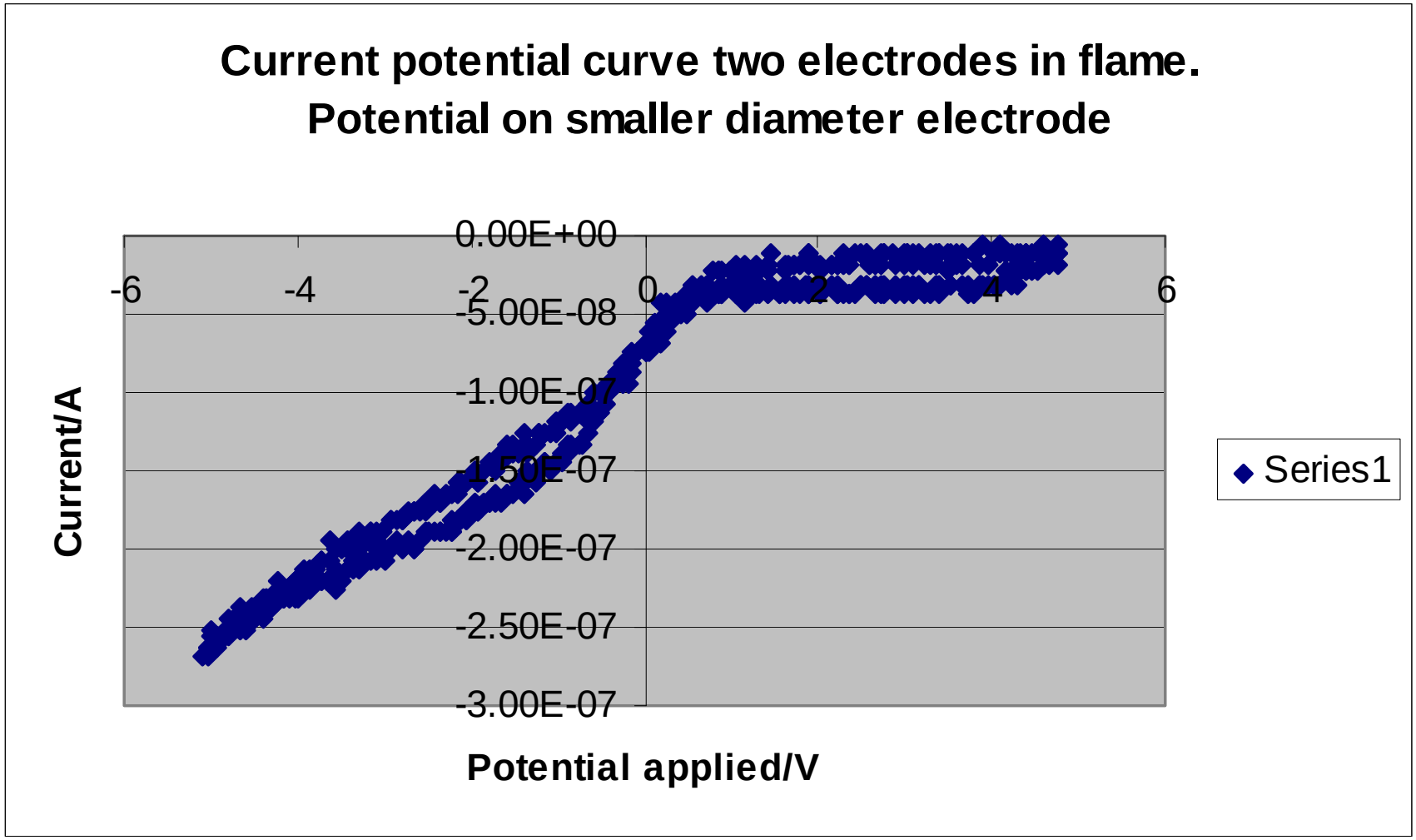
Flames

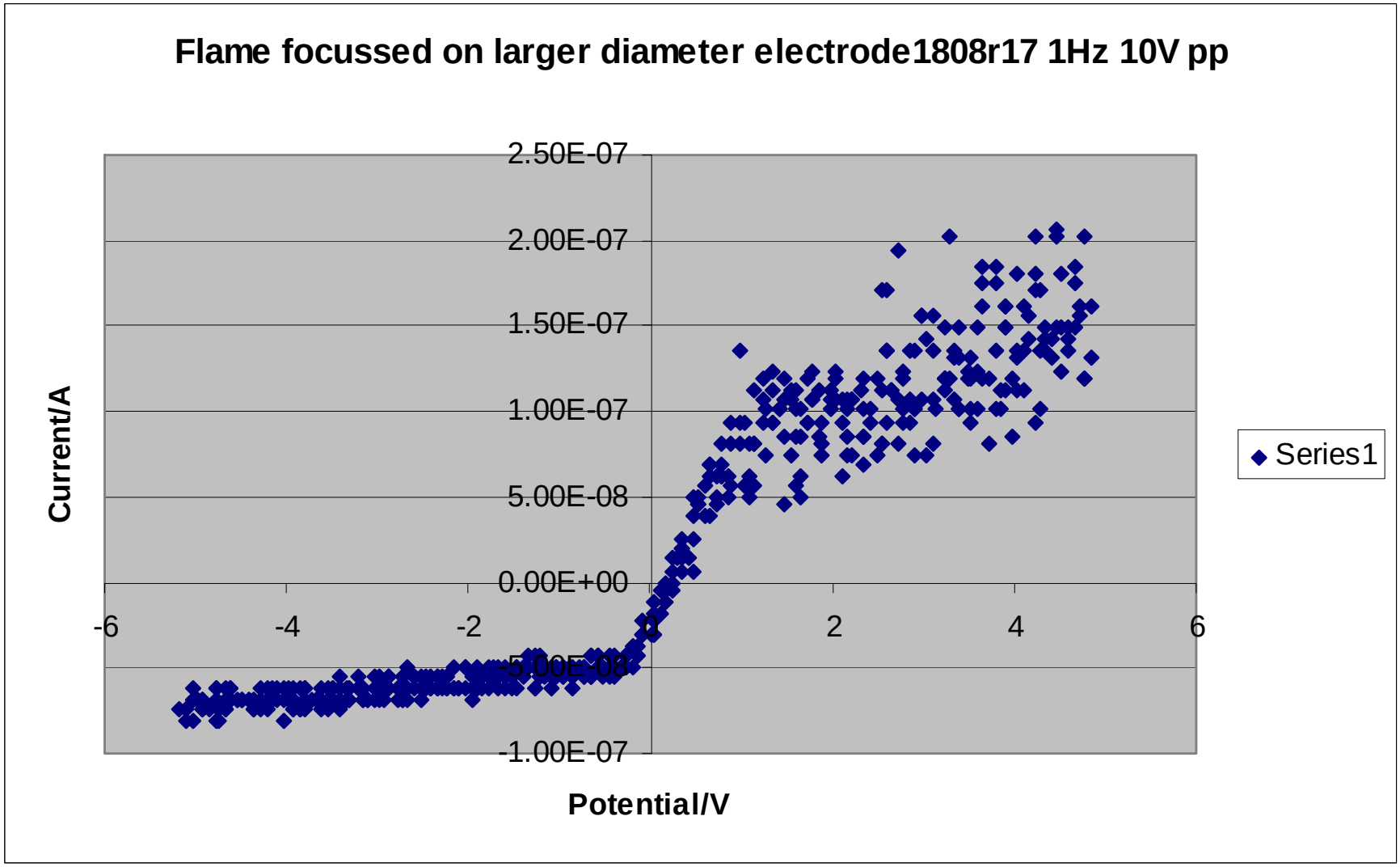
- In the initial part of the work a flame was used as it is easier to make measurements in the flame than in the explosion because of the short duration of the explosion.

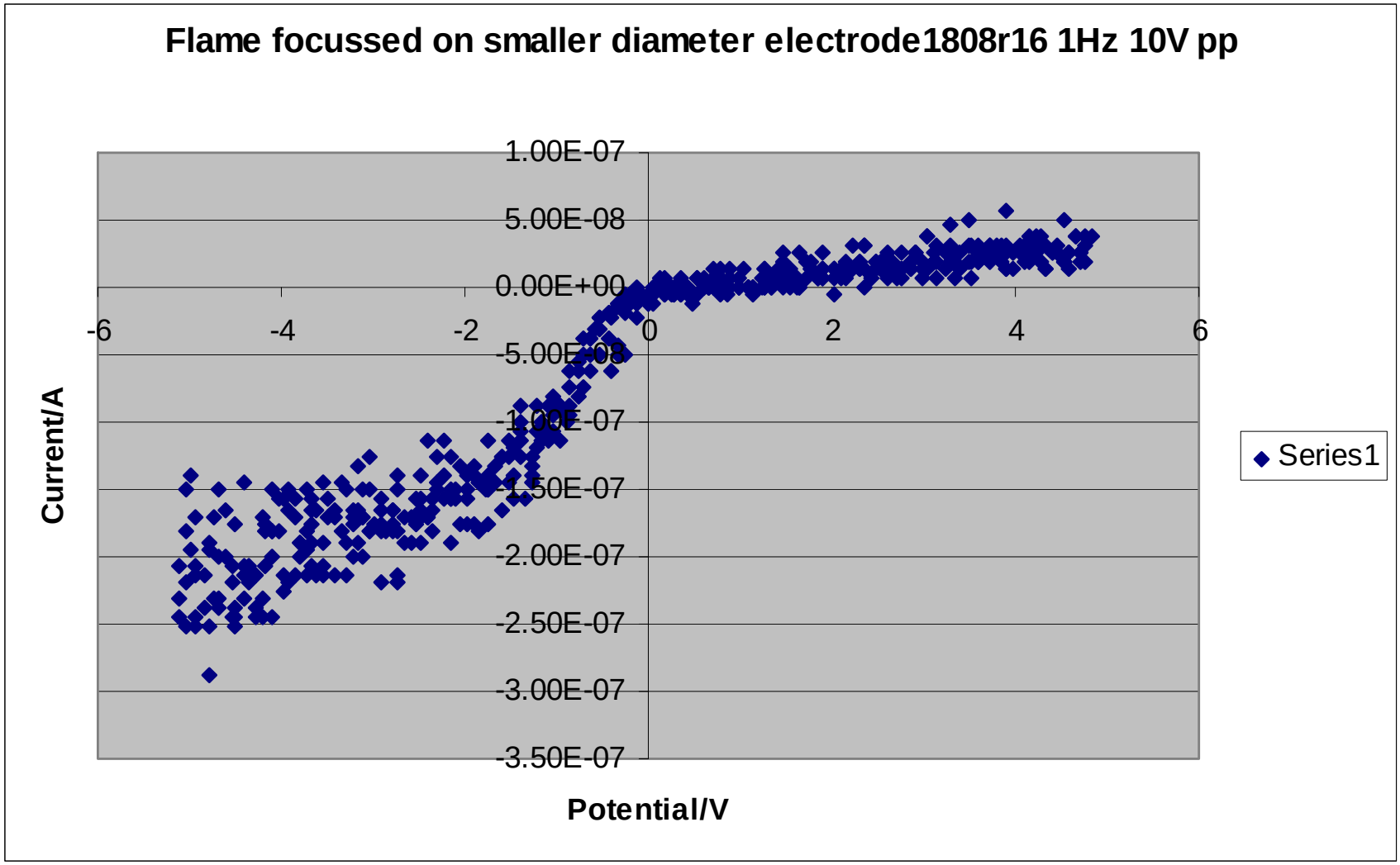


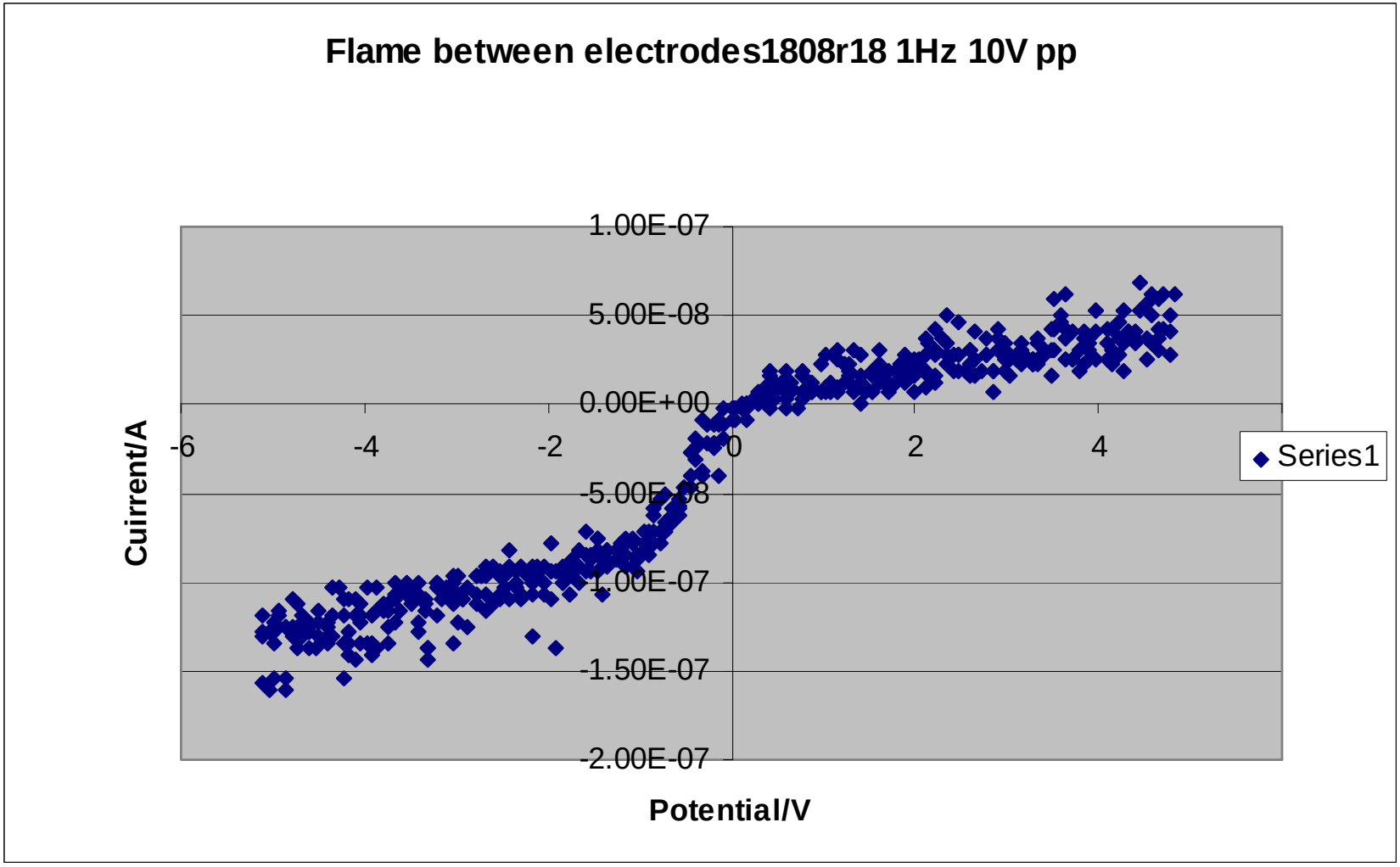
Flame with 2 electrodes

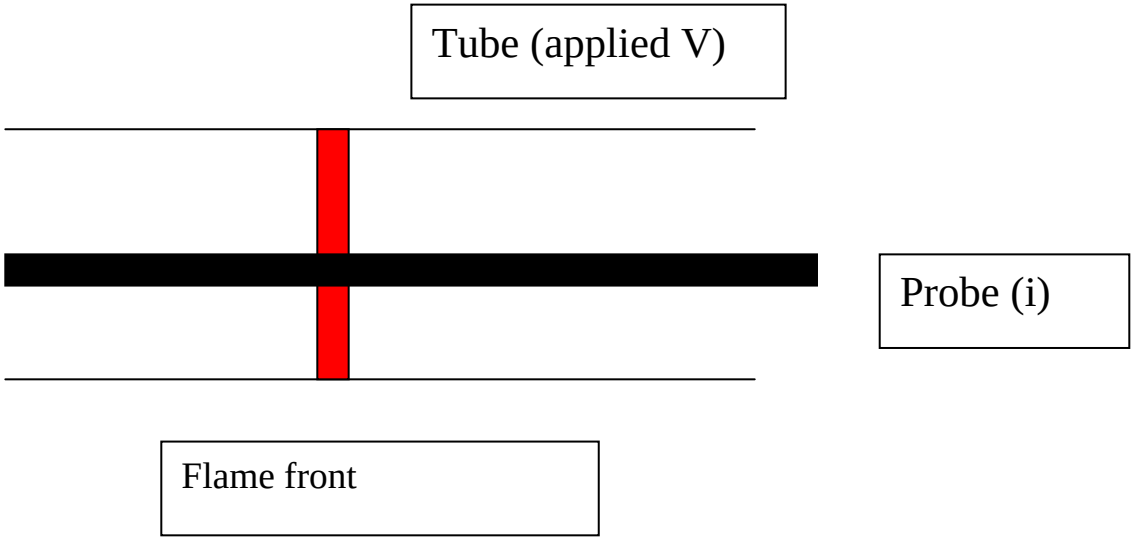
Electrodes
Larger dia I meas.
Smaller dia V appl.

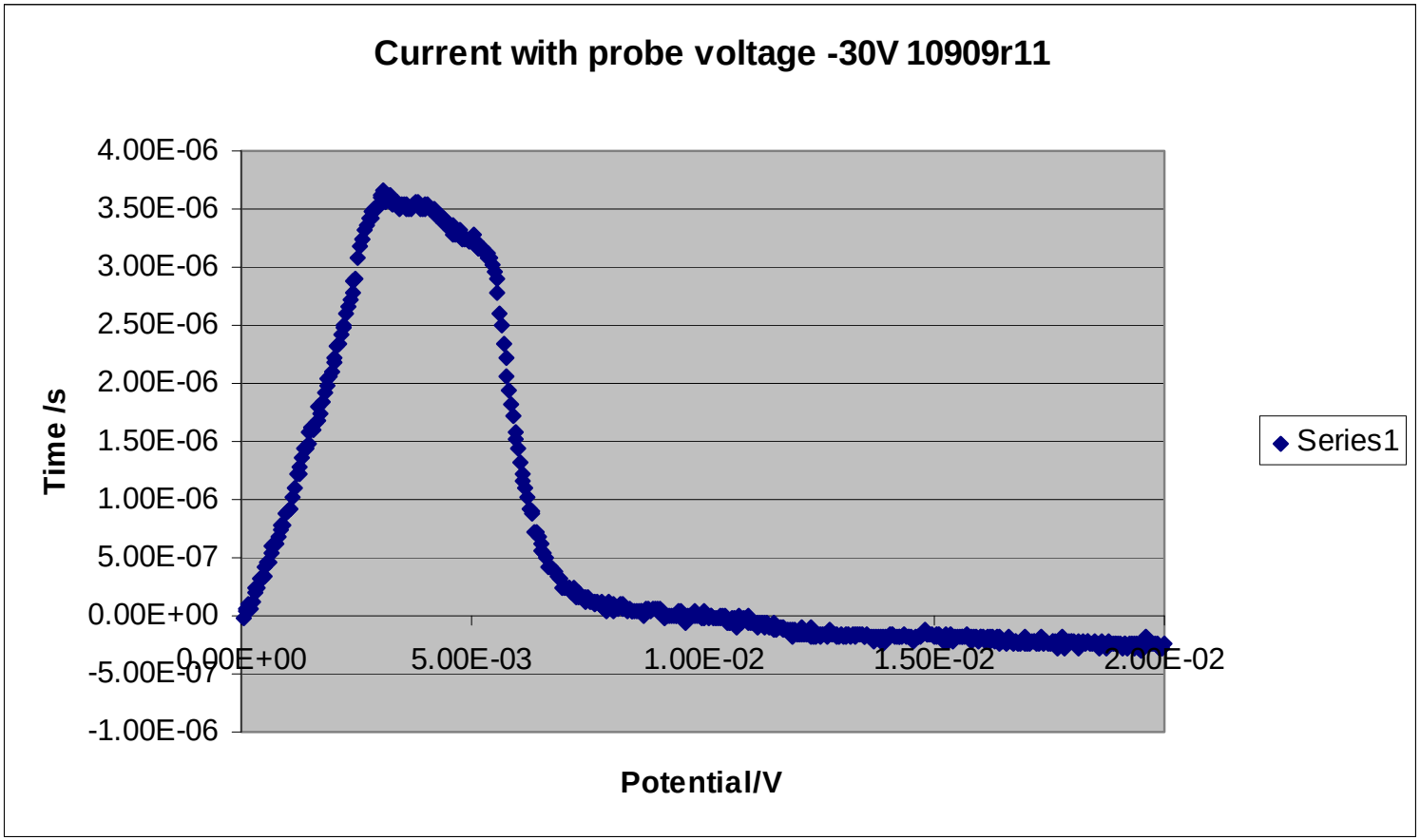

Current potential curve two electrodes in flame.
Potential on smaller diameter electrode
0.00E+00
-5.00E-08
-1.00E-07
-1.50E-07
-2.00E-07
-2.50E-07
-3.00E-07
-6
-4
-2
0
2
4
6
Current/A
Potential applied/V
Series1

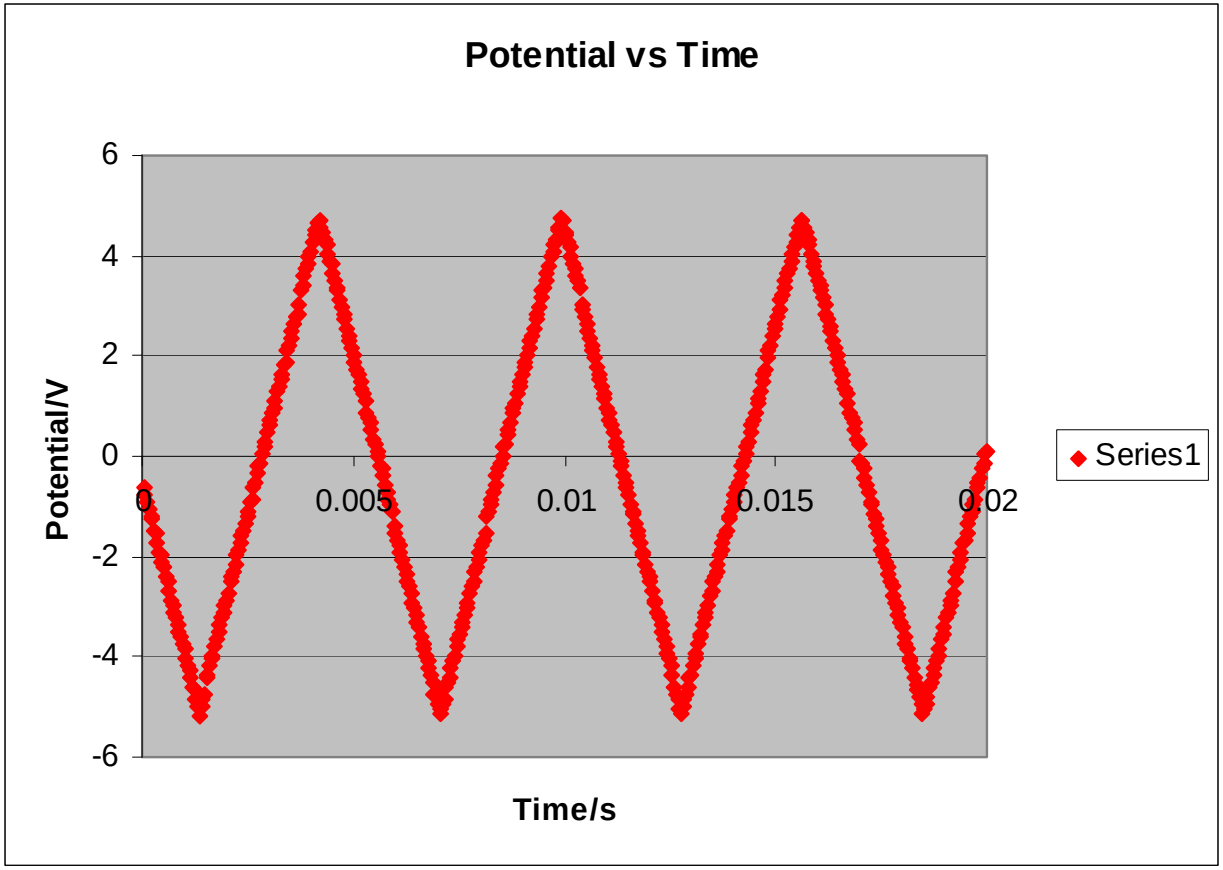

Flame focussed on larger diameter electrode1808r17 1Hz 10V pp
2.50E-07
2.00E-07
1.50E-07
1.00E-07
5.00E-08
0.00E+00
-5.00E-08
-1.00E-07
-6
-4
-2
0
2
4
6
Current/A
Potential/V
Series1

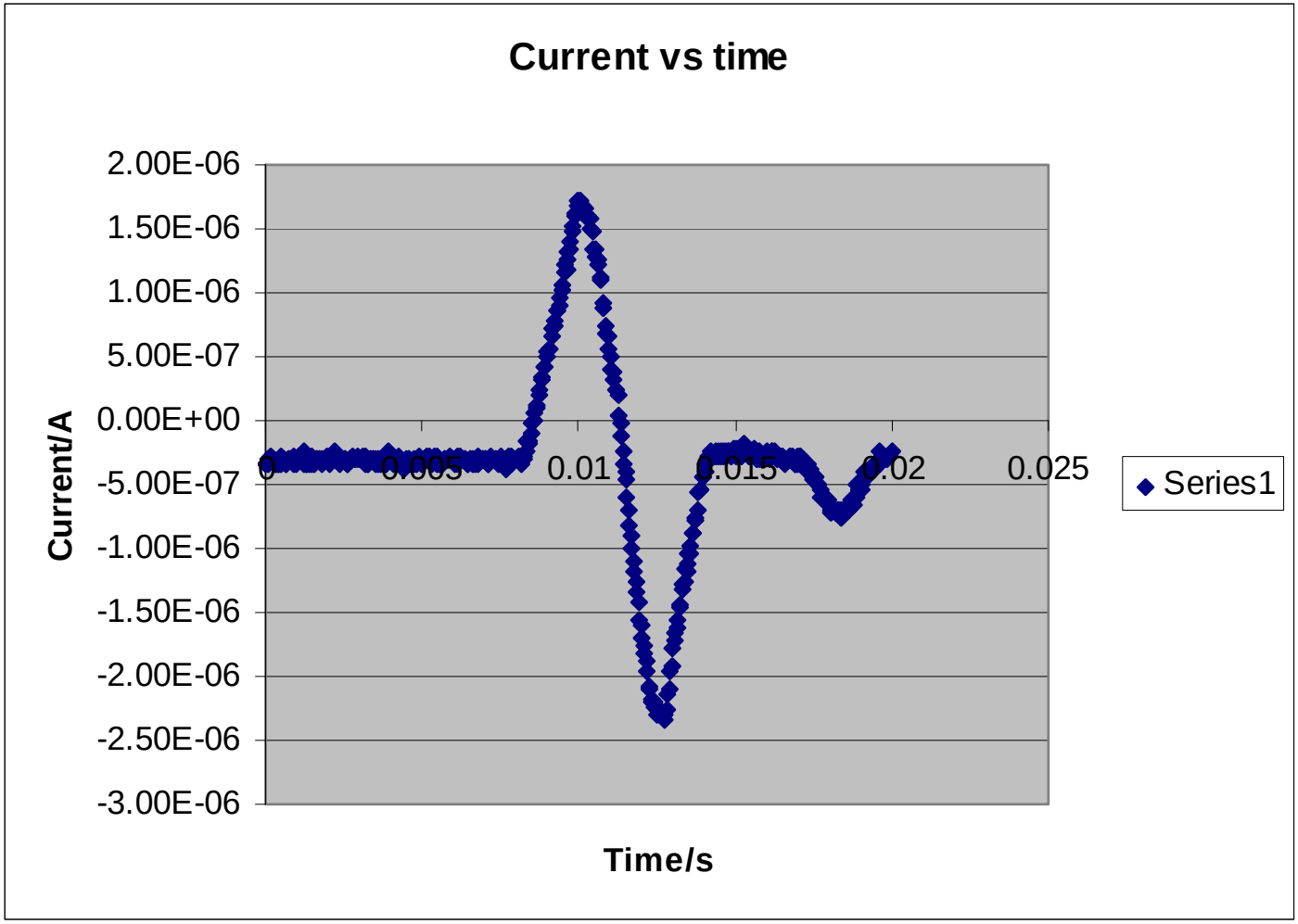

Flame focussed on smaller diameter electrode1808r16 1Hz 10V pp
1.00E-07
5.00E-08
0.00E+00
-5.00E-08
-1.00E-07
-1.50E-07
-2.00E-07
-2.50E-07
-3.00E-07
-3.50E-07
-6
-4
-2
0
2
4
6
Current/A
Potential/V
Series1

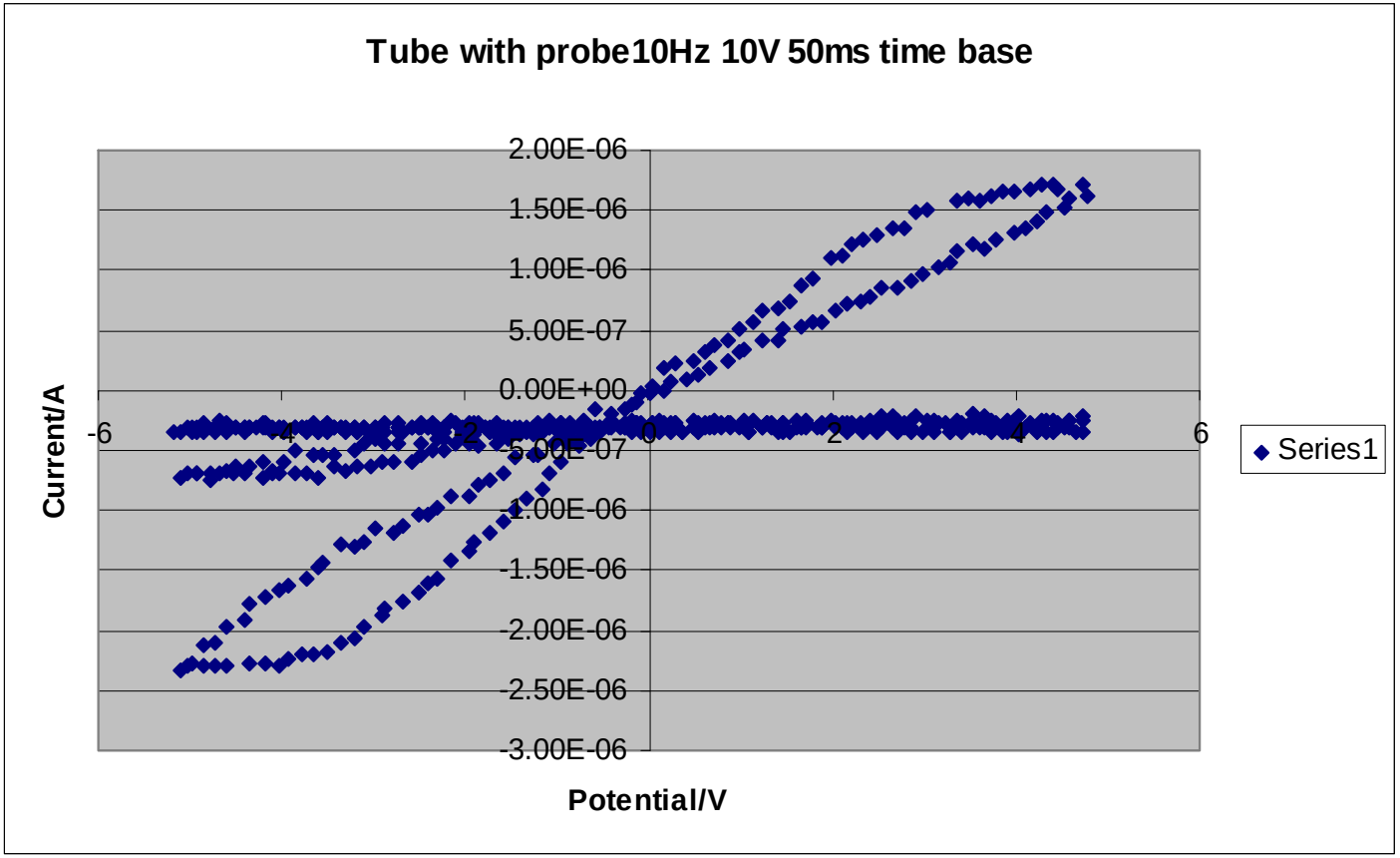

Flame between electrodes1808r18 1Hz 10V pp
1.00E-07
5.00E-08
0.00E+00
-5.00E-08
-1.00E-07
-1.50E-07
-2.00E-07
-6
-4
-2
0
2
4
Cuirrent/A
Potential/V
Series1

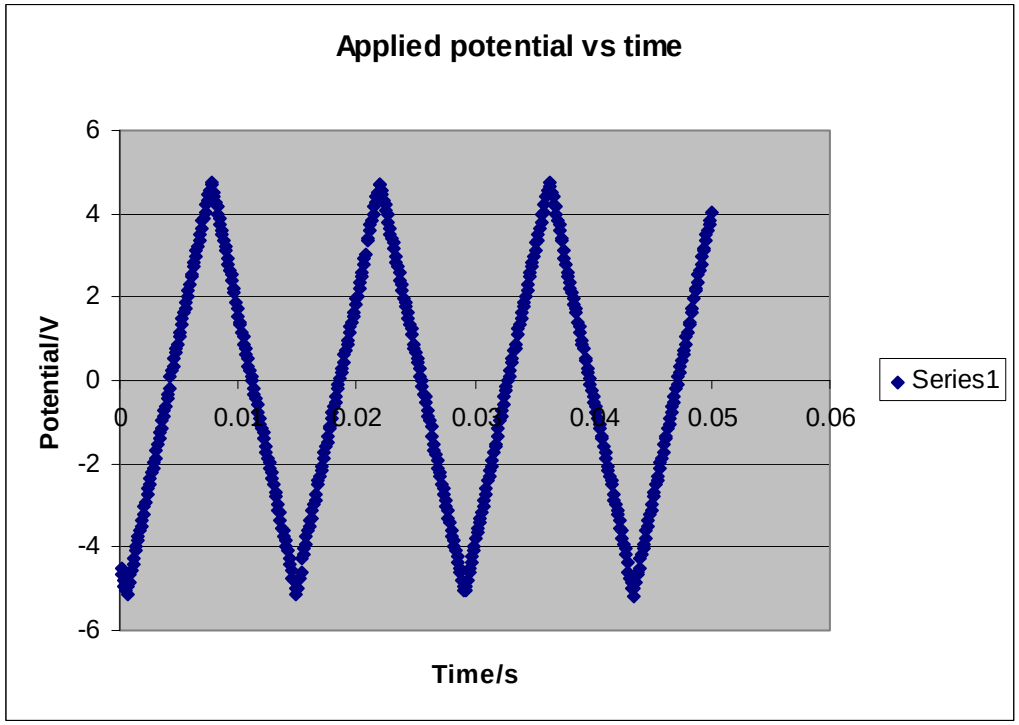

Tube (applied V)
Probe (i)
Flame front

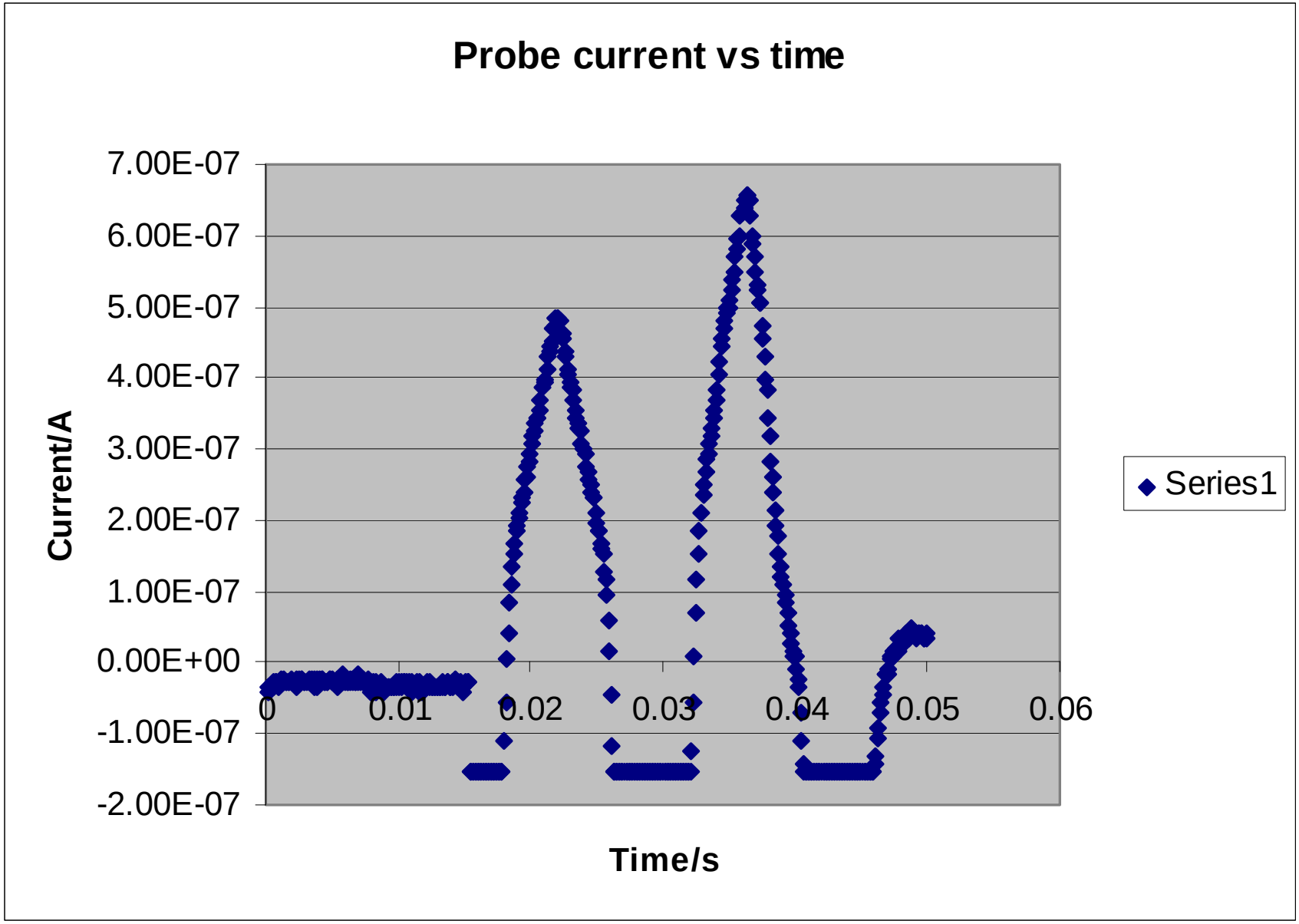

Current with probe voltage -30V 10909r11
4.00E-06
3.50E-06
3.00E-06
2.50E-06
2.00E-06
1.50E-06
1.00E-06
5.00E-07
0.00E+00
-5.00E-07
-1.00E-06
Time /s
0.00E+00
5.00E-03
1.00E-02
1.50E-02
2.00E-02
Potential/V
Series1

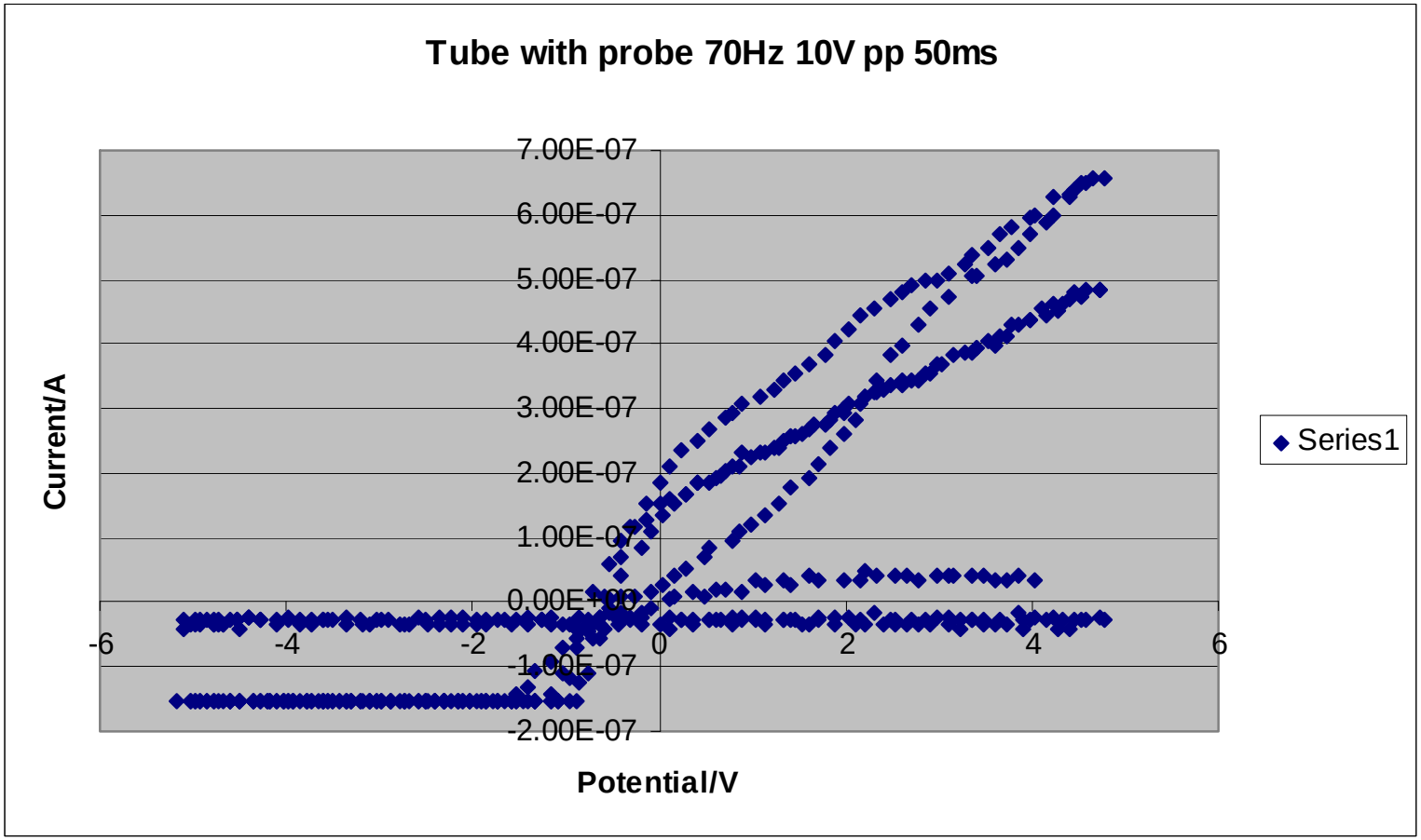

Potential vs Time
6
4
2
0
-2
-4
-6
Potential/V
0
0.005
0.01
0.015
0.02
Time/s
Series1


Current vs time
2.00E-06
1.50E-06
1.00E-06
5.00E-07
0.00E+00
-5.00E-07
-1.00E-06
-1.50E-06
-2.00E-06
-2.50E-06
-3.00E-06
Current/A
0
0.005
0.01
0.015
0.02
0.025
Time/s
Series1


Tube with probe10Hz 10V 50ms time base
2.00E-06
1.50E-06
1.00E-06
5.00E-07
0.00E+00
-5.00E-07
-1.00E-06
-1.50E-06
-2.00E-06
-2.50E-06
-3.00E-06
-6
-4
-2
0
2
4
6
Current/A
Potential/V
Series1


Applied potential vs time
6
4
2
0
-2
-4
-6
Potential/V
0
0.01
0.02
0.03
0.04
0.05
0.06
Time/s
Series1


Probe current vs time
7.00E-07
6.00E-07
5.00E-07
4.00E-07
3.00E-07
2.00E-07
1.00E-07
0.00E+00
-1.00E-07
-2.00E-07
Current/A
0
0.01
0.02
0.03
0.04
0.05
0.06
Time/s
Series1


Tube with probe 70Hz 10V pp 50ms
Current/A
7.00E-07
6.00E-07
5.00E-07
4.00E-07
3.00E-07
2.00E-07
1.00E-07
0.00E+00
-1.00E-07
-2.00E-07
-6
-4
-2
0
2
4
6
Potential/V
Series1

Conclusions

- It is possible to carry out a voltammetric scan in the flame front of the explosion
- Conditions need to be optimised
- Underlying theory needs to be considered and potential scan range extended

Thanks

- To Electrochem 2008 for the opportunity to speak
- Honours project students Lorna Rae and David Woods for their enthusiasm
- Glasgow Caledonian University
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