308 - - - Q200604180005

Scientific Notebook No. 287: Microbially Influenced Corrosion of Container Materials,
~~Continues in Scientific Notebook No. 516,~~ 4/10/06
Continued in Scientific Notebook No. 604
(09/17/2002 through 04/07/2006)

Book #287

MIC work

(2)

21
300

R

CSPE /CLST
20.01402.571
Salt Film Formation Studies
MIC Testing — NRC

CNWRA
CONTROLLED
COPY 287

S. Brossia
x5797

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Roger J Dykstra Roger J Dykstra RJD L. Yang L.Y.
STUART BIRNBAUM Stuart Birnbaum SB
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Revised Initial Entries for Notebook #287:

Title: Microbially Influenced Corrosion of Container Materials

For pages starting at page 32.

Names of the individuals performing the activity:
Lietai Yang, Roger Dykstra, Geri Becker and Stuart Birnbaum (All signatures are in the back of cover page of this book).

Objectives and the proposed approach or procedure:
Microbially influenced corrosion of alloys in solutions containing different microbes. Two types of tests will be conducted, one is polarization test and the other is the corrosion rate measurement, both in electrochemical cells.

Equipments and measurement parameters:

Polarization test will be carried out with a Model 1287A Solartron potentiostat.

Coupling currents from MAS probes will be measured with the Keithly 2182 nanovolt meter and Keithley 7001 Mainframe Switch. The potentials from electrodes will be measured with a Keithley 617 electrometer SN0679628. The pH will be measured with Orion EA940, SN 2330,

Software:
In-house developed visual basic code was used to control the two Keithley meters and to store the data in a computer hard drive. The visual basic code was verified (see page 45, Scientific Note Book # 423).

Test equipment calibration, accuracy, and precision requirements:

. The performance of the potentiostat must be verified according to latest TOP 22.
The Keithley meters (7001 and 2182) must be regularly verified according to TOP 22.

Keithley 617 electrometer, Orion EA940 pH meter, and thermometer: All of these meters must have valid calibration stickers.

Required level of accuracy:
Temperature: ±3 oC, pH: ±0.5, Potential ±5 mV; Currents: ±10 nA.

Potential Source of Uncertainty:
Temperature in room may change with climate. Additional heaters may be required in room during the winter season.

Special personnel training or qualification requirements:
None
Material/chemical:
Varies (see in-progress entries).

L. Y. 2/14/06

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9/17/02

SB 9/17/02

SB 9/17/02

SB 9/17/02

Initial Notebook Entry

Investigation of Localized Corrosion Propagation Rates in Materials

Overall Objectives:	Examine mechanisms and rates of localized corrosion (pitting and crevice corrosion) in materials of interest to HLW disposal in a geologic repository (i.e., A516 carbon steel, stainless steels) as well as constituents of these materials (i.e., Fe, Cr, Ni, etc.) using various DC and AC electrochemical techniques and Raman spectroscopy.
Tests Performed by:	Sean Brossia, Darrell Dunn, other personnel will be identified as they begin work on specific tests
Materials:	Iron, Chromium, Fe-Cr binary materials, Fe-Cr-Ni ternary materials, A516 carbon steel (Heat #D84994)
Equipment:	Specific equipment will be listed and noted with initial experiments. All equipment will be calibrated or performance verified depending on the type of equipment.

8/15/98 SB

Initial Test Entry

In-Situ Study of Salt Film Stability in Simulated Pits and Their Relationship to Pit Propagation

(Continuation of program initiated in Notebook #131, page 3)

Overall Objectives: Examine stability and nature of salt films in simulated pits on various materials using DC and AC electrochemical techniques and Raman spectroscopy.

Tests Performed by: Sean Brossia, Darrell Dunn, other personnel will be identified as they begin work on specific tests

Materials: Iron, Chromium, Fe-Cr binary materials, Fe-Cr-Ni ternary materials, A516 carbon steel, Titanium

8/10/98 SB

8/10/98

EIS of Fe salt film precipitation in simulated pit

Using same setup as before in Raman work

Soln – 0.5 M HCl + 2 M NaCl, deaerated w/ N_2
Temp – room temp — Lot# 972274

EIS setup – Solartron 1287 (SwRI ID 029658)
Solartron 1260 (SN 400122)
ZPlot for Windows
RE – SCE SN: 81220210

min	Files	Conditions	Setup
	feocp1.z	initial open circuit scan	feocp.zpw
	feocp2.z	1 min delay after previous	feocp.zpw
10	fe9001.z	10 min @ 900 mVsce	fe900.zpw
30	fe9002	20 min after fe9001 @ 900	
60	fe9003	30 min after fe9002 @900	
120	fe9004	60 min after fe9003 @ 900	
CSB 8/12/98 180	fe9005	60 m after fe9004 @900	
900 ~~240~~	fe9006	~~60~~ 12 hrs m CSB 8/12/98 after fe9005 @ 900	
960	fe9007	60 m after fe9006 @900	
1020	fe9008	60 m after fe9007 @900	
1080	fe9009	60 m after fe9008 @ 900	
1320	fe90010	~~60~~ 4 hrs m CSB 8/10/98 after fe9009 @ 900	
1380	fe90011	60 m after fe90010 @ 900	
10	fe7501	10 m after fe90011 @ 750 mV	fe750.zpw
30	fe750~~1~~2 CSB 8/10/98	20 m after fe7501 @ 750	
60	fe750~~2~~3 CSB 8/10/98	30 m after fe7502 @750	
120	fe750~~3~~4 CSB 8/10/98	60 m after fe7503 @ 750	
180 CSB 8/10/98	fe750~~4~~5 CSB 8/10/98	60 m after fe7504 @ 750	
	~~fe750~~6 CSB 8/10/98	~~60 m after fe7505 @ 750~~	CSB 8/10/98
	~~fe750~~6	CSB 8/12/98 test eliminated – not needed	CSB 8/12/98

CSB 8/10/98

Cont on p8

8/10/98

cont from p7

	file	Conditions	Set-up
10	fe 6001	10 m after fe 7506 @ 600 mV	fe600.zpw
30	6002	20 m	
60	6003	30 m	
120	6004	60 m	
eliminated	~~6005~~	~~60 m~~ SB 8/12/98	
CSB 8/12/98	~~6006~~	~~60~~ SB 8/12/98	
	fe 4501	10 m after fe 6006 @ 450 mV	fe450.zpw
	4502	20	
	4503	30 CSB 8/10/98	
	4504	~~60~~ 60	
eliminated	~~4505~~	~~60~~ SB 8/12/98	
CSB 8/12/98	~~4506~~	~~60~~ SB 8/12/98	
	fe 3001	10m after 4506 @ 300 mV	CSB 8/10/98 fe 300.zpw
	3002	20	
	3003	30	
	3004	60	
eliminated	~~3005~~	~~60~~ SB 8/12/98	
SB 8/12/98	~~3006~~	~~60~~ SB 8/12/98	
	fe 0001	10 m after fe3006 @ 0 mVsce	fe 0.zpw
	0002	20	
	0003	30	
	0004	60	
eliminated	~~0005~~	~~60~~ SB 8/12/98	
SB 8/12/98	~~0006~~	~~60~~ SB 8/12/98	
	fe -1501	10 m after fe0006 @ -150 mVsce	fe-150.zpw
	-1502	20	
	-1503	30	
	-1504	60	
eliminated	~~-1505~~	~~60~~ SB 8/12/98	
SB 8/12/98	~~-1506~~	~~60~~ SB 8/12/98	

CSB 8/10/98

cont on p9

8/10/98

from p9

	File	Conditions	Setup
	fe -3001	10 m after fe -1506 @ -300 mVsce	fe-300.zpw
	-3002	20	
	-3003	30	
	-3004	60	
eliminated	~~-3005~~	~~60~~ SB 8/12/98	
SB 8/12/98	~~-3006~~	~~60~~ SB 8/12/98	
	fe -4501	10 m after fe -3006 @ -450 mVsce	fe-450.zpw
	-4502	20	
	-4503	30	
	-4504	~~60~~ 60 SB 8/12/98	
eliminated	~~-4505~~	~~60~~ SB 8/12/98	
SB 8/12/98	~~-4506~~	~~60~~ SB 8/12/98	
	fe -6001	10 m after fe -4506 @ -600 mVsce	fe-600.zpw
	-6002	20	
	-6003	30	
	-6004	60	

CSB 8/10/98

8/12/98 further EIS testing

cut down time @ each potential to try and see how quickly things (the system) stabilized.

fe 900 1b	18 hrs @ +900 mVsce	
2b	+5 min	30
3b	+5 min	90
750 1b	1 min @ 750	210
2b	+5 min	390
3b	+5 min	570
600 1b	1 min @ 600	750
2b	+5	1110
3b	+5	1290
450 1b	1 min @ 450	1291
2b	+5	1296
3b	+5	1356
300 1b	1 min @ 300	1476
2b	+5	1716
3b	+5	1717
150 1b	1 min @ 150	1722
2b	+5	1782
3b	+5	1902
0 0 1b	1 min @ 0 mVsce	2142
2b	+5	2143
3b	+5	2148
-150 1b	1 min @ -150 mV	2208
2b	+5	2328
3b	+5	2568
-300 1b	1 min @ -300 mV	2569
2b	+5	2574
3b	+5	2634
-450 1b	1 min @ -450 mV	2754
2b	+5	2994
3b	+5	

CSB 8/12/98

EIS Testing of Fe simulated pit 8/13/98

- Examine Δ's in EIS spectra vs time
  - including development of salt film during hold @ +900 mVsce

fe 900 1c	1 min @ +900 mVsce
2c	+30 m
3c	+60 m] Δ 3c → 4c is 2 hrs
4c	+2 h
5c	+3 h
6c	+3 h
7c	+3 h
8c	4 h - air bubble removed and 8c re-started
9c	+3 h
750 1c	1 min @ 750 mV
2c	+5 m
3c	+60 min
4c	+120 min
5c	+240 min
600 1c	1 min @ 600 mV
2c	+5
3c	+60
4c	+120
5c	+240
450 1c	1 min @ 450 mV
2c	+5
3c	+60
4c	+120
5c	+240
300 1c	1 min @ 300 mV
2c	+5
3c	+60
4c	+120
5c	+240

CSB 8/12/98 cont to p 12

8/13/98
from p11

2995	150	1c	1 min @ 150 mV/sec
3000		2c	+5
3060		3c	+60
3180		4c	+120
3420		5c	+240
3421	000	1c	1 min @ 0.0 mV/sec
3426		2c	+5
3486		3c	+60
3606		4c	+120
3846		5c	+240
3847	-150	1c	1 min @ -150 mV
3852		2c	+5
3912		3c	+60
4032		4c	+120
4272		5c	+240
4273	-300	1c	1 min @ -300
4278		2c	+5
4338		3c	+60
4458		4c	+120
4698		5c	+240
4699	-450	1c	1 min @ -450
4704		2c	+5
4764		3c	+60
4884		4c	+120

CSB 8/13/98

8/18/98

A516 Carbon Steel Simulated Pit

120 mM Na_2CO_3 + 1000 ppm Cl^-, deaerated

4 mm diameter

Raman Spectra:

8/21	A516 0001.spc
8/24	A516 0003
8/24	A516 0004
8/24	A516 0005
8/24	A516 0006
8/24	A516 0007
8/25	A516 0008
8/25	A516 0009

CSB 8/18/98

8/19/98

Fe rod in 0.5 M HCl + 2 M NaCl
polarized to 0.9 V

→ Raman spectra of soln above ppt'd film

fecl 0159	- salt film on Fe	position:	25.11 mm
0160	- 5mW, 40s, 3 ac		25.01
0161	- 5mW, 60s, 3ac		25.41 ~base
0162			25.0
0163			24.5
0164			24.0
0165			23.5
0166			22.5
0167			21.5
0168			20.0
0169			17.5
0170			15 bulk
0171			top of tube / soln
0172			ppt'd film

CSR 8/19/98

8/25/98

Cr rod in 0.5 M HCl + 2M NaCl
→ 1.5V

Raman Spectra

Cr 0005	- orange/yellow cloud in pit	position:	15 mm / base
0006			14
0007			13
0008			12
0009			11
0010			10
0011			7.5
0012			5
0013			2.5

CSR 8/25/98

8/26/98 Cr rod - simulated pit - in 0.5 M HCl + 2 M NaCl

→ polarized to +0.9 Vsce

Raman Spectra

Cr0014 - surface of sample after 22 ks @ +900
15 - 1 mm above surface after 94 ks
16 - surface after 106 ks - faint green cloud
17 - 0.25 mm above surface
18 - 0.50 mm above surface

CSR ~~8/8~~ CSR 8/26/98 8/26/98

Raman of $CrCl_3$ solutions in 0.5 M HCl 9/18/98

~Molar →	molal →	g/L		
0.5	0.496	133.225	100 mL →	13.323
1.0	0.992214	266.45	100 mL →	26.645
2.0	1.984428	532.90	50 mL →	26.645
4.0	3.968856	1065.8	50 mL →	53.290
6.0	5.953284	1598.7	50 mL →	79.935
8.0	7.937712	2131.6	50 mL →	106.580
10.0	9.92214	2664.5	50 mL →	133.225

CSR → 8/27/98

Kawin Analysis of Cr Rod.

CONAM KAWIN

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REPORT DATE: 10/29/98

LAB NO: 1015-033 / 06

JOB NO:

CR ROD

CHEMICAL ANALYSIS

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ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

PAGE 6 OF 6

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SB 11/1/98

Program reinitiated after ~1 yr as a result of higher priorities on other issues.

Are now examining 1 mm ID pits which are 4 mm ~~deep~~ deep. SB 12/8/99

Materials being considered:

316L SS
Zr-4
Ti Gr 7
C-22
CP Ti

- materials have been sent to Kawin for chemical analysis SB 1/15/00

- analysis recv'd & included in SN 368 pgs 31-35
SB 6/20/2000

(Pages 1 to 19 Reviewed by J. Mayer SWRI QA on 8/30/2000)

Sean B 12/8/99

Copy of pg 19 sent to QA.

SBr 9/5/2000
SBrc 9/5/02

Start of NRC MIC Testing

Brian Derby
Sean Brossia
Gevi Becker
Lietai Yang

Look at multielectrode sensor as a way to study MIC.

Innoculate w/ SRB's & slime formers
Carbon steel
316L
C22
some w/ welds.

look @ lpr, wt loss, EIS, appearance & compare w/ sensor

~~mtl.~~ SBr mtls qualified and pedigree in c/N 368 p 24 - 35

SBrown 9/17/02

Na_2S 7.8 g/L

2/4/03
304 loop testing
Mixed up the following solutions:
0.5 M NaCl
29.250 g NaCl with 1 liter H2O — NaCl lot# 027168

0.5 M NaCl + 0.1 M Na2S2O3
29.246 g NaCl and 15.837 g Na2S2O3 with 1 liter H2O — NaCl lot# 027168, Na2S2O3 lot# 923931A

~~FW = 158.1~~ J.Y.
FW = 158.1/1 7/2/03

1.0 M NaCl
58.29 g NaCl with 1 liter H2O — NaCl lot# 027168

1.0 M NaCl + 0.1 M Na2S2O3
58.42 g NaCl and 15.83 g Na2S2O3 with 1 liter H2O — NaCl lot# 027168, Na2S2O3 lot# 923931A

Used the following test equipment:

Ohaus scale	Serial # 2883	Cal Due date: 29 July 03
Kiethley	Serial # 0579628	Cal Due date 22 Sep 03
FS pH/Ion	Serial# 3340	Cal Due date 07 Aug 03
Reference Fisher	13-620-52 Serial # 0249108 & # 0249091	RJD 2/10/03

Initial 3 tests were run on the Solartron Multistat model 1480, but software would not reverse at the correct current. Samples showed a lot of corrosion products coming off samples and solution was very dark. Started test over using the Solartron model SI 1287.

Test 1
0.5 M NaCL + 0.1 M Na2S2O3
Initial Ph = 7.714, finial pH = 9.176
Ecor = -198 mV, Ept = 184 mV
No corrosion observed, see graph for polarization curve.

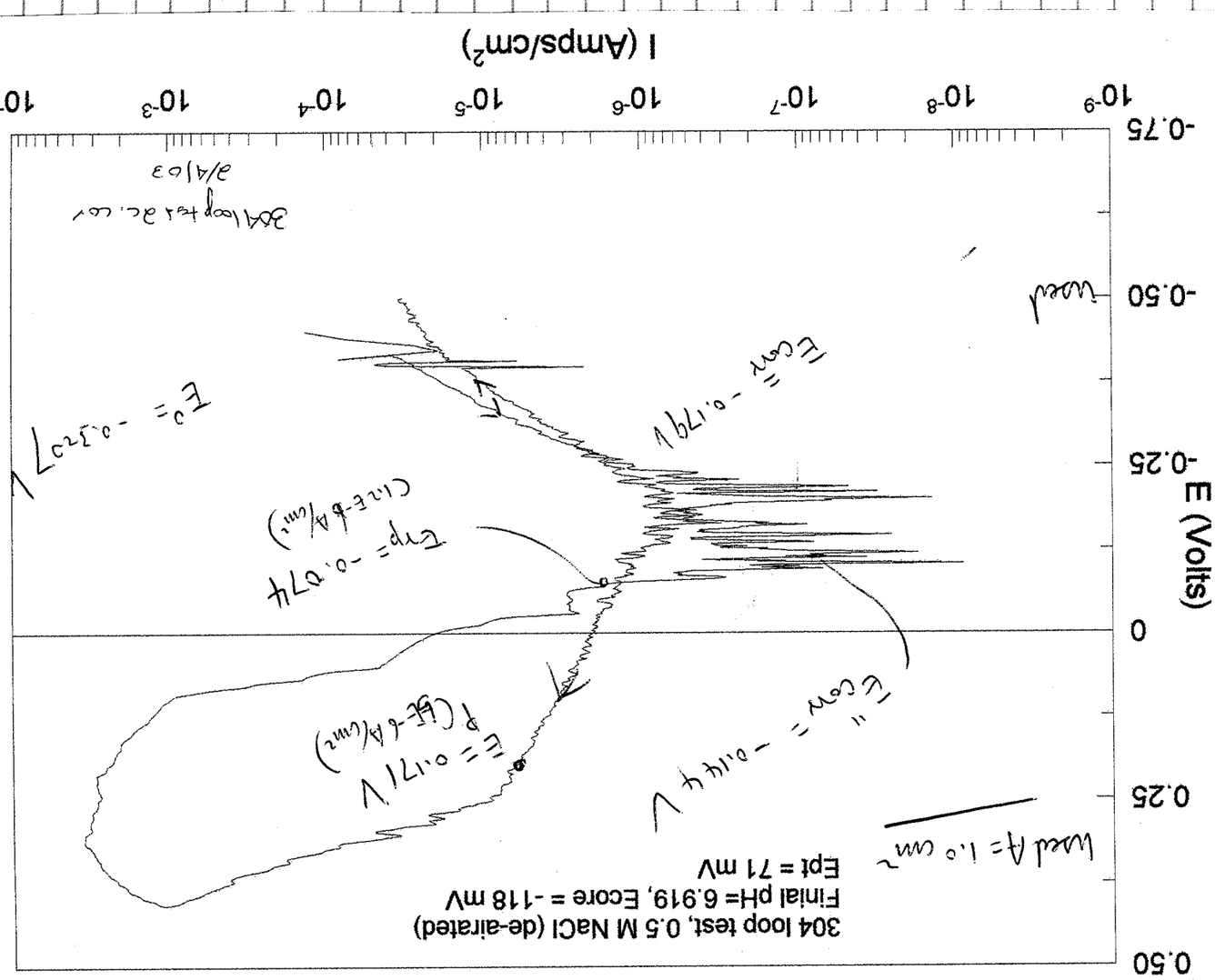
Test 2
0.5 M NaCL (de-aerated)
Initial Ph = N/A, finial pH = 6.919
Ecor = -118 mV, Ept = 71 mV
No corrosion observed, see graph for polarization curve.

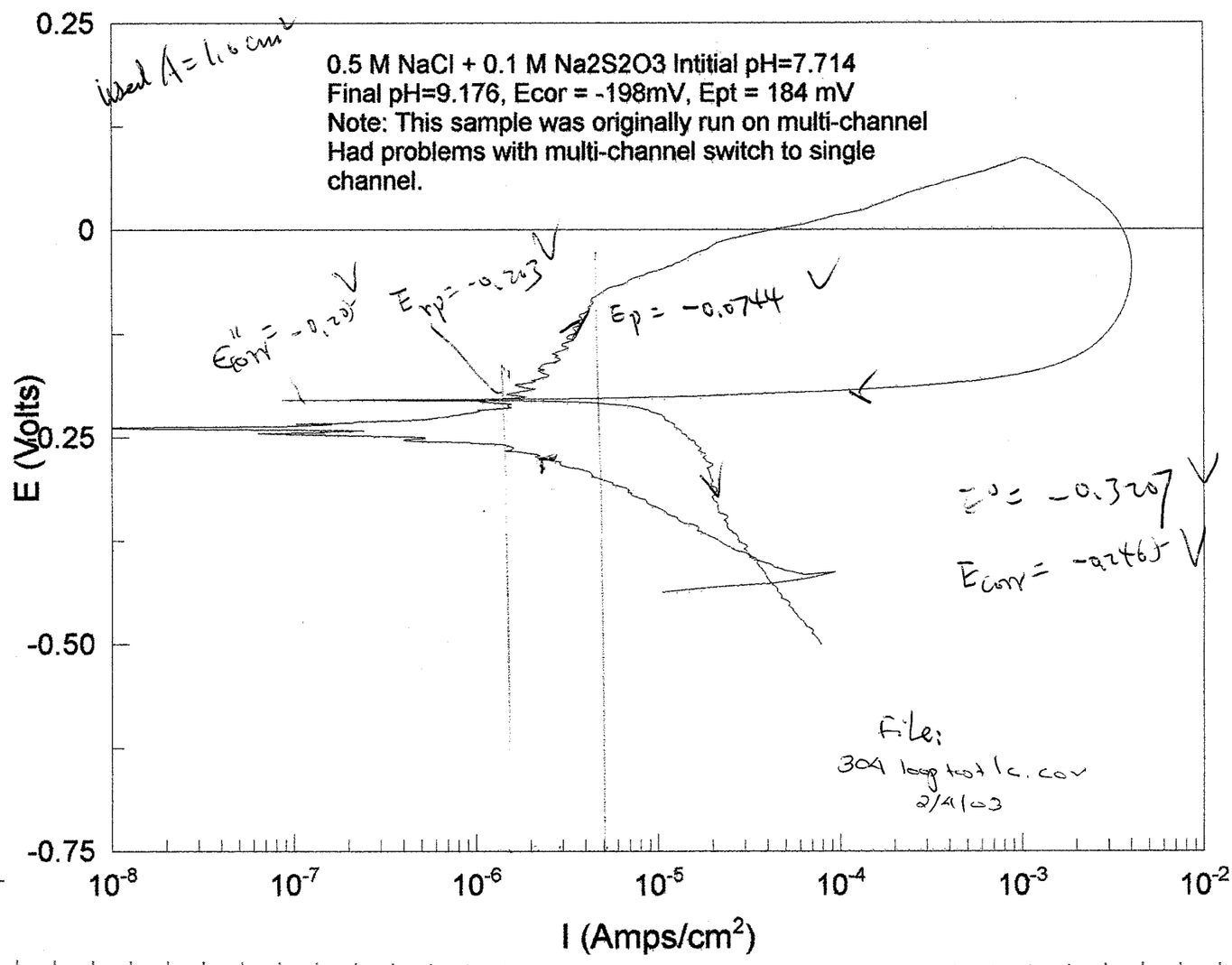
Test 3
1.0 M NaCL
Initial Ph = 6.448, finial pH = 6.883
Ecor = -173 mV, Ept = 490 mV
No corrosion observed, see graph for polarization curve.

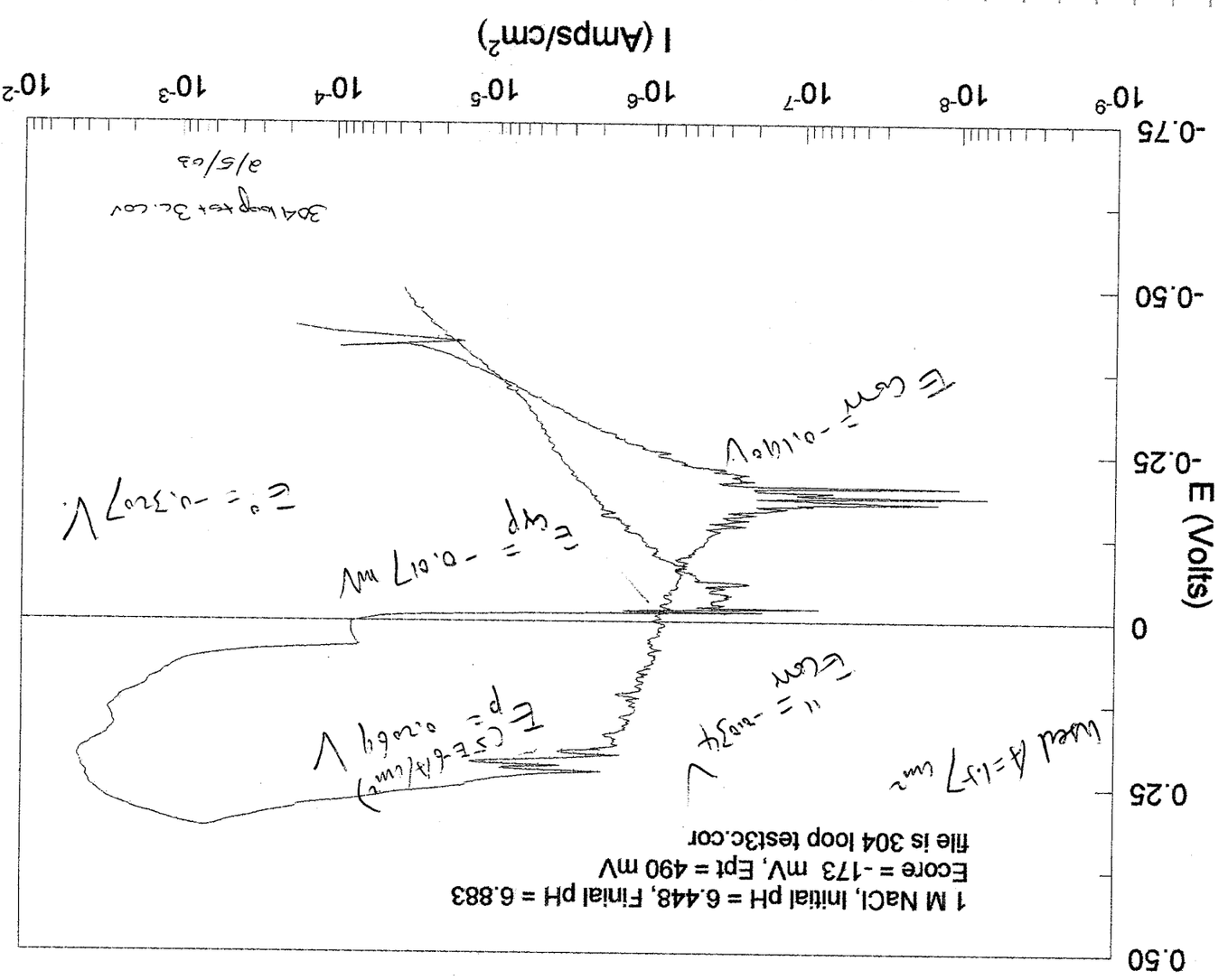
Roger J Dykson 2/10/03

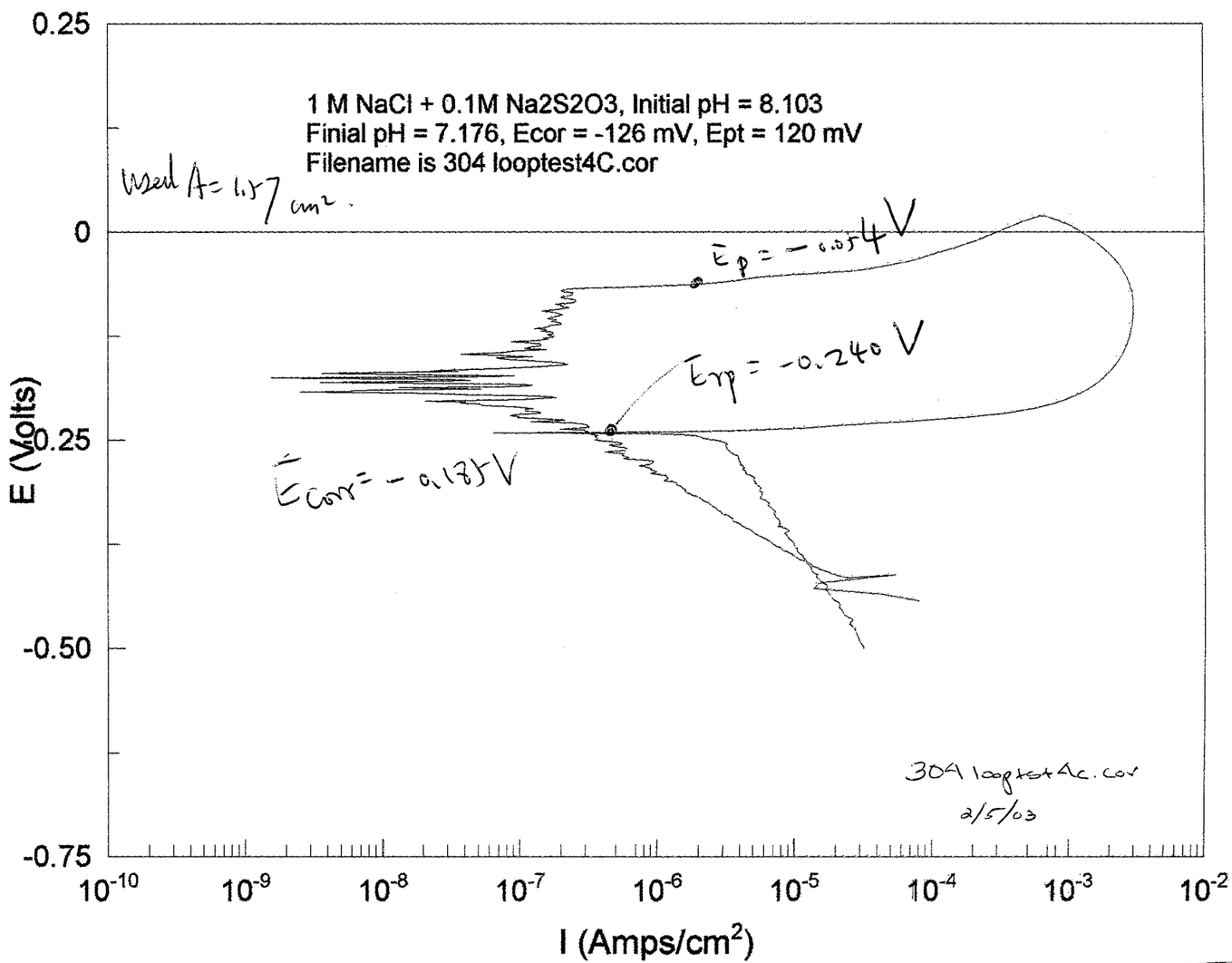
Test 4
1.0 M NaCL + 0.1 M Na2S2O3
Initial Ph = 8.103, finial pH = 7.176
Ecor = -198 mV, Ept = 184 mV
No corrosion observed, see graph for polarization curve

Roger J Dykson 2/10/03


304 loop test, 0.5 M NaCl (de-airated)
Finial pH= 6.919, Ecore = -118 mV
Ept = 71 mV
Used A= 1.0 cm²
E'' corr = -0.1494 V
E = 0.1717 V
P (μA/cm²)
Ecorr = -0.1794 V
Used
304loop test ac.cor
3/4/03
E (Volts)
I (Amps/cm²)


0.5 M NaCl + 0.1 M Na2S2O3 Intitial pH=7.714
Final pH=9.176, Ecor = -198mV, Ept = 184 mV
Note: This sample was originally run on multi-channel
Had problems with multi-channel switch to single
channel.
Used A= 1.0 cm²
Ep = -0.0744 V
Ecorr = -0.2467 V
File:
304 loop test 1c.cor
2/4/03
E (Volts)
I (Amps/cm²)


1 M NaCl, Initial pH = 6.448, Finial pH = 6.883
Ecore = -173 mV, Ept = 490 mV
file is 304 loop test3c.cor
E (Volts)
I (Amps/cm²)
304 loop test 3c.cor
2/5/03


1 M NaCl + 0.1M Na2S2O3, Initial pH = 8.103
Finial pH = 7.176, Ecor = -126 mV, Ept = 120 mV
Filename is 304 looptest4C.cor
E (Volts)
I (Amps/cm²)
304 looptest4c.cor
2/5/03

FW = 240.18

2/11/03

Test 5
0.5 M NaCL 100mL (de-aerated) + 0.94 g Na2S* 9H2O
Initial Ph = N/A, finial pH = N/A
Ecorr = -423 mV, Ept = 548 mV
No corrosion observed, see graph for polarization curve.
This test reversed at 100 mA

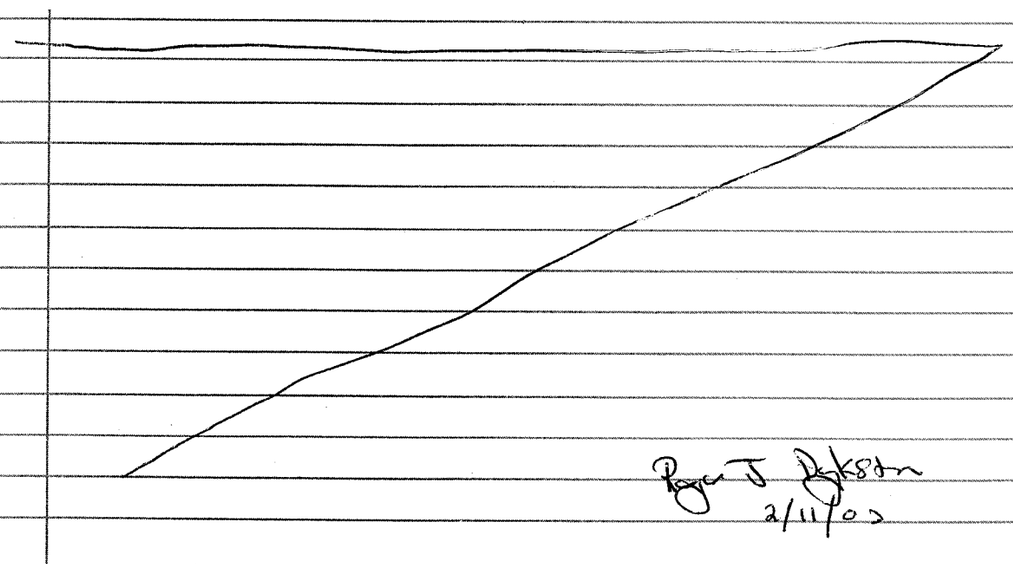
3.91 / 0.1L mM = 39.1 mM

Test 6
0.5 M NaCL 100mL (de-aerated) + 0.94 g Na2S* 9H2O
Initial Ph = N/A, finial pH = N/A
Ecorr = -423 mV, Ept = 548 mV
Corrosion observed black deposits coming off loop, see graph for polarization curve.
This test reversed at 10mA

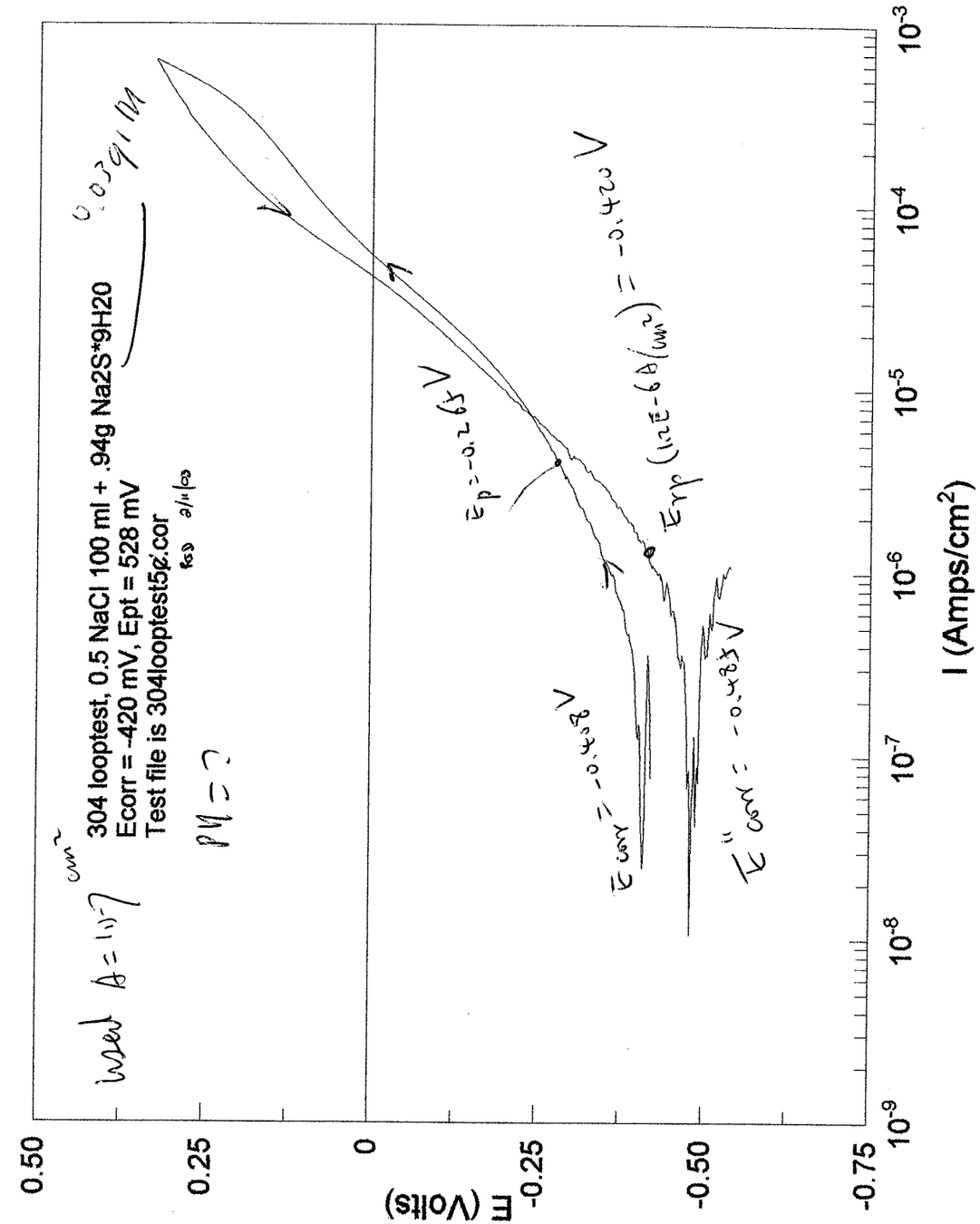
39.1 mM

Test 7
1.0 M NaCL 100mL (de-aerated) + 0.748 g Na2S* 9H2O
Initial Ph = N/A, finial pH = N/A
Ecorr = -440 mV, Ept = 521 mV
Corrosion observed black deposits coming off loop, see graph for polarization curve.

31.1 mM



Roger J Dykstra
2/11/03



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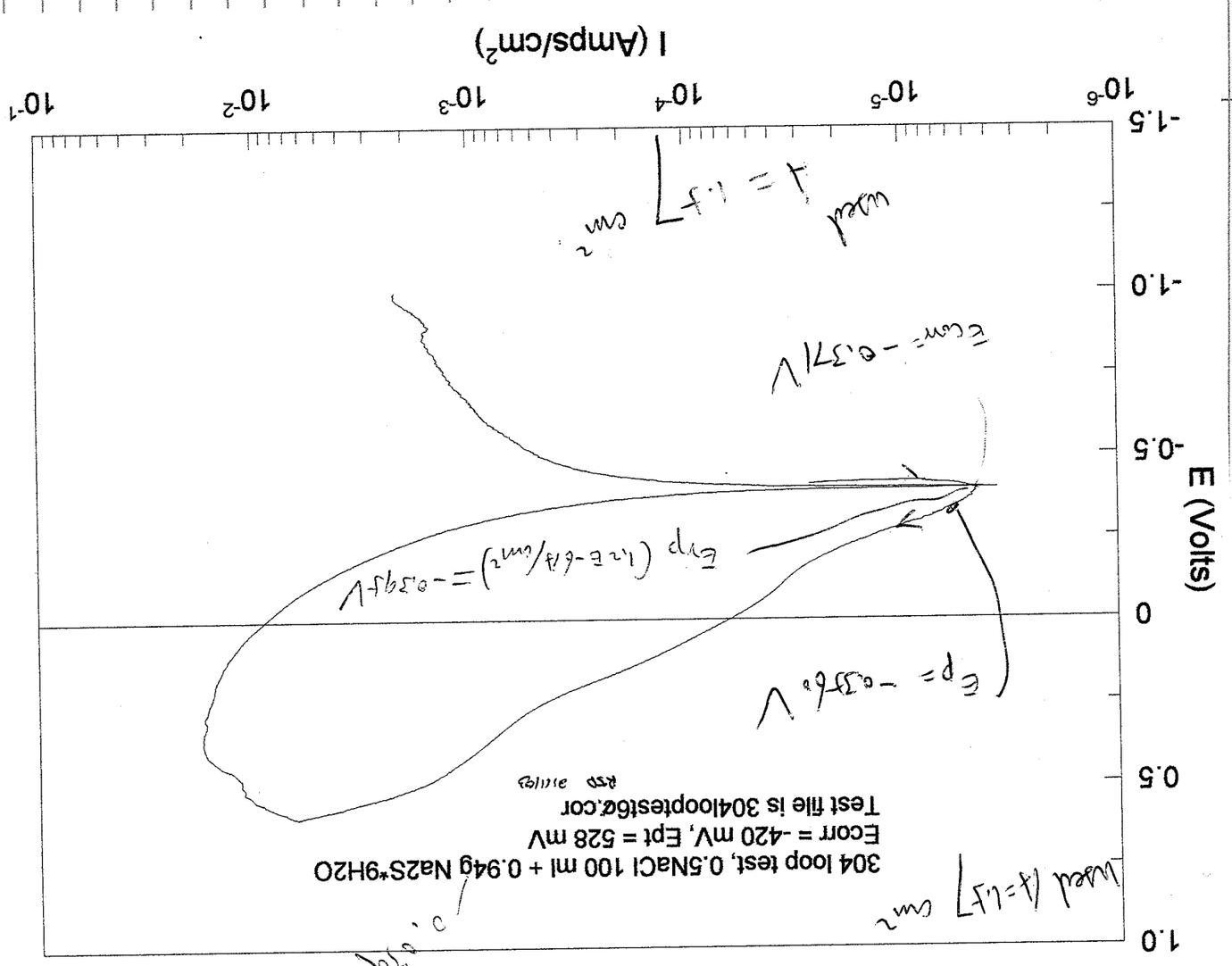
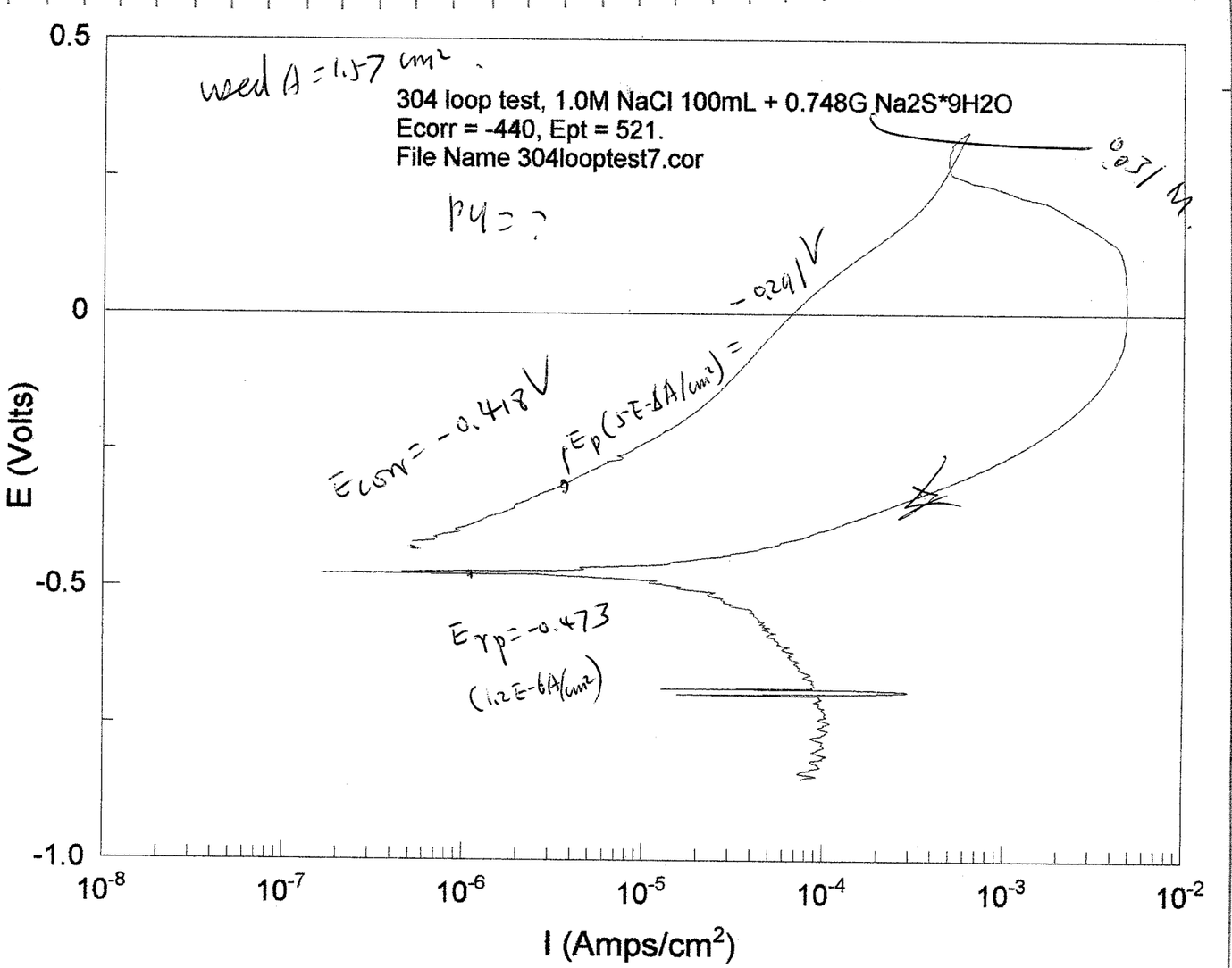
2/11/03


304 loop test, 0.5NaCl 100 ml + 0.94g Na2S*9H2O
Ecorr = -420 mV, Ept = 528 mV
Test file is 304looptest6a.cor
used A = 1.57 cm²
Ep = -0.5266 V
Ep (1.2E-6A/cm²) = -0.5295 V
Ecorr = -0.371 V
used A = 1.57 cm²
E (Volts)
I (Amps/cm²)


used A = 1.57 cm²
304 loop test, 1.0M NaCl 100mL + 0.748G Na2S*9H2O
Ecorr = -440, Ept = 521.
File Name 304looptest7.cor
pH = ?
Ecorr = -0.418V
Ep (5E-6A/cm²) = -0.491V
Ep = -0.473
(1.2E-6A/cm²)
E (Volts)
I (Amps/cm²)

Initial Entry For Tests starting Page 33 is in page 0

Pages 21 – 32 copied and sent to QA.

J. Yost 4/7/03

All electronic Data Files are stored in Notebooks / Notebook 522 & 287 & book MIC folder

J. Yost 4/11/03

File: 03 – April 14b Rep

Results see page 40

J. Yost 4/15/03

Continued from page 94 and page 97 Book #522

4/11/03

9:00 in the Nh-control cell.

$\varphi_{304} = -227.6$ mV SCE

$\varphi_{304\ wire} = -169.1$

$\varphi_{Pt\ wire} = +62$

$\varphi_{Pt\text{-}counter} = -34$

9:01 Repassivation test with 304 coupon.
03_April 11a Rep. Result see page 35

13:27 Repassivation test with 304 wire.
03 April 11b Rep. Result see page 37

14:00 Harvest ≈ 10 ml from test cell. Run serial dilution subcultures to test for the presence of SRB.

Inoculate 30 ml. SRB ~~add~~ cultures into test cell.

Sub slime corner for inoculation on 4-14 into 3rd cell. 4-11-03

4/14/03

10:11 Repassivation test with 304 wire in Nh-control cell started again.
03_April 14a Rep. Result see page 38

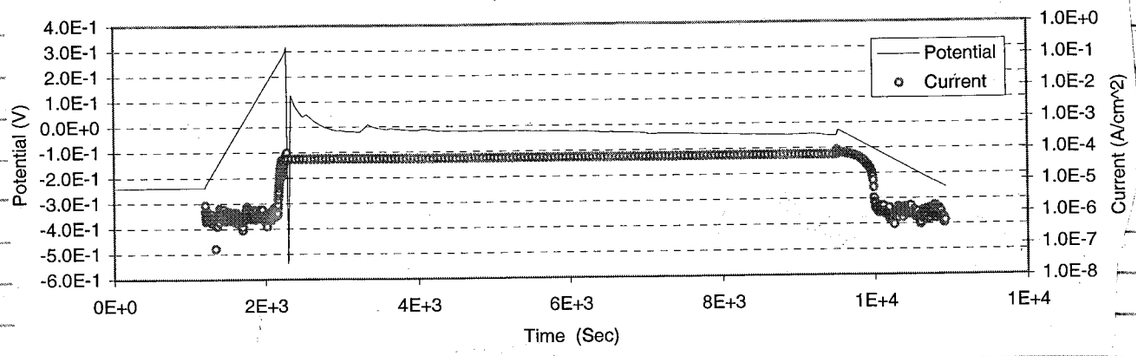
15:17 Found that in Nh-control cell, Pt-wire and Pt-counter contacted each other — separated.

J. Yost 4/15/03

Repassivation test with 304 coupon in Nh-control cell

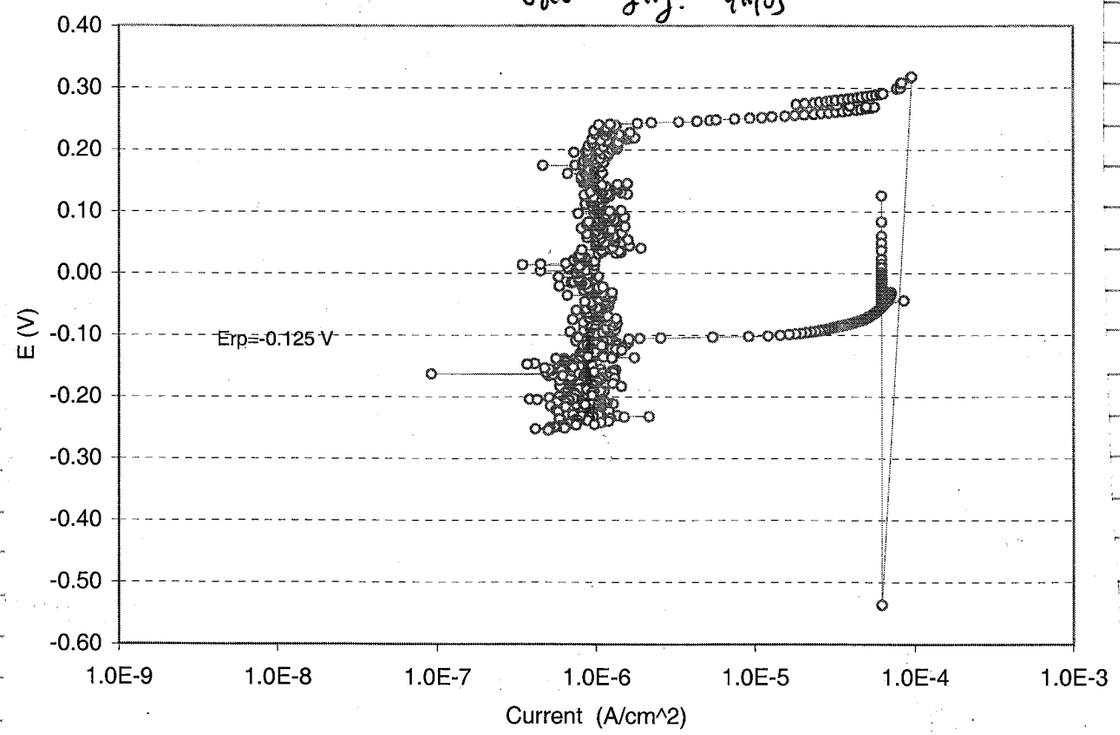
08a J.Y. 4/11/03

File: 03_April07cRep / Tab: EI_Time_chart



03_April07cRep E_I_Cart

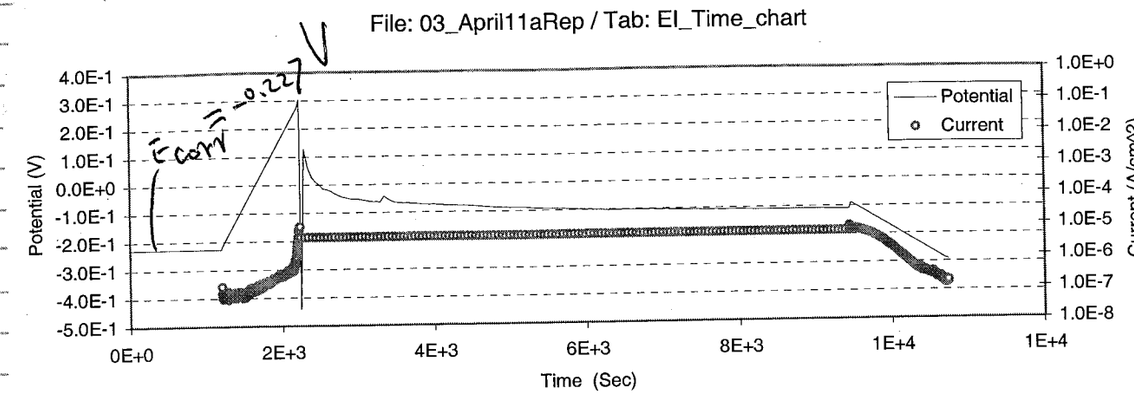
08a J.Y. 4/11/03



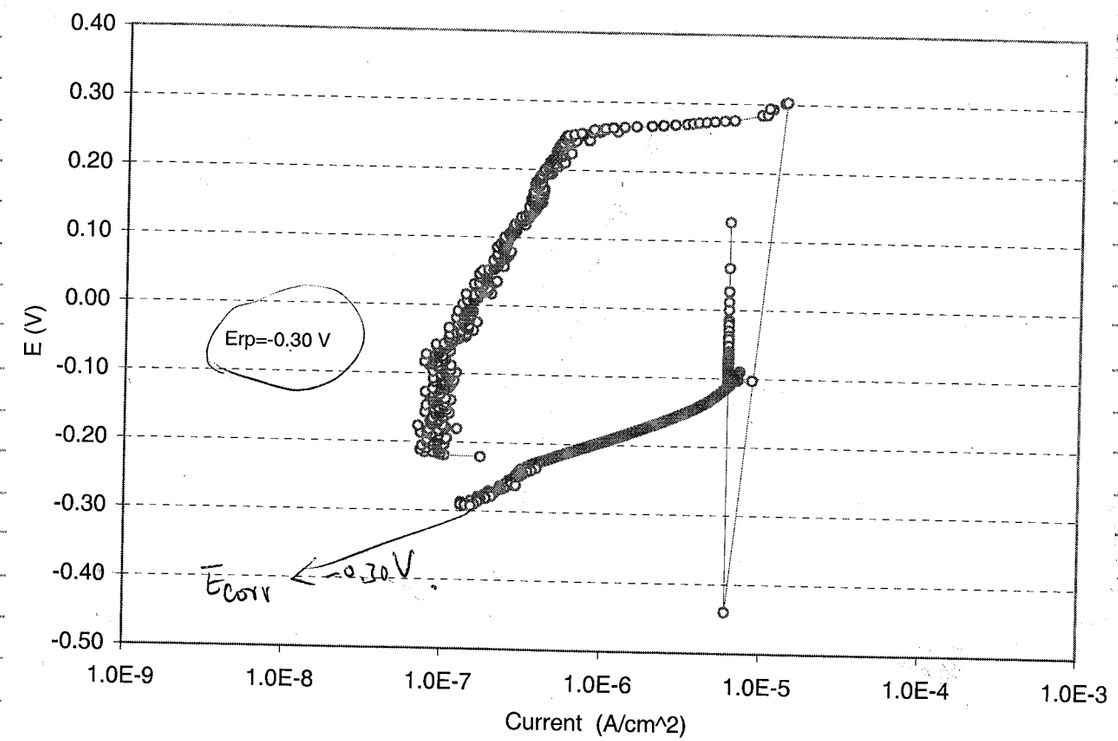
304 wire in Nh side cell

see page 94, Book 522 J.Y. 4/15/03

File: 03_April11aRep / Tab: EI_Time_chart



03_April11aRep E_I_Cart



304 coupon in Nh - control cell.

See page 33 J.Y. 4/15/03

-14-03 From Harvest of 4-11-03.
RB for SRB
500

	4/14	4/22 SRB.
10^{0} (0.01)	>100 cfu/ml	same
10^{-1} (0.01)	>1000 cfu/ml	same
10^{-3} (0.01)	> 10^{+5} cfu/ml	same
10^{-4} (0.01) reincubate →		no SRB recovered. 4/22/03 SRB.

Harvest growth from Test cell ≈10 ml. Perform serial dilutions to determine quantitative culture concentration.

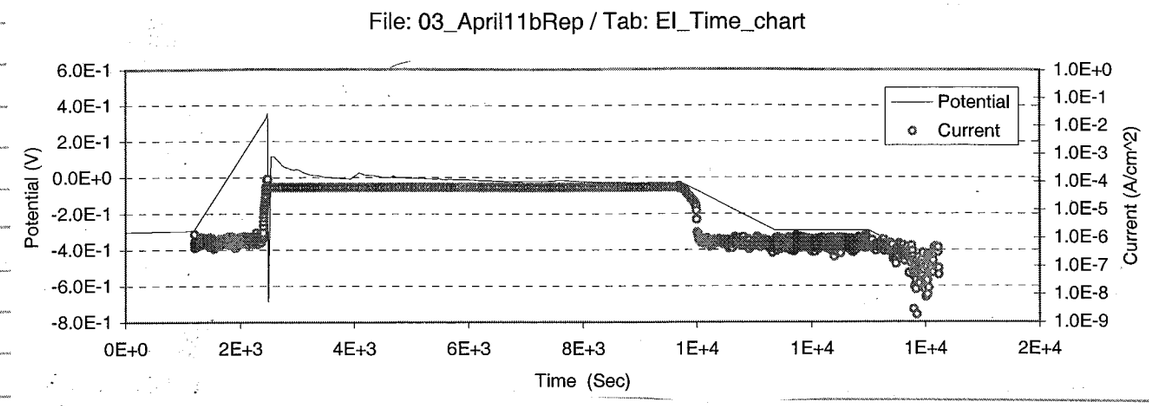
Inoculate 3rd cell with 72 hr. culture of pline pomer (Vibrio natriegens). 4-14-03

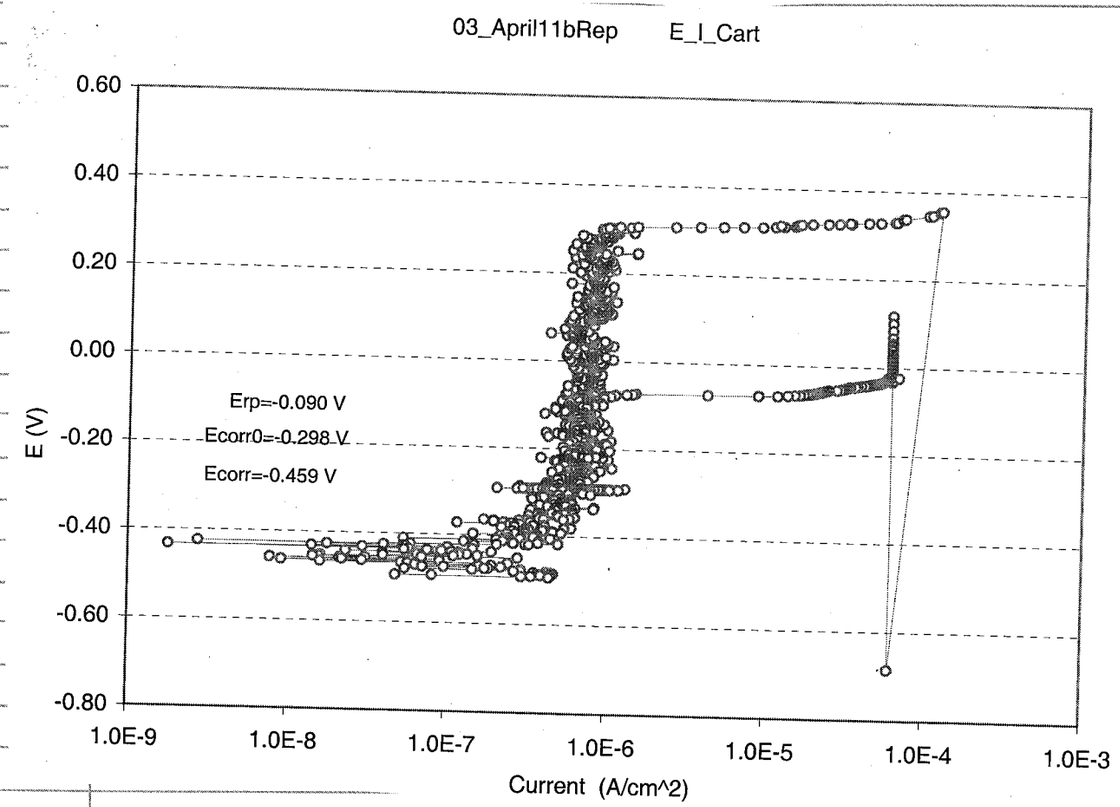
/15/03 8:58 Noticed salt bridge broken.
Cell Air side — N2-test side
liquid inside gone to Air cell.

/15/03 9:58 Salt bridge fixed, 0.5M NaCl filled.

In N2- control cell
$\varphi_{304\,wire} = -130$ mV$_{SCE}$, $\varphi_{304\,compon} = -360$ mV
$\varphi_{Pt\text{-}wire} = 3.8$ mV, $\varphi_{Pt,counter} = 163$ mV

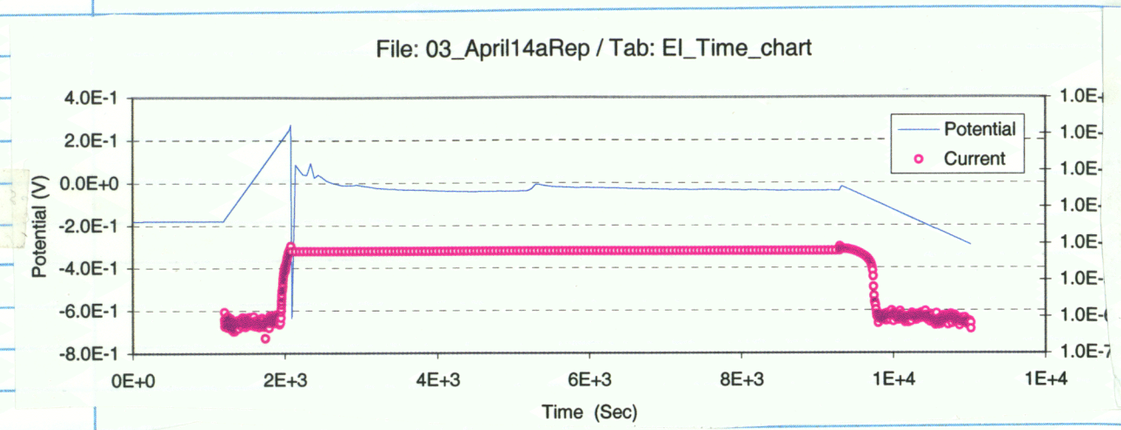
4/15/03



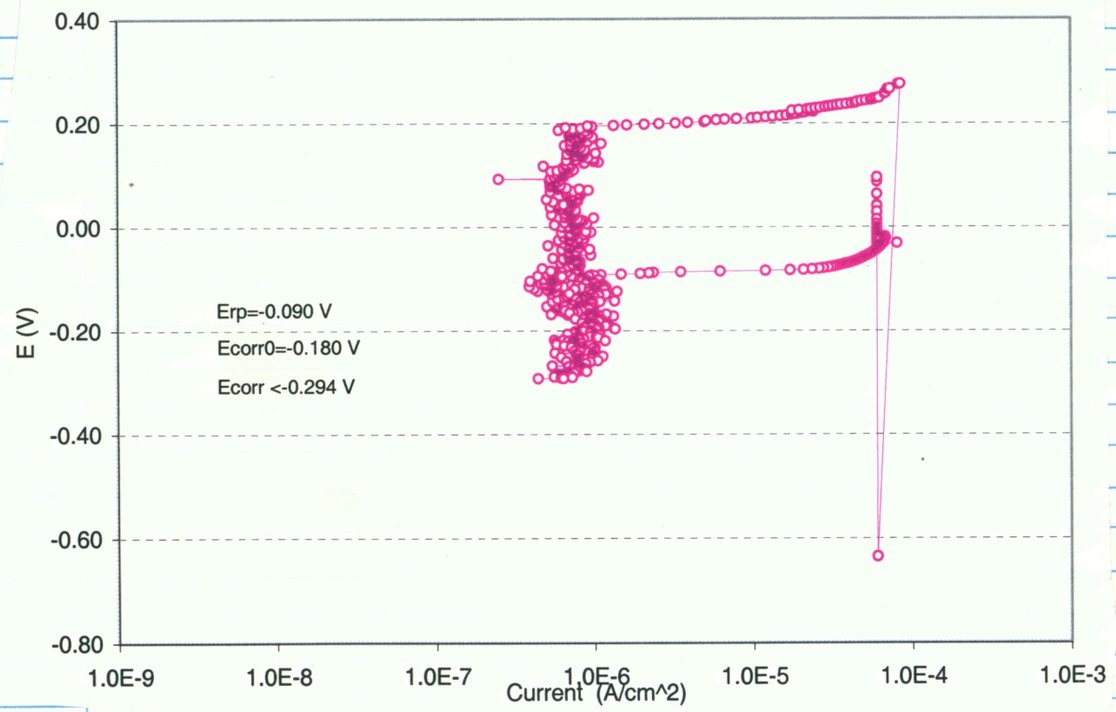


304 wire in N2 - control cell
See page 33

4/15/03



03_April14aRep E_I_Cart



J.Y. 4/15/03

304 wire in N2 - control cell

See page 33

No shine

4/15/03 1000 added CE to air side
Replaced salt bridge between
air & SRB cells. For some reason
it was broke.
1009 Started Repassivation test
on Air side with 304 coupon (surface area 32 cm²)
1430 Saved file 03April15a Rep (Results see page 41)
1455 Started Repassivation test on
Air side with 304 wire (surface area 3.2 cm²)
Same file as 03 April 15 b Rep, (results see page 42)

4/16/03 0840 Started Repassivation test
on N2 side with 304 control coupon (surface area 32 cm²)
file is 03-April 16a Rep — results see page 43.
1254 Test finished

1323 Started Repassivation test
on N2 side with 304 wire (surface area 3.2 cm²)
file is 03-April 16 b Rep
1325 Stop test.

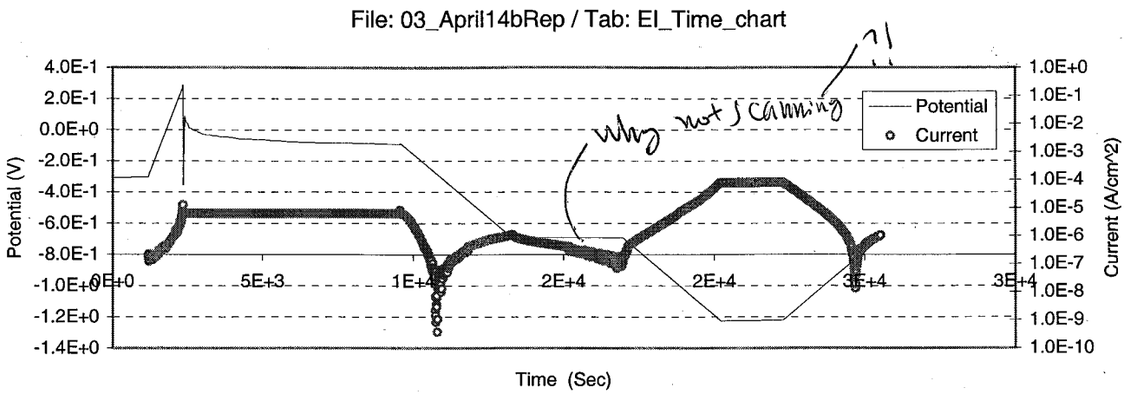
1330 Started linear polarization test
on N2 side with 304 wire (surface area 3.2 cm²)
file is LPR 03-April 16a-Data see page 46.

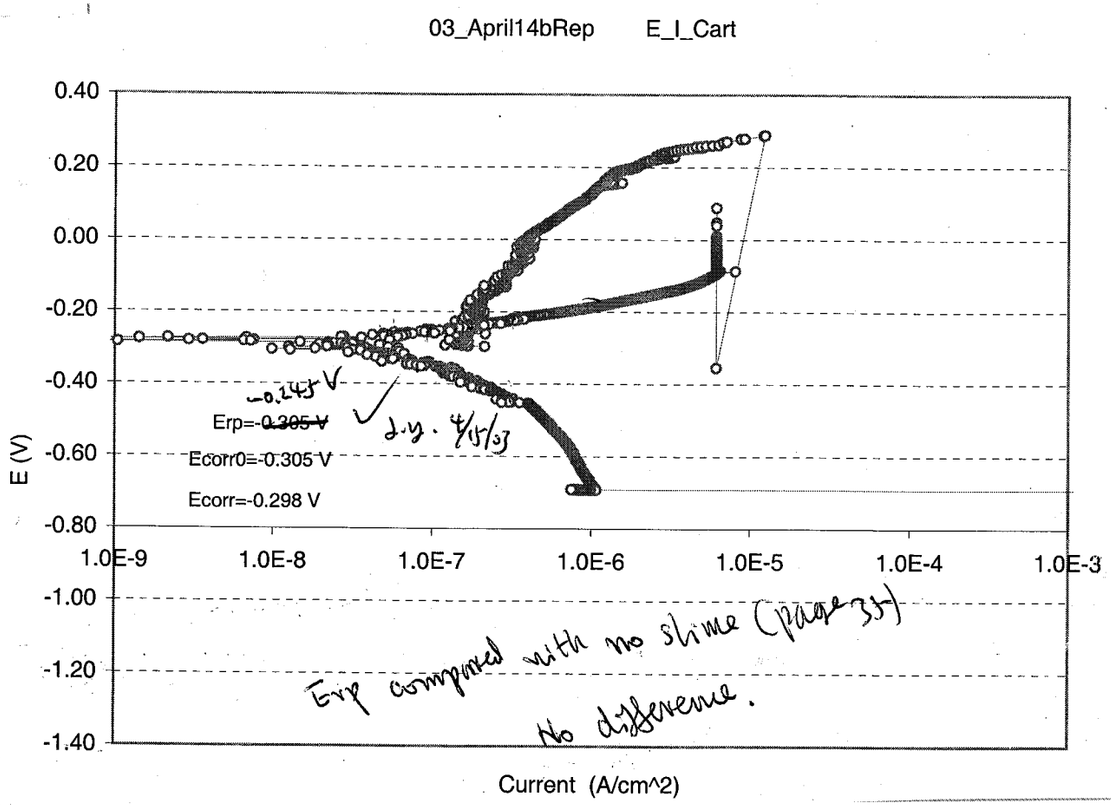
1346 Started linear polarization test
on N2 side with 304 control coupon (surface area 32 cm²)
file is LPR 03-April 16 b-Data see page 47

1359 Started linear polarization test
on N2 control side with 304 coupon (surface area 32 cm²)
file is LPR 03-April 16 c-Data — see page 47
N2 ~~test~~ control cell J.Y. 4/16/03, J.Y. 4/17/03 changed back. J.Y.

1409 Started linear polarization test
on N2 ~~control side~~ with 304 wire (surface area 3.2 cm²)
file is LPR 03-April 16 d-Data — see page 47

J.Y. 4/16/03



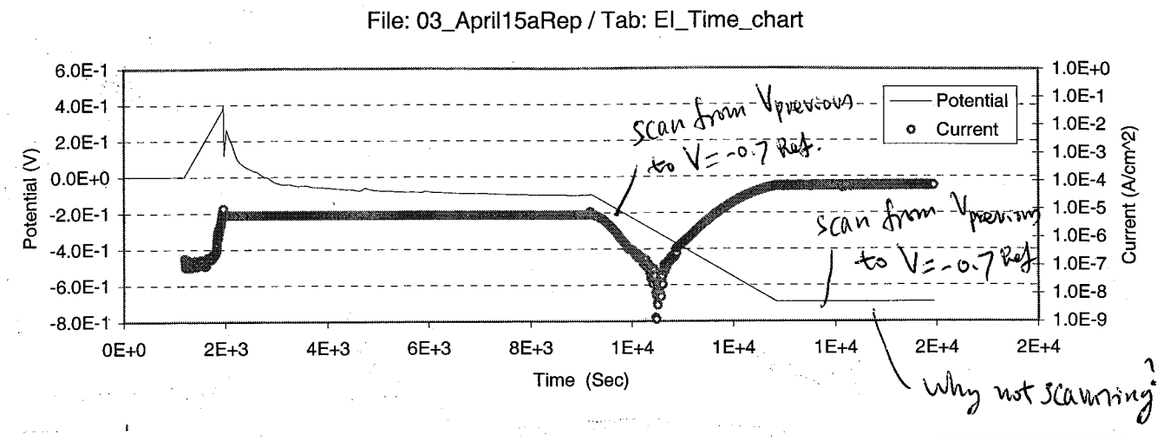


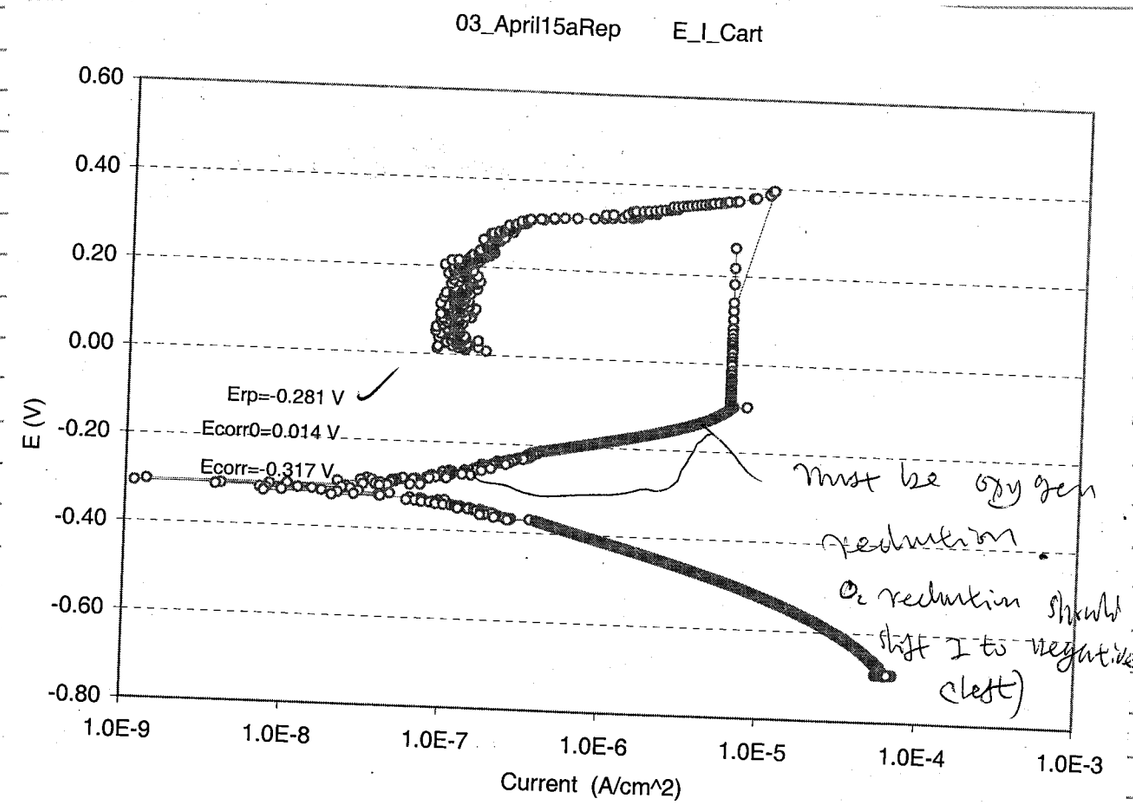
After slime Former added!!

304 Coupon in Air-Control Cell

see page 33.

J.Y. 4/15/03





304 Coupon in Air-Cell.

see page 39.

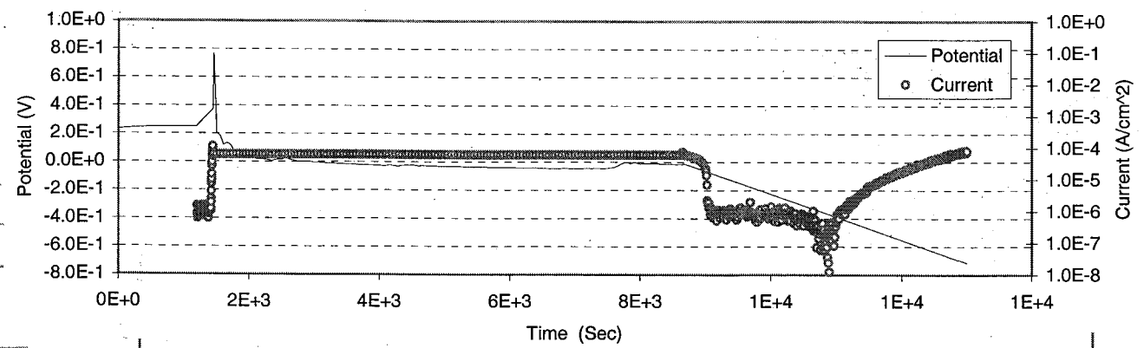
J.Y. 4/15/03

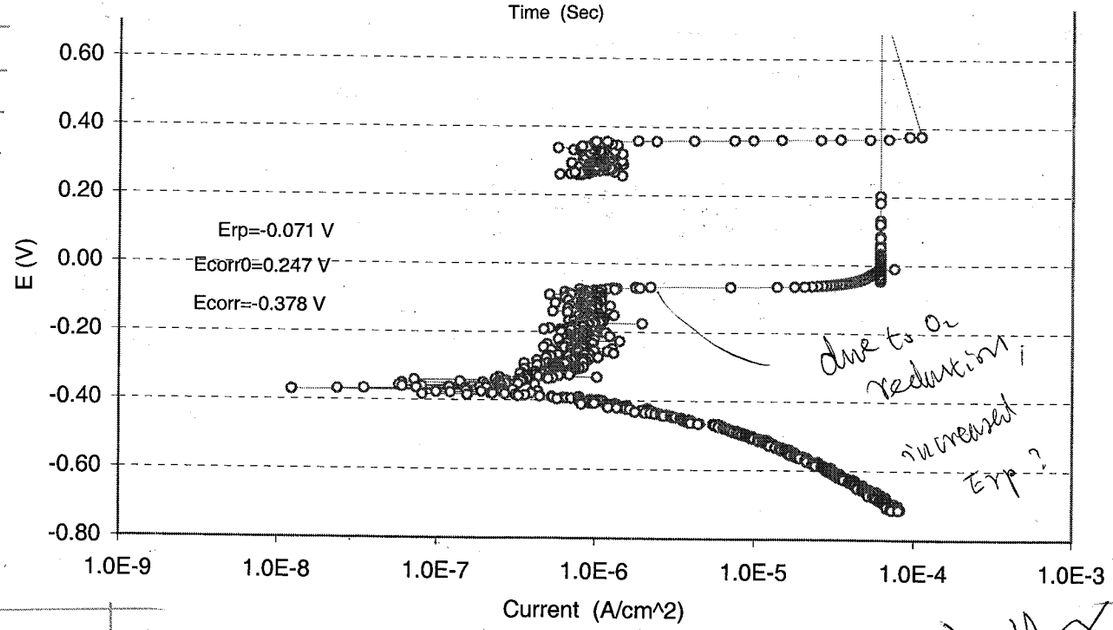
4/16/03 1115 Started linear polarization test
on Air side 304 wire (surface area 3.2 cm²)
file name LPR03_April16 & RTO Data see page 47

1137 Started linear polarization test
on Air side 304 coupon (surface area 3.2 cm²)
file name LPR03_April16 & RTO Data — see page 47

1449 Started Repassivation Test (result: see page 47)
on N2 side with 304 wire (surface area 3.2 cm²)

File: 03_April15bRep / Tab: EI_Time_chart

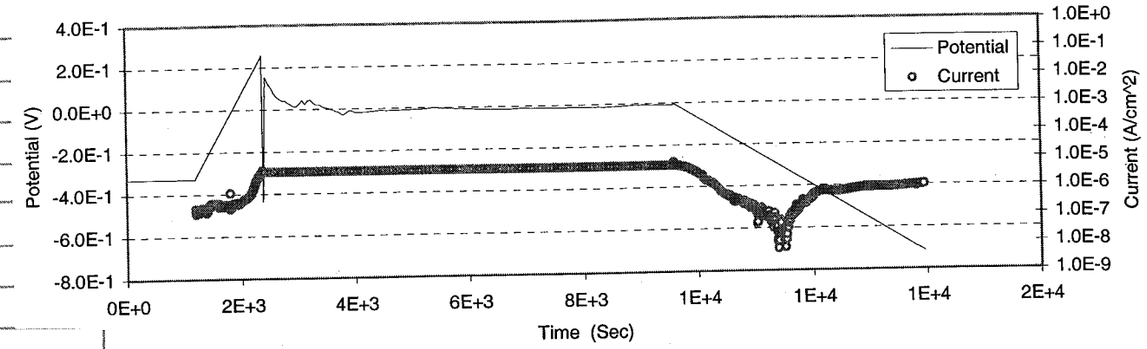




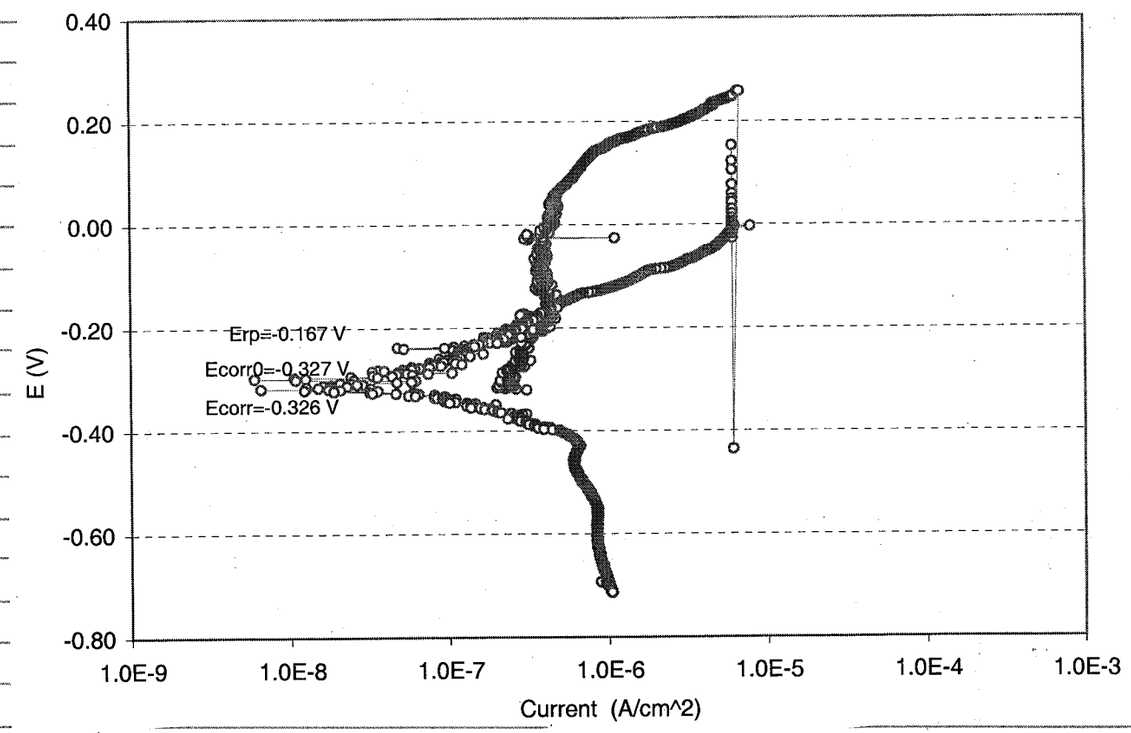
304 wire, in Air cell
see page 39.

4/16/03

File: 03_April16aRep / Tab: EI_Time_chart



03_April16aRep E_I_Cart



304 Coupon in Air test cell
see page 39.

4/16/03

4/17/03 H_2 - control cell

$\varphi_{Pt\ wire} = +27$ mV$_{SCE}$ $\varphi_{304\ wire} = -167$ mV

$\varphi_{Pt\ counter} = +34$ mV$_{SCE}$ $\varphi_{304\ coupon} = -399.3$ mV

$\varphi_{ref,\ H_2\text{-control}} - \varphi_{ref,\ H_2\ test} = -19.0$ mV

$\varphi_{ref,\ Air\text{-cell}} - \varphi_{ref,\ H_2\ test} = -21.7$ mV

Air - Cell:

$\varphi_{304\ Coil\ \#1} = 3.1$ mV $\varphi_{304\ wire} = -47$ mV

$\varphi_{304\ Coil\ \#2} = -278$ mV $\varphi_{304\ Coil\ \#3} = -238$ mV

$\varphi_{304\ coupon} = -131$ mV$_{SCE}$

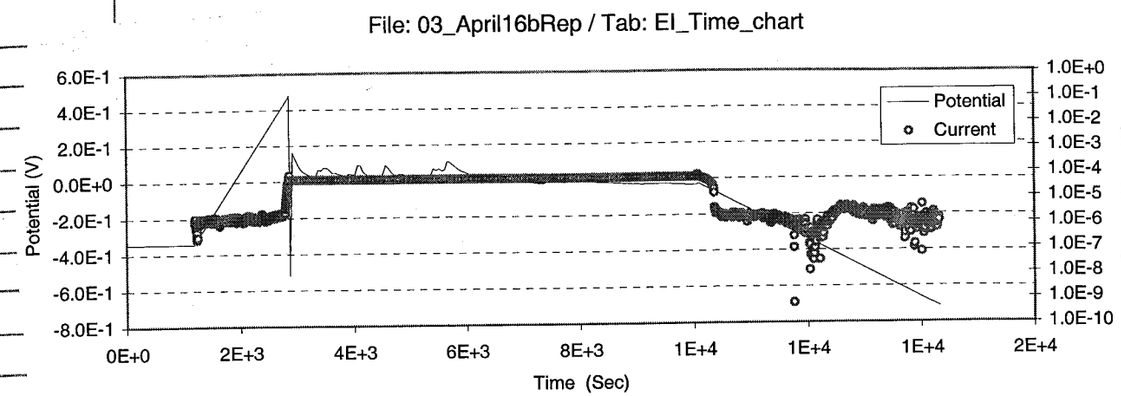
4/17/03 9:07 Repassivation test, 03_April17aRep results see page 51

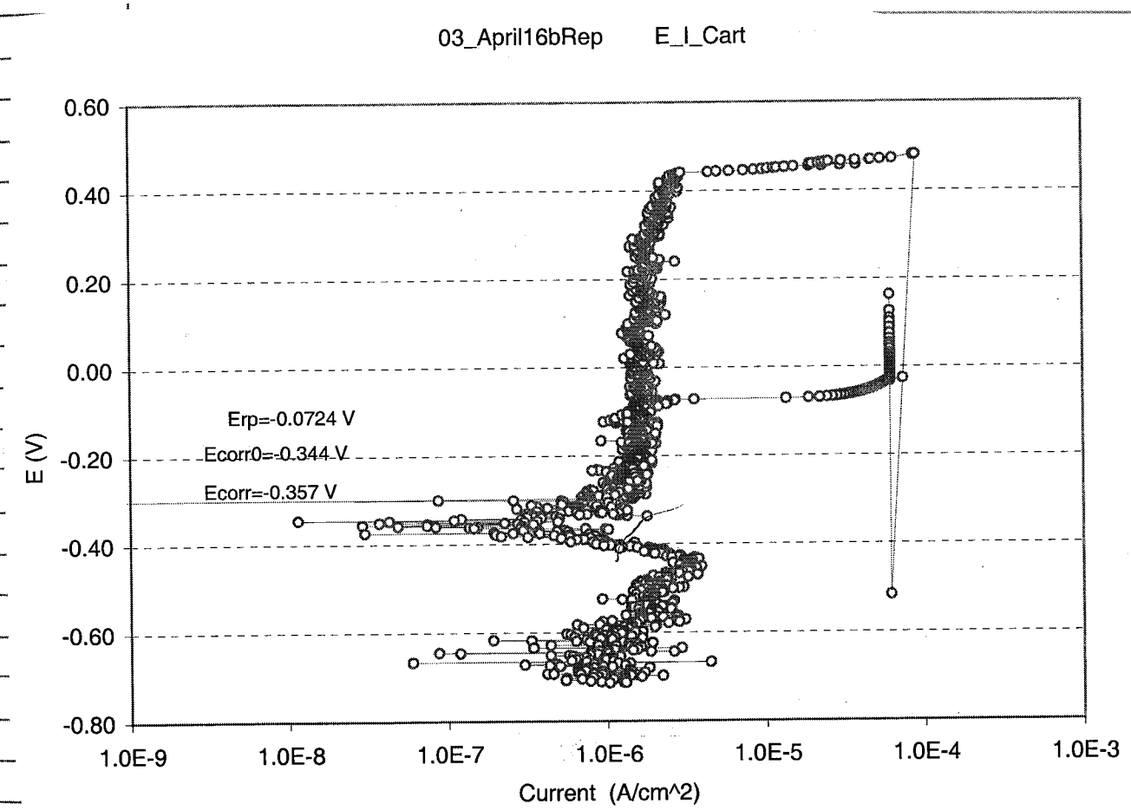
Started with 304 coupon in H_2 - Control cell.

13:19 Cycl. Test 03_April17bRep results see page 52-53

with Pt wire in H_2 - Control cell.

J. Y. 4/17/03





304 Wire in H_2 - test cell.

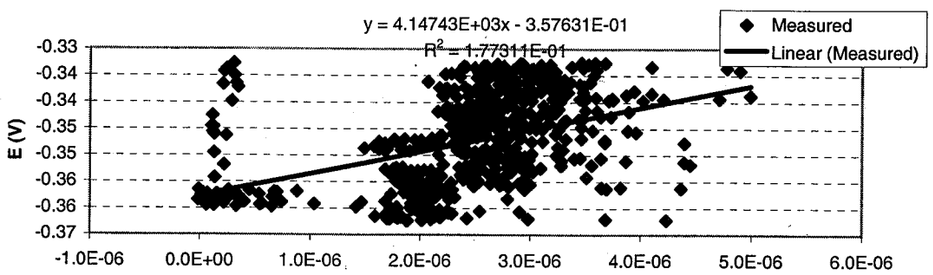
see page

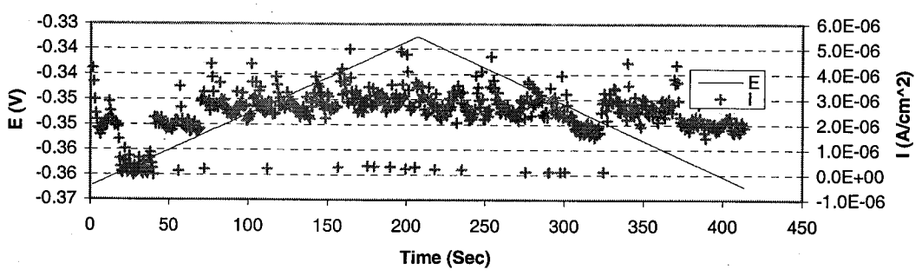
J. Y. 4/17/03

File: LPR_03_April16a_Processed

LPR File saved by COrrWare 304 Wire in N2 Test Cell
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.015 OC,0.015 OC,Reverse,0.1667mV/S,LPR_03_April16a_LPR.txt][default],LPR_03_April16a_Data.cor
Date: 04-16-2003 Time: 13:35:50

Time(Second	ECorr_1(V)	Rp_1(Ohms*c	ICorr_1(A/cm	Rate_1(MPY)	ECorr_2(V)	Rp_2(Ohms*c	ICorr_2(A/cm	Rate_2(MPY)
0	-3.48E-01	6.16E+01	4.22E-04	0.00E+00	-3.75E-01	1.05E+04	2.48E-06	0.00E+00





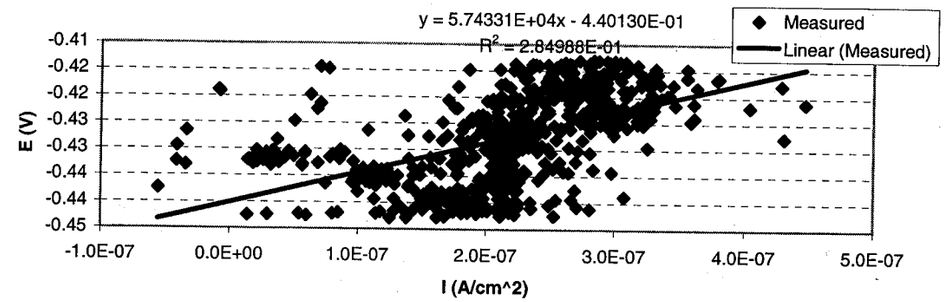
from page 41

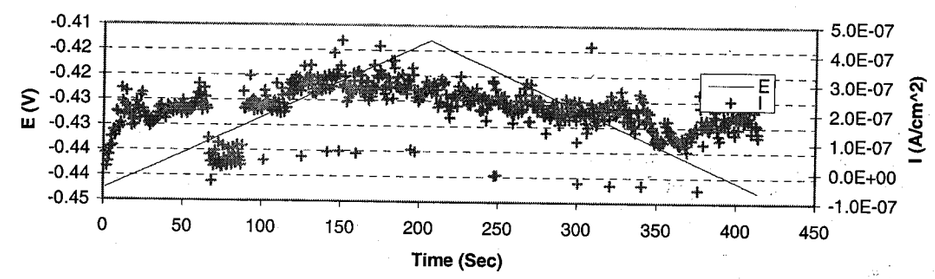
J. Yang
4/17/07

File: LPR_03_April16b_Processed

LPR File saved by COrrWare 304 control Coupon in N2 Test Cell
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.015 OC,0.015 OC,Reverse,0.1667mV/S,LPR_03_April16b_LPR.txt][default],LPR_03_April16b_Data.cor
Date: 04-16-2003 Time: 13:48:30

Time(Second	ECorr_1(V)	Rp_1(Ohms*c	ICorr_1(A/cm	Rate_1(MPY)	ECorr_2(V)	Rp_2(Ohms*c	ICorr_2(A/cm	Rate_2(MPY)
0	-4.28E-01	-1.83E+02	1.42E-04	0.00E+00	-4.60E-01	1.52E+05	1.71E-07	0.00E+00





from page 41

No results are good. the results from following files not recorded in this book!

J. Yang
4/17/07

File: LPR_03_April16c_Processed

File: LPR_03_April16d_Processed

File: LPR_03_April16e_Processed

File: LPR_03_April16f_Processed

from page 42

4-18-03
0930

Harvest samples as follows:

1.) 10 ml from test cell.
perform serial dilution
and subculture for SRB
quantitative concentration

2.) 10 ml from cell #3
perform serial dilutions
and subculture for slime
former quantitative concentration

4-18-03

What was the reading for 4-14 harvest

10^4 - 4/28

4/22/03 Results: (From 4-18-03 harvest)
Slime former: no growth on plates
or in broth.

SRB: no growth on plates
Broth culture has growth to 10^{+4}

(From 4-14-03 harvest) - SRB only.

SRB: Growth @ 10^{+4} broth culture.
no growth on plated media culture

4/28/03 - Harvest of 4-14-03 - results still same: growth of SRB in Baar's broth only at 10^4 cfu/ml serial dilution.

10/3/03

4.21.03 0921 Started Linear Polarization test of 304 Coupon in Air cell. (area = 32 cm²)
File name LPR_03_April0421a_Data1 Results see page 54

0938 Started linear Polarization test (area = 3.2 cm²) of 304 wire in Air cell
File name LPR_03_April0421b_Data1 results see page 55

1009 Started linear Polarization test (area = 3.2 cm²) of 304 wire in Air cell (repeat) without other work to see if eliminates noise.
File name LPR_03_April0421c_Data1
results see page 56.

1027 Started linear Polarization test of 304 wire in N2 cell (area = 3.2 cm²)
File name LPR_03_April0421d_Data1
results see page 57.

1045 Started linear Polarization test of 304 wire in N2 cell (area = 3.2 cm²)
File name LPR_03_April0421e_Data1
results see page 58.

1223 Started linear Polarization test of 304 coupon in N2 Control cell (area 32 cm²)
File name LPR_03_April0421f_Data1
results see page 59

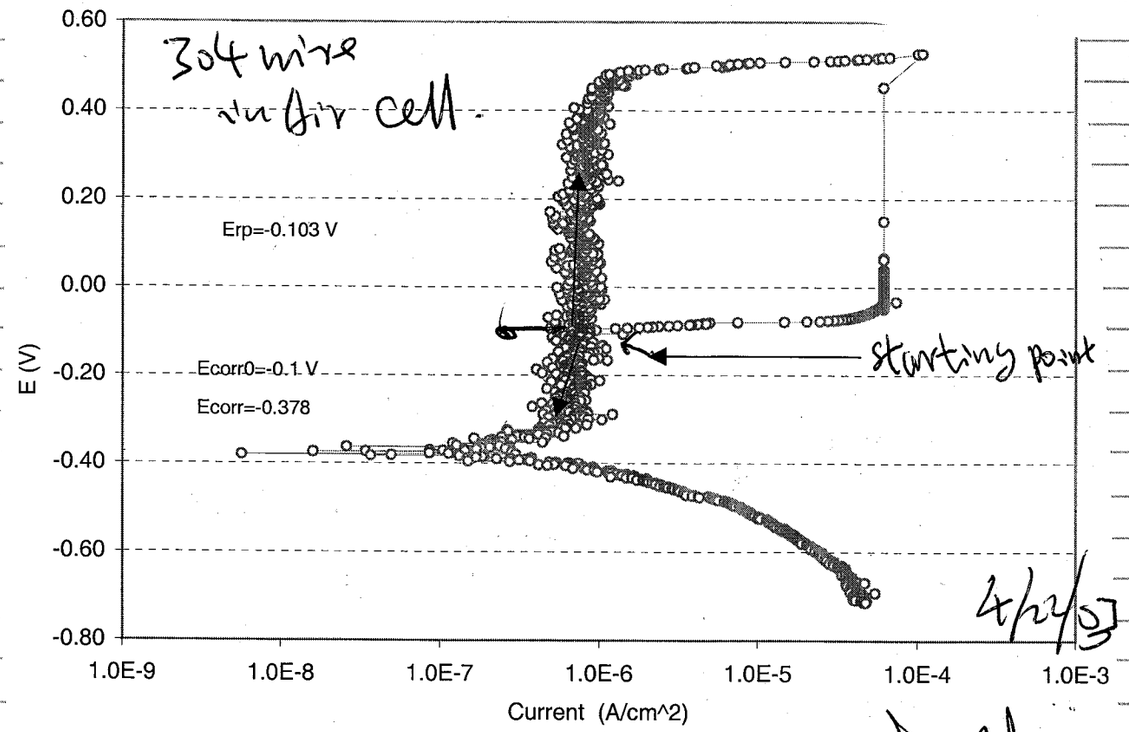
1240 Started linear Polarization test of 304 wire in N2 Control cell (area 3.2 cm²)
File name LPR_03_April0421g_Data1
results see page 60.

1257 Started linear Polarization test of 304 wire in Air cell (area 3.2 cm²)
Turned the gas (air) down to see if its generating noise.
File name LPR_03_April0421h_Data1
results see page 61

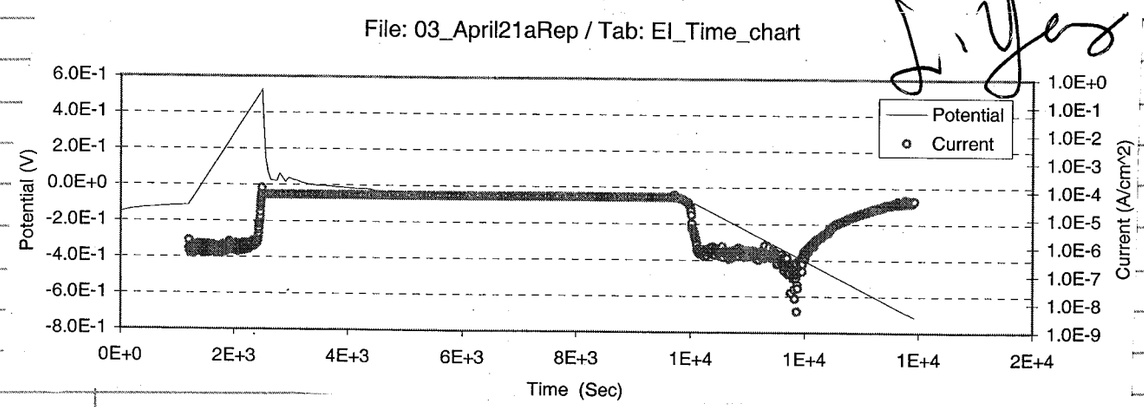
4/21/03

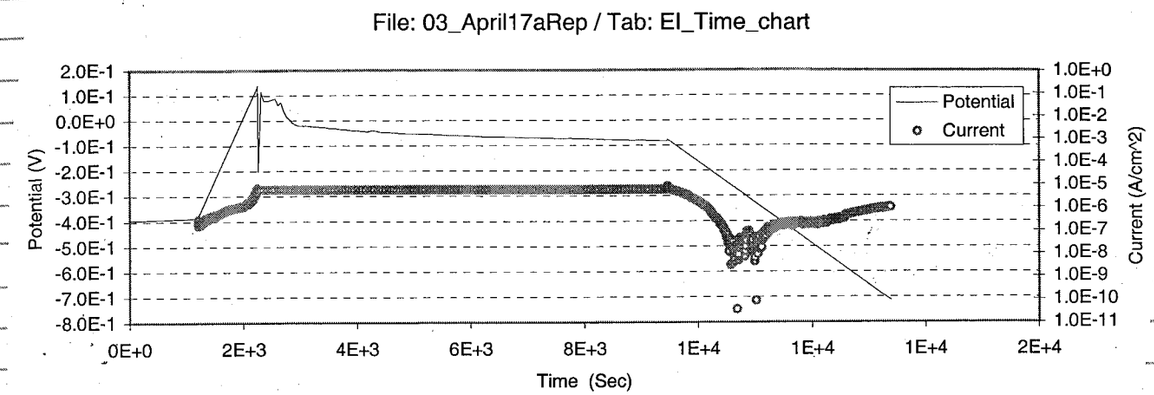
4/21/03 1310 Started linear polarization test of 304 wire in Air cell with all gas turned down.
File LPR_03April0421i_Data1. Results see page 61

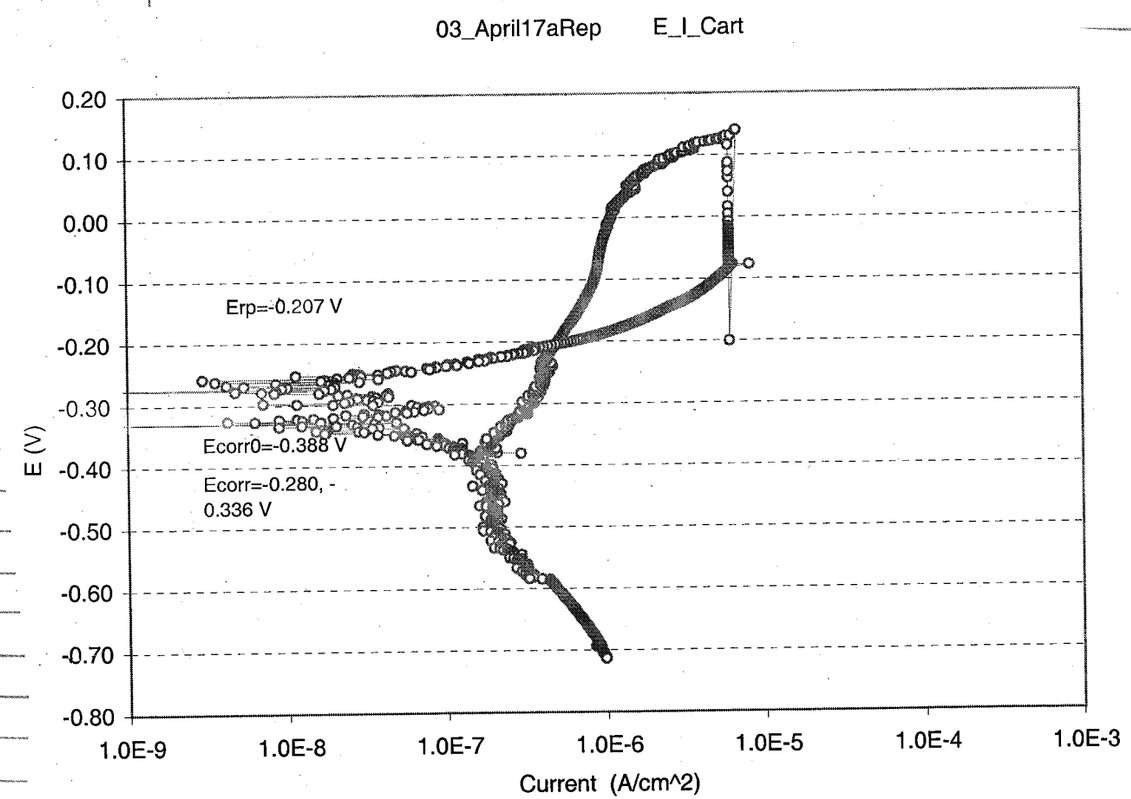
1335 Started Repassivication test on 304 wire in Air cell
File: 03_April21aRep.
see this page



4/22/03

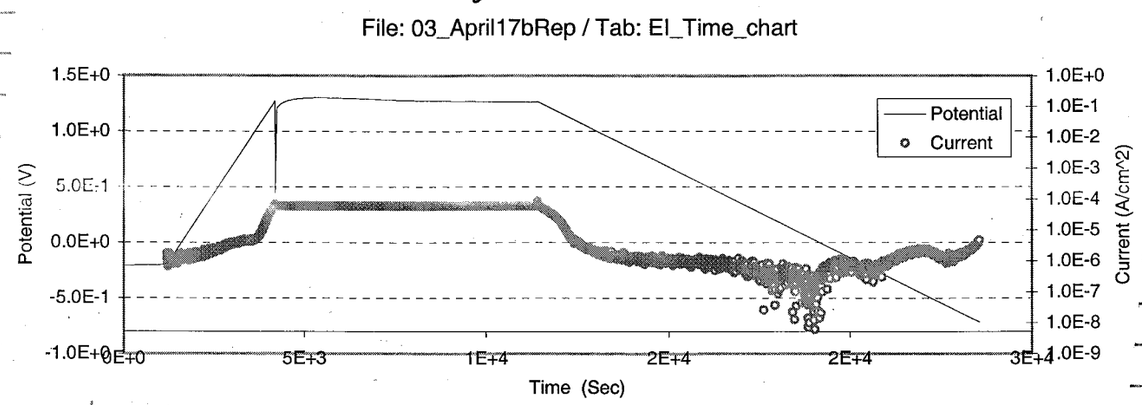


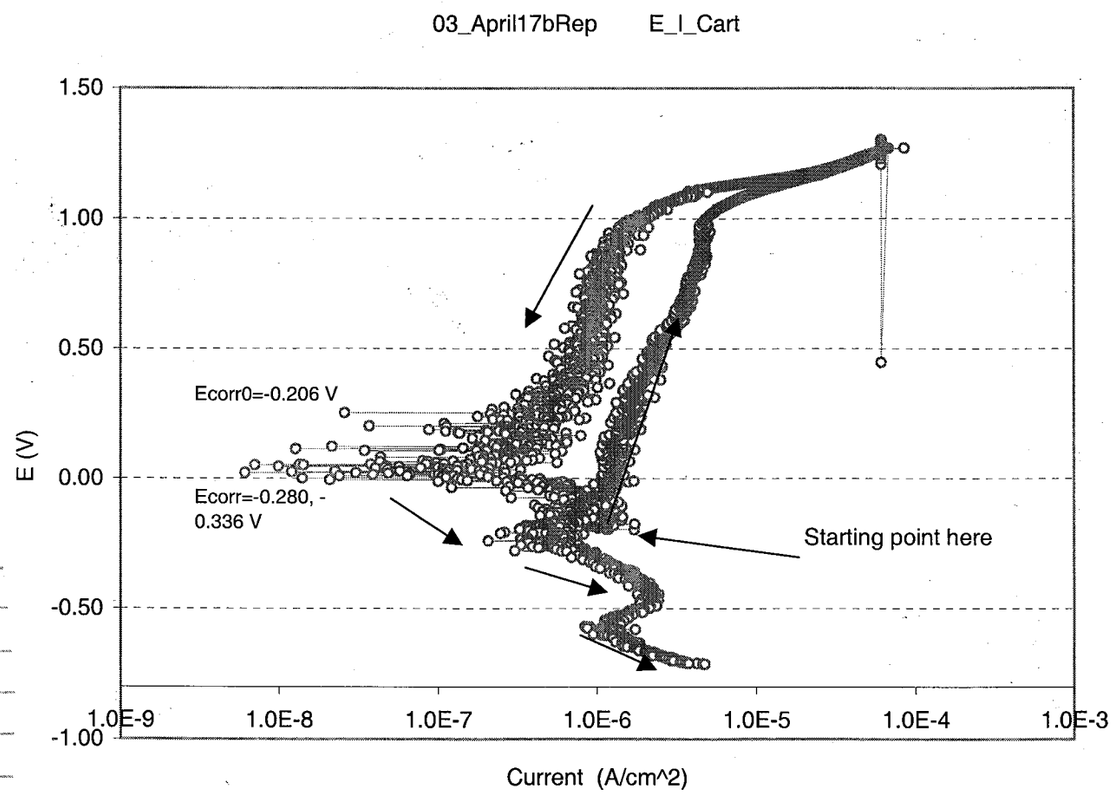




304 coupon in the control cell.
see page 44

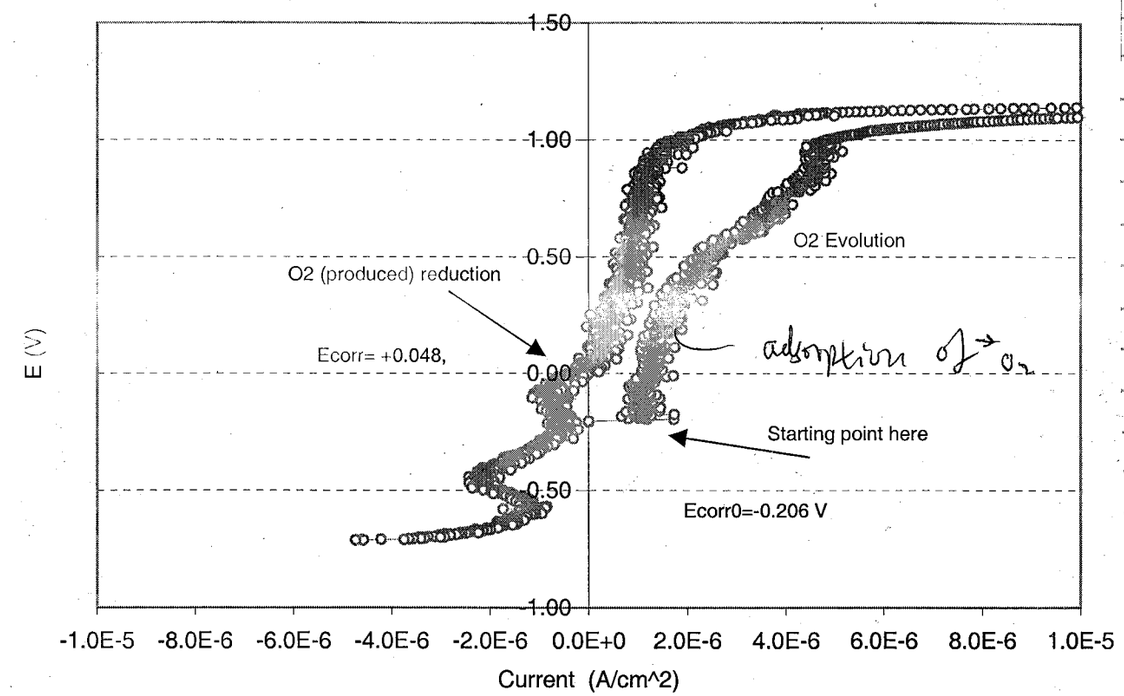
4/21/03





Pt-wire in N2-Control cell.

4/1/03.



Same as page 52

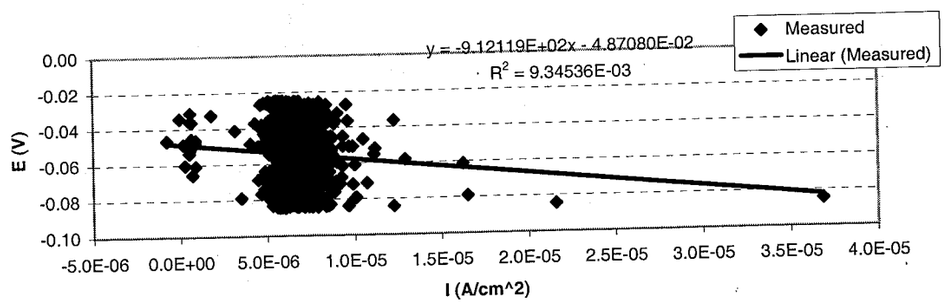
4/1/03.

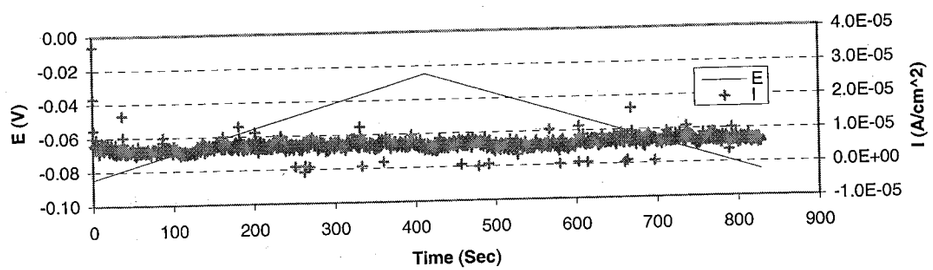
File: LPR_03_April21a_Processed

See Page 49.

LPR File saved by COrrWare 304 Coupon inAir Cell
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.03 OC,0.03 OC,Reverse,0.1667mV/S,LPR_03_0421_LPR1.cor][default],LPR_03_0421_I
Date: 04-21-2003 Time: 09:21:13

Time(Seco	ECorr_1(V	Rp_1(Ohm	ICorr_1(A/(	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*c	ICorr_2(A/(	Rate_2(MPY)
0	-6.30E-02	1.21E+03	2.15E-05	0.00E+00	-3.43E-02	-3.20E+03	8.13E-06	0.00E+00





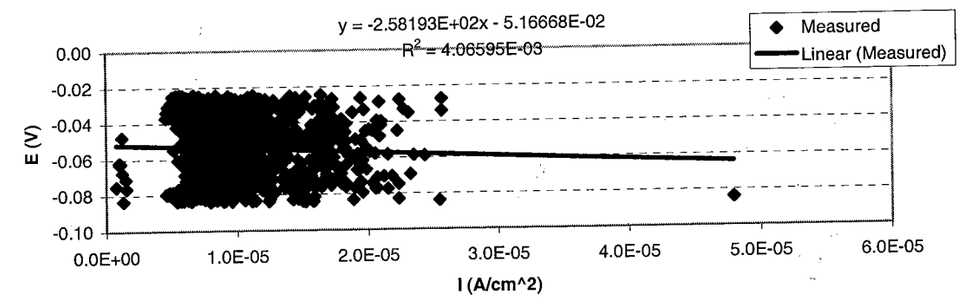
J. Y. 4/21/03

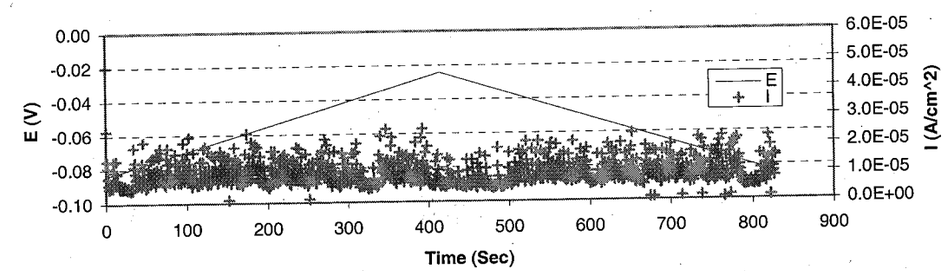
File: LPR_03_April21b_Processed

See Page 49

LPR File saved by COrrWare 304 Wire inAir Cell
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.03 OC,0.03 OC,Reverse,0.1667mV/S,LPR_03_0421b_LPR1.cor][default],LPR_03_0421b
Date: 04-21-2003 Time: 09:38:25

Time(Seco	ECorr_1(V	Rp_1(Ohm	ICorr_1(A/(	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*c	ICorr_2(A/(	Rate_2(MPY)
0	-5.64E-02	2.18E+02	1.20E-04	0.00E+00	-4.83E-02	-6.40E+02	4.06E-05	0.00E+00





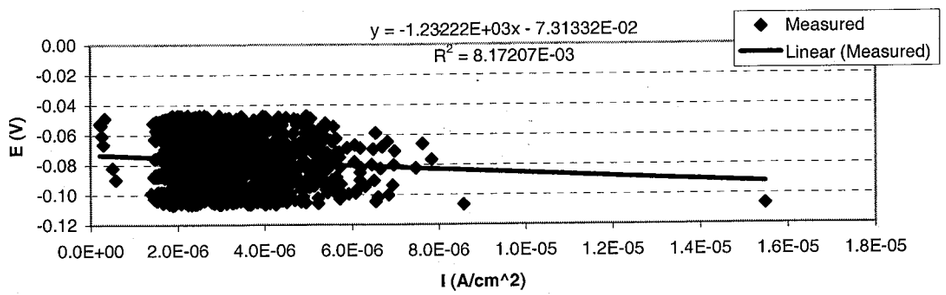
J. Y. 4/21/03.

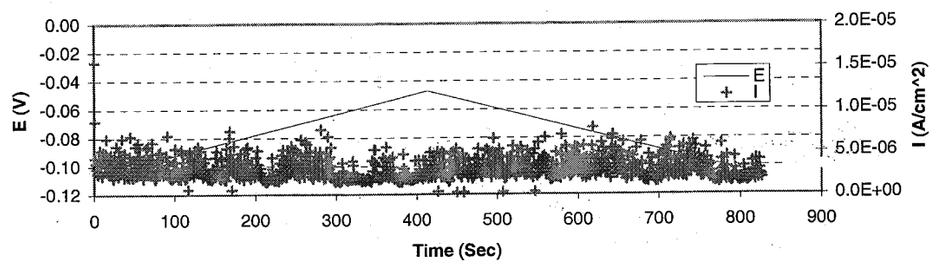
File: LPR_03_April21c_Processed

see page 49

LPR File saved by COrrWare 304 Wire inAir Cell repeat
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.03 OC,0.03 OC,Reverse,0.1667mV/S,LPR_03_0421c_LPR1.cor][default],LPR_03_0421c
Date: 04-21-2003 Time: 10:11:25

Time(Seco	ECorr_1(V	Rp_1(Ohm	ICorr_1(A/c	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*c	ICorr_2(A/c	Rate_2(MPY)
0	-6.41E-02	-4.36E+03	5.96E-06	0.00E+00	-8.45E-02	2.49E+03	1.05E-05	0.00E+00





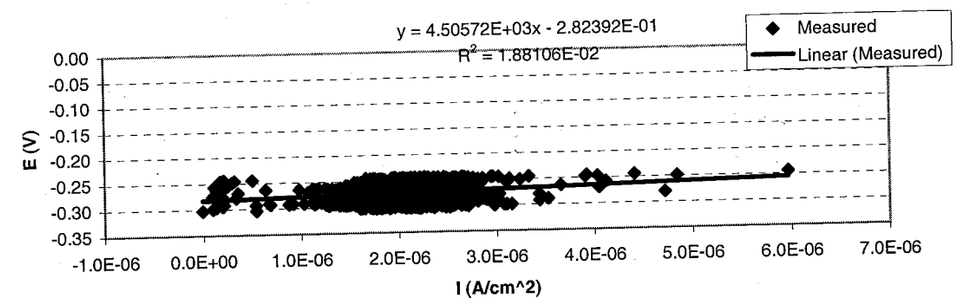
J. Yu
4/21/03

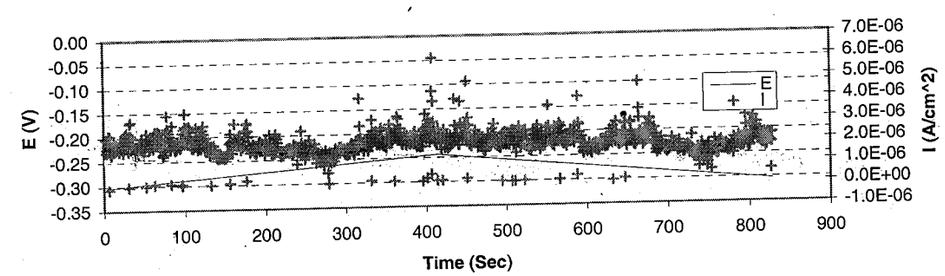
File: LPR_03_April21d_Processed

see page 49.

LPR File saved by COrrWare 304 Wire in N2 Cell
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.03 OC,0.03 OC,Reverse,0.1667mV/S,LPR_03_0421d_LPR1.cor][default],LPR_03_0421c
Date: 04-21-2003 Time: 10:28:19

Time(Seco	ECorr_1(V	Rp_1(Ohm	ICorr_1(A/c	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*c	ICorr_2(A/c	Rate_2(MPY)
0	-2.73E-01	-4.21E+02	6.17E-05	0.00E+00	-2.98E-01	1.26E+04	2.07E-06	0.00E+00





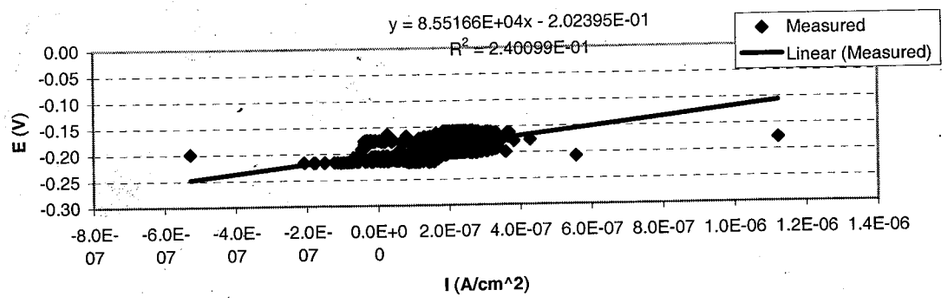
J. Yu
4/21/03

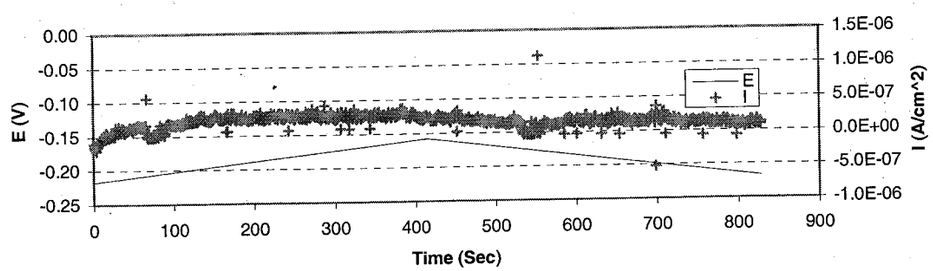
File: LPR_03_April21e_Processed

See page 49.

LPR File saved by COrrWare 304 Wire. in N2 Cell
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.03 OC,0.03 OC,Reverse,0.1667mV/S,LPR_03_0421e_LPR1.cor][default],LPR_03_0421e
Date: 04-21-2003 Time: 10:47:13

Time(Seco	ECorr_1(V	Rp_1(Ohm	ICorr_1(A/c	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*c	ICorr_2(A/c	Rate_2(MPY)
0	-1.87E-01	-2.72E+02	9.56E-05	0.00E+00	-1.97E-01	6.71E+04	3.88E-07	0.00E+00





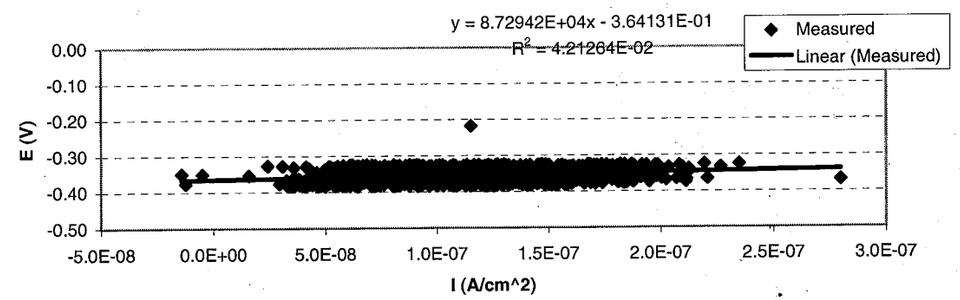
J. Y. 4/21/03

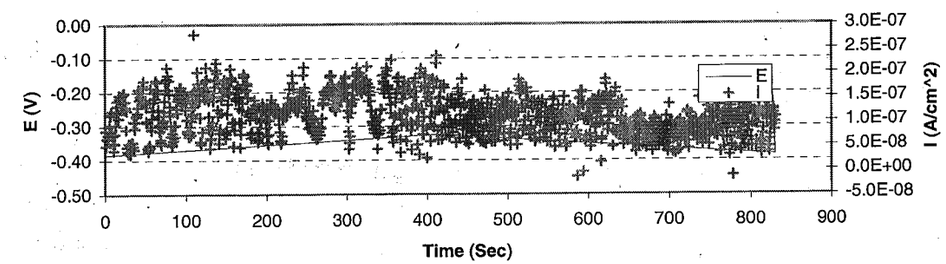
File: LPR_03_April21f_Processed

see page 49.

LPR File saved by COrrWare 304 Coupon in N2 Control Cell
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.03 OC,0.03 OC,Reverse,0.1667mV/S,LPR_03_0421f_LPR1.cor][default],LPR_03_0421f
Date: 04-21-2003 Time: 12:26:02

Time(Seco	ECorr_1(V	Rp_1(Ohm	ICorr_1(A/c	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*c	ICorr_2(A/c	Rate_2(MPY)
0	-3.54E-01	-4.18E+02	6.22E-05	0.00E+00	-3.73E-01	1.85E+05	1.41E-07	0.00E+00





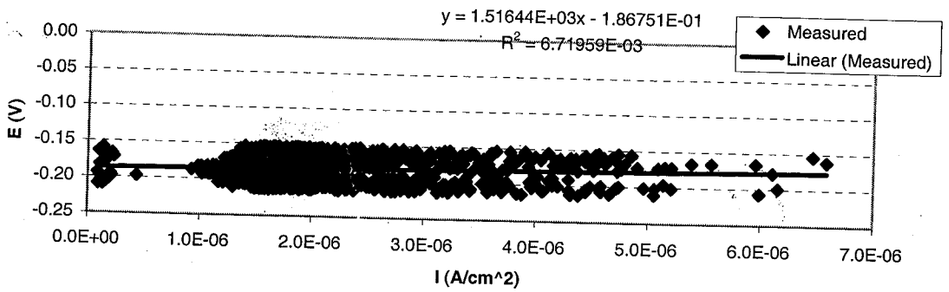
J. Y. 4/21/03

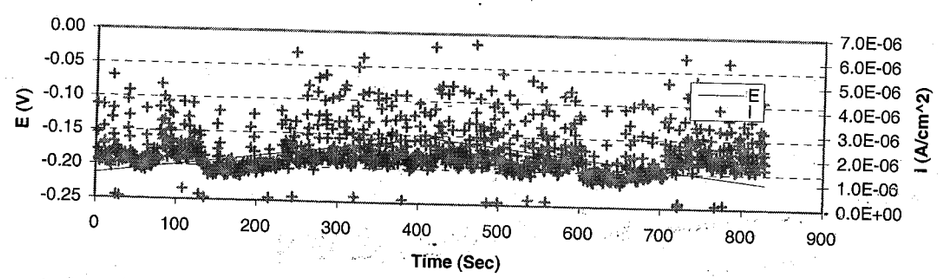
File: LPR_03_April21g_Processed

See page 49

LPR File saved by COrrWare 304 Wire in N2 Control Cell
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.03 OC,0.03 OC,Reverse,0.1667mV/S,LPR_03_0421g_LPR1.cor][default],LPR_03_0421g
Date: 04-21-2003 Time: 12:42:24

Time(Seco	ECorr_1(V	Rp_1(Ohm	ICorr_1(A/c	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*c	ICorr_2(A/c	Rate_2(MPY)
0	-1.83E-01	-9.66E+01	2.69E-04	0.00E+00	-1.86E-01	7.79E+02	3.34E-05	0.00E+00





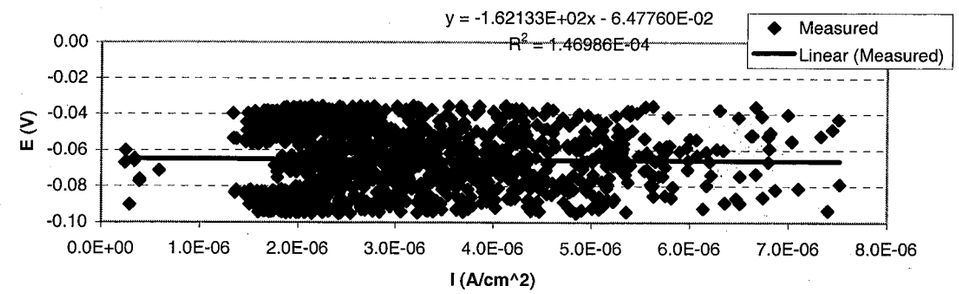
J. Yo
4/21/03

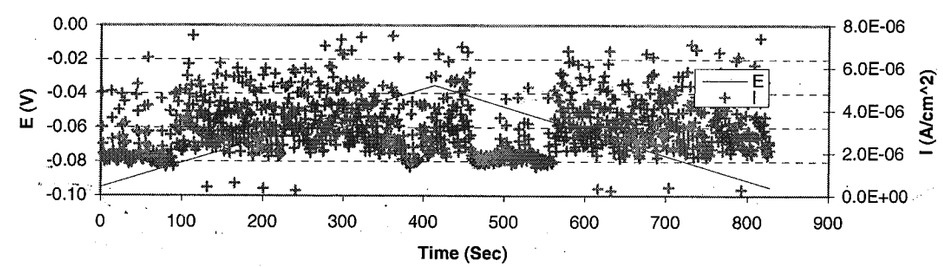
File: LPR_03_April21h_Processed

See page 49

LPR File saved by COrrWare 304 Wire in Air Cell Cell Gas flow turned down
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.03 OC,0.03 OC,Reverse,0.1667mV/S,LPR_03_0421h_LPR1.cor][default],LPR_03_0421h
Date: 04-21-2003 Time: 13:00:30

Time(Seco	ECorr_1(V	Rp_1(Ohm	ICorr_1(A/c	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*c	ICorr_2(A/c	Rate_2(MPY)
0	-7.23E-02	2.25E+03	1.15E-05	0.00E+00	-5.79E-02	-2.45E+03	1.06E-05	0.00E+00





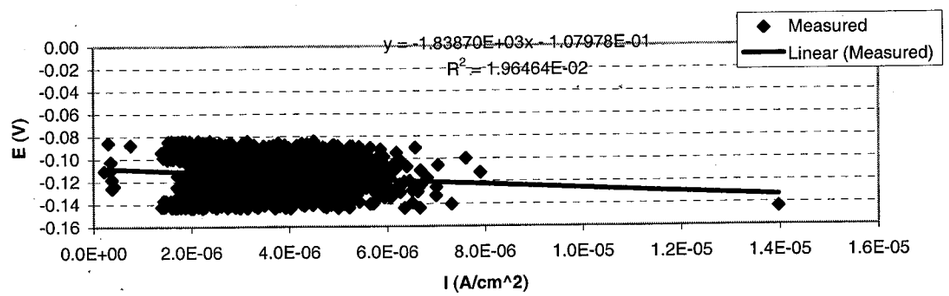
J. Yo
4/21/03

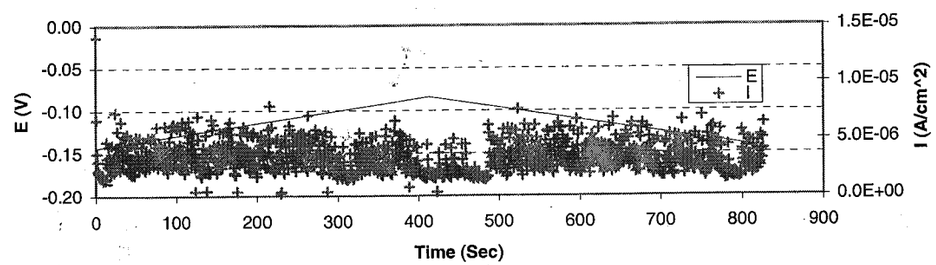
File: LPR_03_April21i_Processed

see page 50

LPR File saved by COrrWare 304 Wire in Air Cell Cell Gas flow turned down completely
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[-0.03 OC,0.03 OC,Reverse,0.1667mV/S,LPR_03_0421i_LPR1.cor][default],LPR_03_0421i_
Date: 04-21-2003 Time: 13:17:26

Time(Seco	ECorr_1(V	Rp_1(Ohm	ICorr_1(A/(	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*c	ICorr_2(A/(	Rate_2(MPY)
0	-1.08E-01	-1.78E+03	1.46E-05	0.00E+00	-1.10E-01	-1.42E+03	1.83E-05	0.00E+00





J. Y. 4/21/03

04/22/03 0940 Started Linear Polarization test of 304 wire in air cell area = 3.2 cm²
file name LPR_03_0422a_Data.cor
see page 64

0910 Started linear Polarization test of 304 coupon in air cell area = 32 cm²
file name LPR_03_0422b_Data.cor
see page 65

1228 Started linear Polarization test of 304 coupon in N2 cell area = 32 cm²
file name LPR_03_0422c_Data.cor
see page 66

1344 Started linear Polarization test of 304 wire in N2 cell area = 3.2 cm²
file name LPR_03_0422d_Data.cor

4/22/03. Concern regarding lack of positive growth of slime former from harvest taken 4-18-03. Increase N2 bubble rate to increase probability of uniform microbial distribution throughout the cell. Make serial dilutions of this harvest and perform quantitative cultures to compare against harvest taken previous to this one, (in which cell was agitated only.) @ 4/22/03.

Duplicate above with SRB harvest.

Culture slime former onto SRB media to ensure growth does occur. 4/22/03

4/28/03 - slime former does grow well on SRB media @

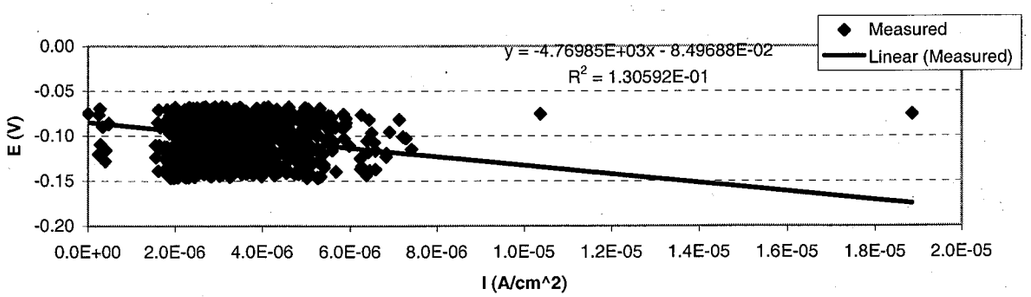
J. Y. 10/3/03

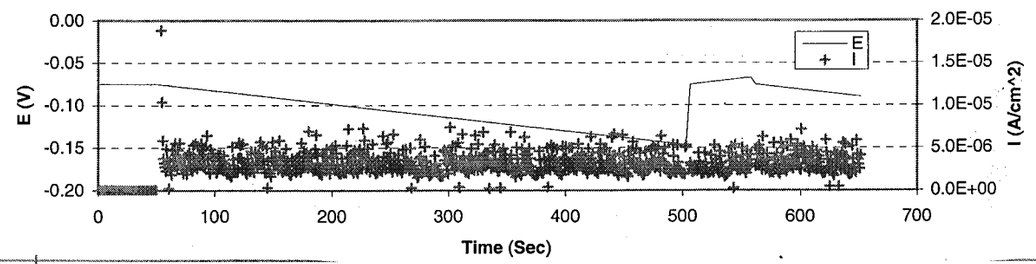
File: LPR_03_April22a_Processed

LPR File saved by COrrWare
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[0 OC,-0.4 OC,Reverse,0.1667mV/S,LPR_03_0422a_LPR.cor][default],LPR_03_0422a_D
Date: 04-22-2003 Time: 08:52:52

304 wire in air cell, see page 63

Time(Seco	ECorr_1(V	Rp_1(Ohms*cı	ICorr_1(A/(	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*cm2)	ICorr_2(A/(	Rate_2(MF
0	-1.14E-01	8.32E+02	3.12E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
453	-7.31E-02	5.72E+02	4.54E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
509	-8.41E-02	3.81E+02	6.82E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00





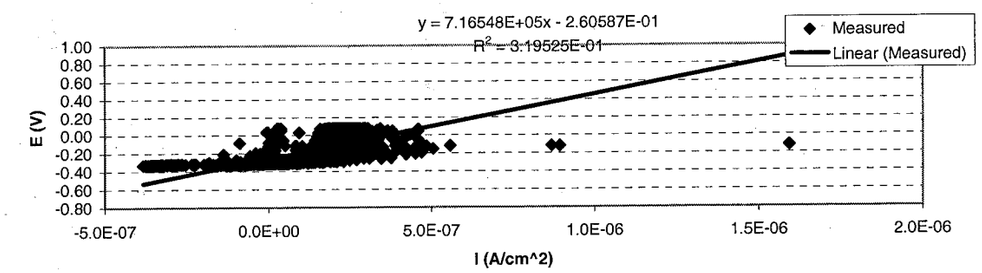
J. Yao
4/22/03

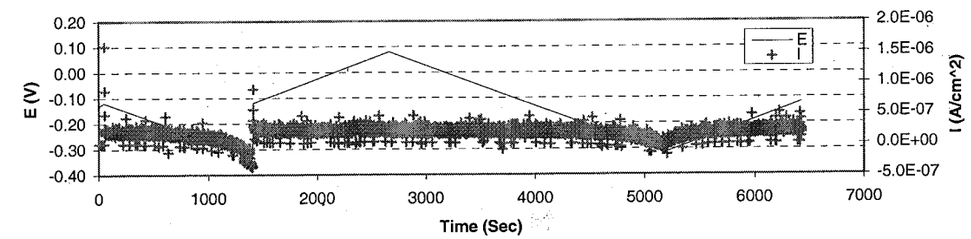
File: LPR_03_April22b_Processed

LPR File saved by COrrWare
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[0 OC,-0.4 OC,Reverse,0.1667mV/S,LPR_03_0422b_LPR.cor][default],LPR_03_0422b_Data.cor (app
Date: 04-22-2003 Time: 09:14:29

304 Coupon in air cell, see page 63

Time(Seco	ECorr_1(V	Rp_1(Ohms*cı	ICorr_1(A/(	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*cm2)	ICorr_2(A/(	Rate_2(MPY)
0	-2.70E-01	3.90E+05	6.67E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1356	-2.40E-02	2.07E+04	1.26E-06	0.00E+00	-8.24E-02	3.03E+05	8.59E-08	0.00E+00
3865	-3.10E-01	6.22E+05	4.18E-08	0.00E+00	-3.23E-01	6.11E+05	4.25E-08	0.00E+00





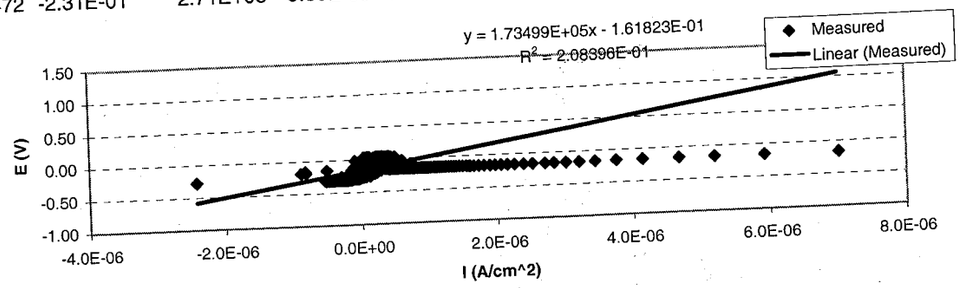
J. Yao
4/22/03

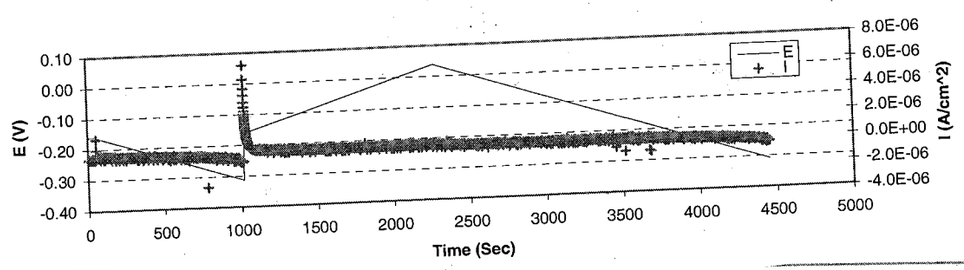
File: LPR_03_April22c_Processed

LPR File saved by COrrWare
CORRW POLARIZATION RESISTANCE
CorrWare for Windows: Version 2.4b
Polarization Resistance,[0 OC,-0.4 OC,Reverse,0.1667mV/S,LPR_03_0422c_LPR.cor][default],LPR_03_0422c_Data.cor (a
Date: 04-22-2003 Time: 12:29:20

304 coupon in Nh cell, see Page 63

Time(Seco	ECorr_1(V	Rp_1(Ohms*cr	ICorr_1(A/(	Rate_1(MF	ECorr_2(V	Rp_2(Ohms*cm2)	ICorr_2(A/(	Rate_2(MPY)
0	-2.39E-01	2.24E+05	1.16E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
966	-4.37E-02	-5.27E+04	4.94E-07	0.00E+00	-1.38E-01	4.74E+05	5.48E-08	0.00E+00
3472	-2.31E-01	2.71E+05	9.60E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00





J. [illegible] 4/22/03

5/6/03 [illegible]
10:50

Harvest of 4/22/03 for slime former and for SRB culture results:

Slime former from 4/22 Ng (plates & tubes) Both samplings

SRB from 4/22 Ng on plates - Both samplings

10^2 tubes - from Both samplings.
5/6/03 [illegible].

J. [illegible] 10/13/03

04/23/03 0904 Started Linear Polarization test of 304 wire in N2 cell. area = 3.2 cm²
file name LPR_03_0423a_Data.cor

1243 Started Linear Polarization test of 304 Coupon in N2 cell area = 32 cm²
file name LPR_03_0423b_Data.cor

computer results see Pages 80-83 (for April 8 — April 23)

04/24/03 Stop test, dismantled system J.Y. 10/6/03

pH of bugs cell = 8.58
Has sulfide smell
Has dark appearance in liquid
pH air cell = 9.032

pH of N2 cell = 7.475
Has a yellow appearance
Volume ≈ 750 ml for all cells

Results see page 297, page 298 and page 300

4/28/03 Program started again 03_April 28A.

04/29/03 Sensors 304-#11, 304-#12

connected to II-2, II-3; II-5, I-4 respectively after they were washed and placed in air to get background readings.

Continued page 111.

J. Y.
10/3/03

4/29/03 Machine shop cut #4 & #5 coupons into 2 pieces each. The new labels is 4A, 4B & 5A, 5B.

Got back ground current readings for Sensors 304-#11 & 304-#12.
304-#11 A connected to II-2
304-#11 B connected to II-3
304-#12 A connected to I-4
304-#12 B connected to II-5

Got back ground current readings for wires with no sensors connected

See attached for results.

P.O. 1829305 Line 1, 4T R254.

See book #423, page 31.

Confirmatory Analysis see page 110.

J. Y.
9/8/03

Roger J Dykstra
10/6/03

Sensor 304-#11	Ch 1		Ch 2		Ch 3		Ch 4		Ch 5		Ch 6		Ch 7		Ch 8	
No connection to-II-2	-5.891	nA	3.413	nA	4.486	nA	5.065	nA	3.959	nA	3.727	nA	4.274	nA	3.848	nA
	1.391	nA	4.184	nA	2.121	nA	1.953	nA	4.392	nA	1.450	nA	4.050	nA	2.736	nA
	5.200	nA	1.523	nA	1.668	nA	1.757	nA	1.767	nA	0.860	nA	1.561	nA	1.882	nA
Average	0.233	nA	3.040	nA	2.758	nA	2.925	nA	3.373	nA	2.012	nA	3.295	nA	2.822	nA

	Ch 1		Ch 2		Ch 3		Ch 4		Ch 5		Ch 6		Ch 7		Ch 8	
No connection to-II-3	-5.038	nA	-5.402	nA	-6.882	nA	-4.484	nA	-5.491	nA	-5.919	nA	-5.760	nA	-5.240	nA
	-3.260	nA	-2.989	nA	-6.234	nA	-3.665	nA	-4.275	nA	-4.423	nA	-4.809	nA	-4.226	nA
	-2.001	nA	-3.280	nA	-4.132	nA	-1.912	nA	-3.418	nA	-2.121	nA	-3.484	nA	-3.129	nA
Average	-3.433	nA	-3.890	nA	-5.749	nA	-3.354	nA	-4.395	nA	-4.154	nA	-4.684	nA	-4.198	nA

Sensor 304-#12	Ch 1		Ch 2		Ch 3		Ch 4		Ch 5		Ch 6		Ch 7		Ch 8	
No connection to-I-4	-0.258	nA	-0.183	nA	-0.107	nA	-0.179	nA	-0.371	nA	-0.592	nA	-0.525	nA	-0.353	nA
	-0.385	nA	-0.034	nA	-0.316	nA	-0.179	nA	-0.289	nA	-0.454	nA	-0.635	nA	-0.532	nA
	-0.405	nA	-0.029	nA	-0.334	nA	-0.311	nA	-0.275	nA	-0.370	nA	-0.639	nA	-0.488	nA
Average	-0.349	nA	-0.082	nA	-0.252	nA	-0.223	nA	-0.312	nA	-0.472	nA	-0.600	nA	-0.458	nA

	Ch 1		Ch 2		Ch 3		Ch 4		Ch 5		Ch 6		Ch 7		Ch 8	
No connection to-II-5	-0.296	nA	-0.177	nA	-0.150	nA	-0.129	nA	-0.136	nA	-0.057	nA	-0.233	nA	0.051	nA
	0.377	nA	0.428	nA	0.346	nA	0.457	nA	0.462	nA	0.580	nA	0.544	nA	0.634	nA
	0.513	nA	0.427	nA	0.537	nA	0.599	nA	0.562	nA	0.612	nA	0.478	nA	0.585	nA
Average	0.198	nA	0.226	nA	0.244	nA	0.309	nA	0.296	nA	0.378	nA	0.263	nA	0.423	nA

Robert Dekstra 10/6/99

No Sensor Connected

Robert Dekstra 10/6/99

Sensor Data

Sensor 304-#11	Ch 1		Ch 2		Ch 3		Ch 4		Ch 5		Ch 6		Ch 7		Ch 8	
A connected to-II-2	-4.240	nA	4.394	nA	5.083	nA	4.537	nA	3.284	nA	4.336	nA	6.468	nA	6.622	nA
	-0.731	nA	1.358	nA	3.248	nA	0.811	nA	1.571	nA	0.118	nA	1.900	nA	3.754	nA
	2.228	nA	2.660	nA	2.101	nA	2.322	nA	1.064	nA	2.838	nA	2.754	nA	3.425	nA
Average	-0.914	nA	2.804	nA	3.477	nA	2.557	nA	1.973	nA	2.431	nA	3.707	nA	4.600	nA

	Ch 1		Ch 2		Ch 3		Ch 4		Ch 5		Ch 6		Ch 7		Ch 8	
B connected to-II-3	-5.477	nA	-7.094	nA	-5.199	nA	-4.604	nA	-3.697	nA	-6.213	nA	-2.935	nA	-5.391	nA
	-4.036	nA	-3.293	nA	-3.429	nA	-2.110	nA	-2.679	nA	-3.187	nA	-1.858	nA	-3.798	nA
	-3.448	nA	-5.983	nA	-3.560	nA	-3.019	nA	-7.865	nA	-3.102	nA	-3.025	nA	-3.159	nA
Average	-4.320	nA	-5.457	nA	-4.063	nA	-3.244	nA	-4.747	nA	-4.167	nA	-2.606	nA	-4.116	nA

Sensor 304-#12	Ch 1		Ch 2		Ch 3		Ch 4		Ch 5		Ch 6		Ch 7		Ch 8	
A connected to-I-4	-0.064	nA	0.448	nA	-1.101	nA	0.231	nA	-0.532	nA	-0.570	nA	-0.254	nA	-0.992	nA
	-0.656	nA	-0.158	nA	-2.144	nA	-0.264	nA	-0.731	nA	-1.060	nA	-0.459	nA	-1.868	nA
	-0.360	nA	0.120	nA	-1.654	nA	-0.065	nA	-0.834	nA	-0.826	nA	-0.494	nA	-1.440	nA
Average	-0.360	nA	0.137	nA	-1.633	nA	-0.033	nA	-0.699	nA	-0.819	nA	-0.402	nA	-1.433	nA

	Ch 1		Ch 2		Ch 3		Ch 4		Ch 5		Ch 6		Ch 7		Ch 8	
B connected to-II-5	-0.444	nA	-0.163	nA	-0.188	nA	-0.106	nA	-0.021	nA	0.094	nA	0.010	nA	0.280	nA
	-0.118	nA	0.133	nA	0.088	nA	0.170	nA	0.203	nA	0.234	nA	0.371	nA	0.411	nA
	-0.111	nA	0.098	nA	0.009	nA	0.177	nA	0.185	nA	0.222	nA	0.230	nA	0.291	nA
Average	-0.224	nA	0.023	nA	-0.030	nA	0.080	nA	0.122	nA	0.183	nA	0.204	nA	0.327	nA

* in air, no solution

Robert Dekstra 10/6/99

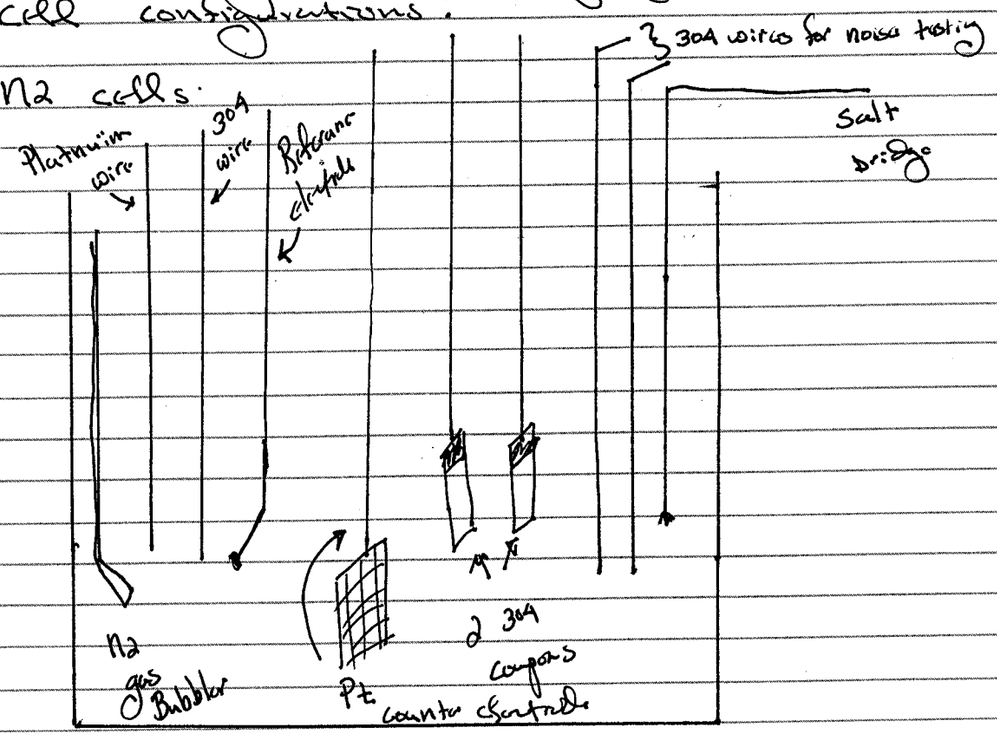
4/30/03 0930 Disconnected II-2 & II-3 wire @ resistor connection.
background basically the same as page 71

1045 Connected II-2 & II-3 and I-4 & II-5 to sensors in air. Cells assembled and ready to fill with solution

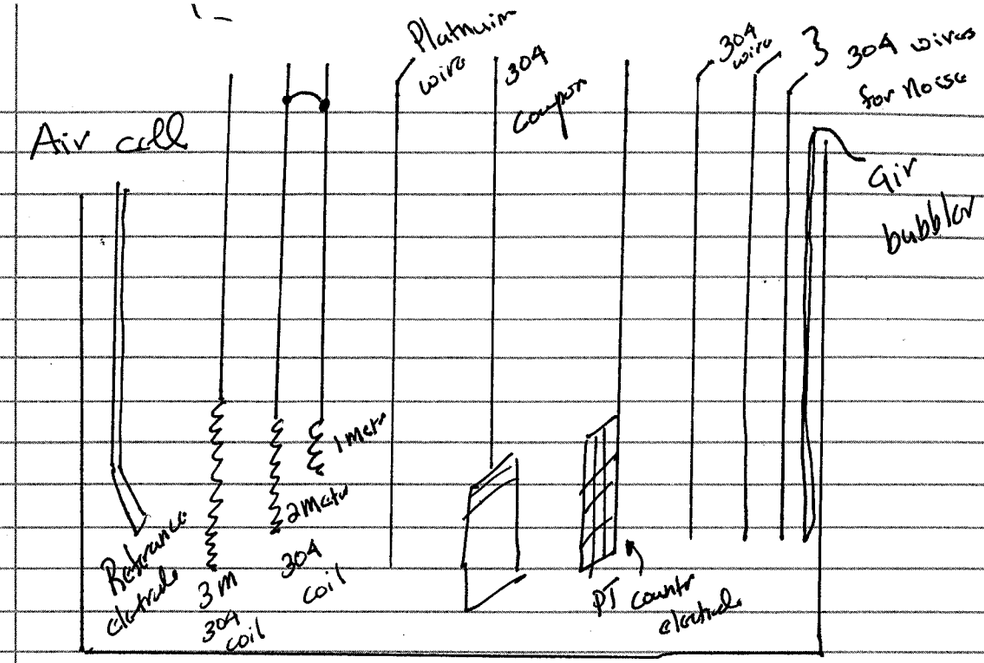
1230 Started to add 0.5 M of NaCL to cells.
Solution was 2000 mL of DI with 58.36 g NaCL. 2000 mL of DI with 58.45 g of NaCL

The following are drawings of the cell configurations:

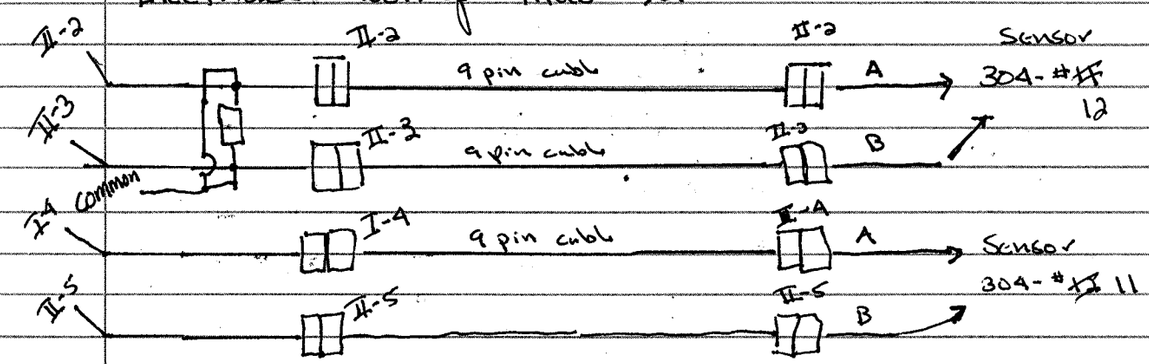
N2 cells:



Roger J Bykstra 10/6/03

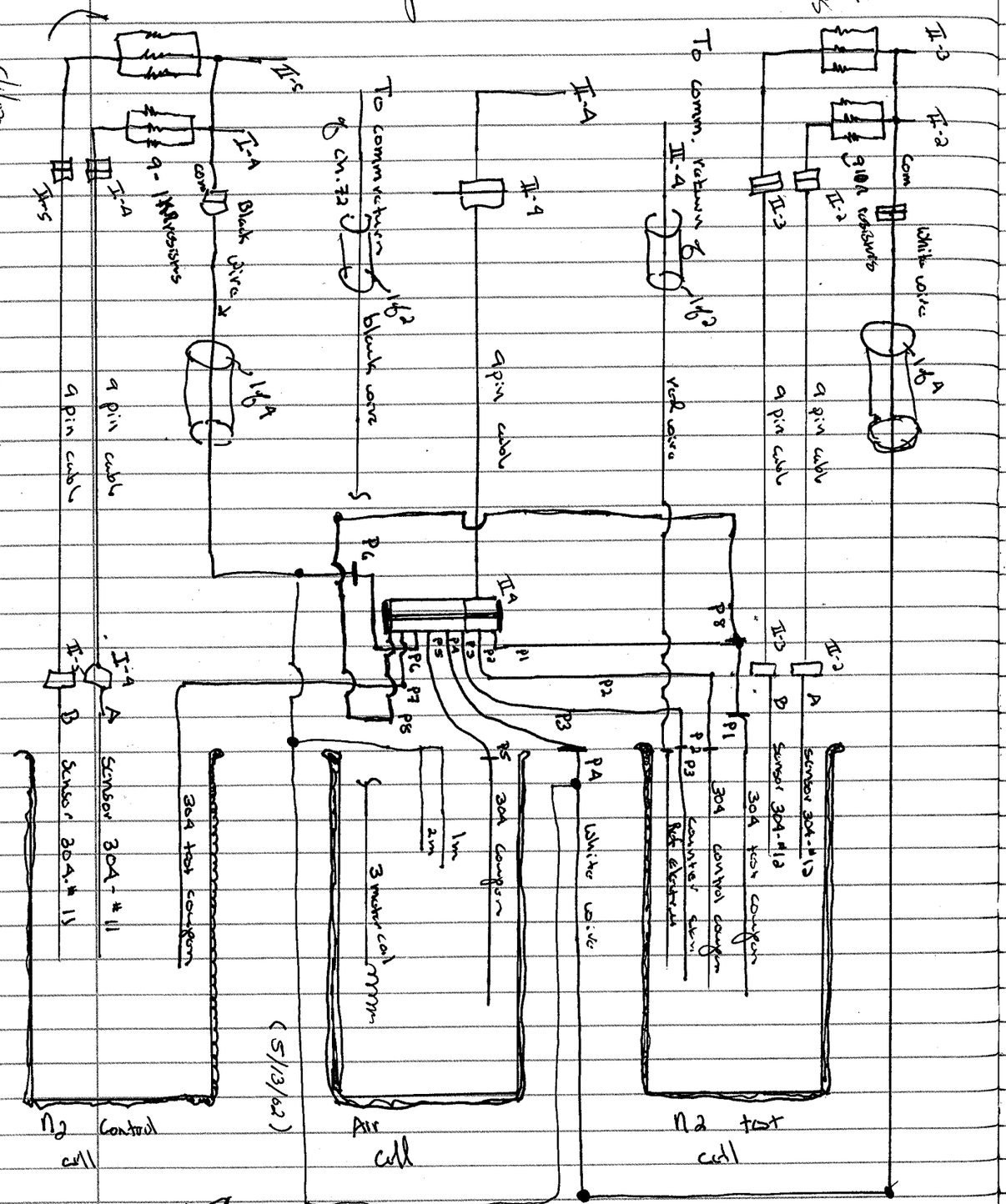


Electrical hookup thus far:



Roger J Bykstra 10/6/03

1/30/03 1430 Electrical hook-up



J. [illegible] 10/3/03

5/1/03 0949

For troubleshooting switched II-2 & II-3 and I4 & II5 to see why no current in sensor 304-#11 (N2 control cell)

1226 Connected II-2 & II3 back up to Sensor 304-#12 A & B.

1429 Disconnected Black & white wire

1444 Δ out 1KΩ resistor on I-4 & II5 to 10KΩ resistor.

5/2/03 Disconnected II5 & I-4 and hooked up to spare sensor for trouble shooting

1221 Swapped II-3 & II-2 and I-4 & II-5 for trouble shooting

Sensor 304-12 (this is C22)	I-4	1606	3518	2460	-6110	-5146	-3888	2848	3368
	II-5	1690	1428	1844	1887	-14138	1748	2398	1589
Spare 304	II-2	2.19	37.87	6.22	9.656	-11.855	-16.83	42.0	89
	II3	0.25	-44	-0.213	4.6	-15	-19	-12	7.7

1241 Swapped II-3 & II2 and 1-4 & II5 for trouble shooting

Spare 304	I-4	-12	-5.9	6.2	12.4	-37	-20	-15	5.2
	II-5	-6.3	28.21	27	12.2	-8.1	-14.3	24.6	4.3
Sensor 304-12	II-2	1631	3540	2442	-6048	-5218	-3858	2865	3357
	II-3	1694	1439	1844	1889	-14244	1765	2420	1598

1255 placed 8 C-22 pins on spare sensor.

J. [illegible] 10/3/03

5/2/03 I-4 57 68 77 100 64 87 98 -1.3
II-5 1492 -48505 3743 -4483 1171 1158 3384 14719

~~removed~~ Removed 304 from spare sensor
304 I-4 6.15 4.3 -5.7 -4.6 -2.7 3.3 0.11 -3.01
II-5 174 191 -782 186 115 -50 -21 124
I-4 -0.4 2.3 -3.6 -0.6 -0.49 -0.73 0.284 -4.39
II-5 166 178 -947 179 150 14.83 46.98 115.7

Put 304 back on spare sensor (removed c-22)
Moved II-3 II-2 to sensor 304-#11.

1414 Moved II-3 & II2 to sensor 304#12 after cleaning 304-#12 tips with acid

1414 Moved I-4 & II 5 to sensor 304-#11

304-#12 & 304-#11 are 304 SS sensor's.

1434 Δ out 304-leads on sensor 304-#12

1447 Reading taken on II-2, II-3, I-4 & II 5

I-4 -267.776 -406.891 28.924 35.289 27.734 17.669 27.412 65.802
-266.482 -409.55 28.81 35.541 26.95 17.244 27.957 65.294

II-5 45.438 65.797 32.231 27.606 81.418 42.925 27.963 29.756
44.787 65.652 32.055 27.654 86.292 42.954 28.151 30.268

II-2 87.018 59.503 187.67 47.737 29.791 -52.173 72.724 71.574
193.965 178.248 279.165 123.465 126.463 -267.76 177.748 186.83

II-3 ~~45.438~~ 79.906 58.445 59.434 76.939 -48.662 51.638 51.09 23.324
202.64 192.52 183.52 226.54 92.24 177.67 177.35 133.42

J. Yoo 10/3/03

5/2/03
1500 Raised both sensors out of water for back ground readings

Sensor-#11 I-4 -5.904 -0.88 -0.455 2.527 -0.125 -0.516 -3.57 -0.75
2nd set → -5.945 -1.3 1.48 2.028 -0.865 -1.412 -3.91 -0.32

II-5 -2.338 -3.077 0.8 0.933 6.811 -0.65 -8.679 0.694
2nd set → -2.4 -3.388 4.3 -0.577 2.648 1.5 -3.658 0.39

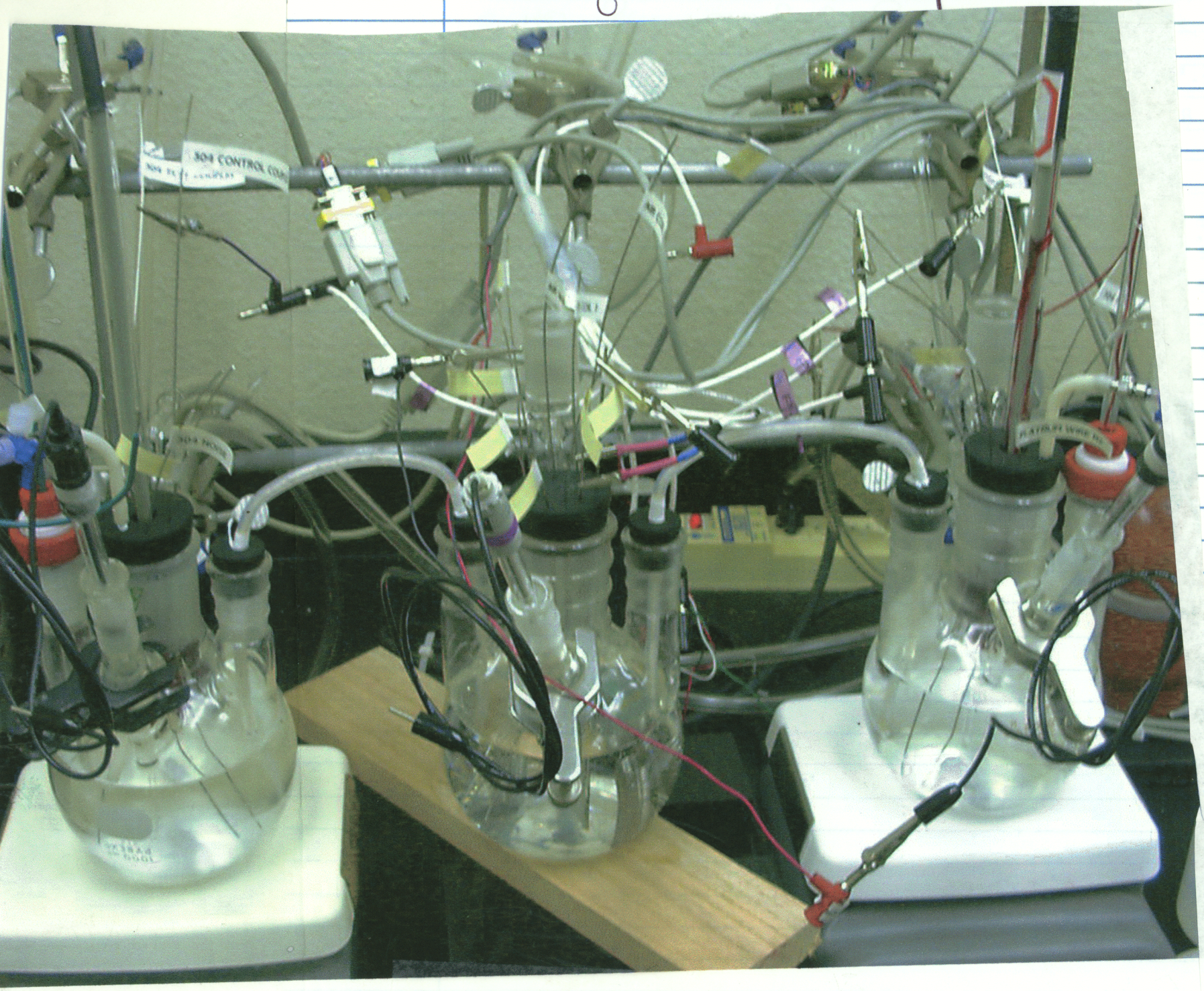
Sensor-#12
II-2 1.029 50.62 107.075 -.2671 1.583 -160.193 7.344 1.309
2nd set → 2.3 54.7 114.37 2.447 2.305 -159.9 12.62 -0.903

II-3 0.528 0.906 -1.248 6.665 -0.77 -3.697 11.832 -7.511
2nd set → -3.2 -2.6 -2.571 6.181 3.859 -4.664 11.165 -13.47

1520 Put both sensors back into liquid.

J. Yoo 10/3/03

5/5/03 Picture of the test set-up.



J. [illegible] 10/3/03

5/5/03 Started bubbling N2 & air @ 1246 computer time.

Readings

1406	I-4	104.439	37.486	10.941	8.74	4.312	4.497	0.909	14.84
	II-5	13.388	-385.59	26.197	6.184	22.857	3.012	2.009	-4.612
	II-2	22.457	-2563.76	91.658	91.162	216.638	-440.077	587.12	259.1
	II-3	24.192	51.421	65.997	279.108	3979.05	92.561	1902.65	7460.

1416 Brought both sensors up from bottom to ≈ 2mm depth.

ref potential (air) - N2 potential (test) = 0.4 mV

ref pot N2(control) - ref (N2 test) = -0.5 mV

Started rotation of N2 cells with mechanical rotator. see page 231

1452 Linear polarization check of air 304 coupon Sil LPR_03_0505_Data1.cor (3.2 cm² area)

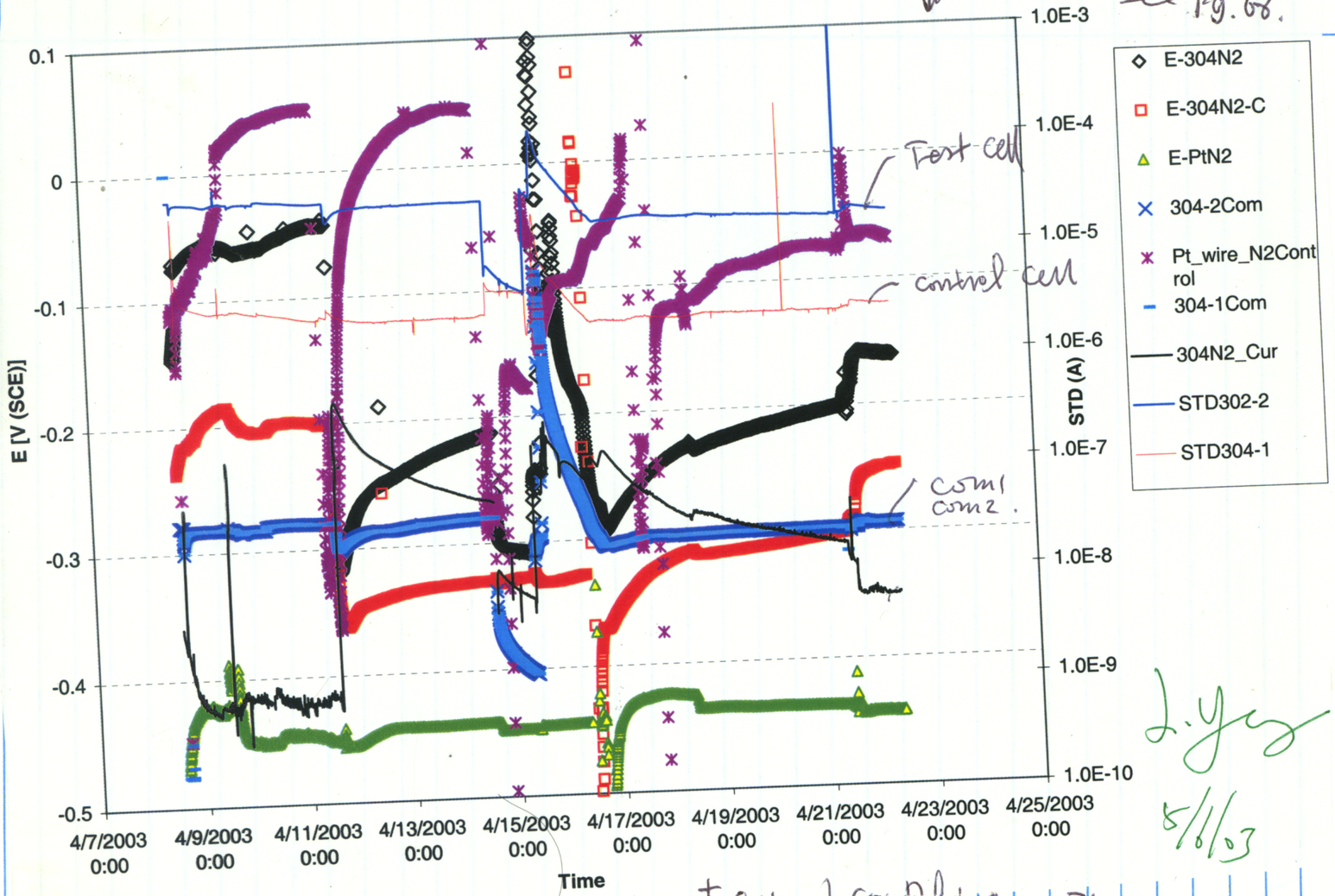
1505 Linear polarization check of air wire Sil LPR_03_0505_Data2.cor see page 221

1523 Started Repassivation test of air wire Sil temp.cor will change to 03_May05a Rep

J. [illegible] 10/3/03

File: Mic_03_April08a00_a03 / Tab: Chart_STD_Potential

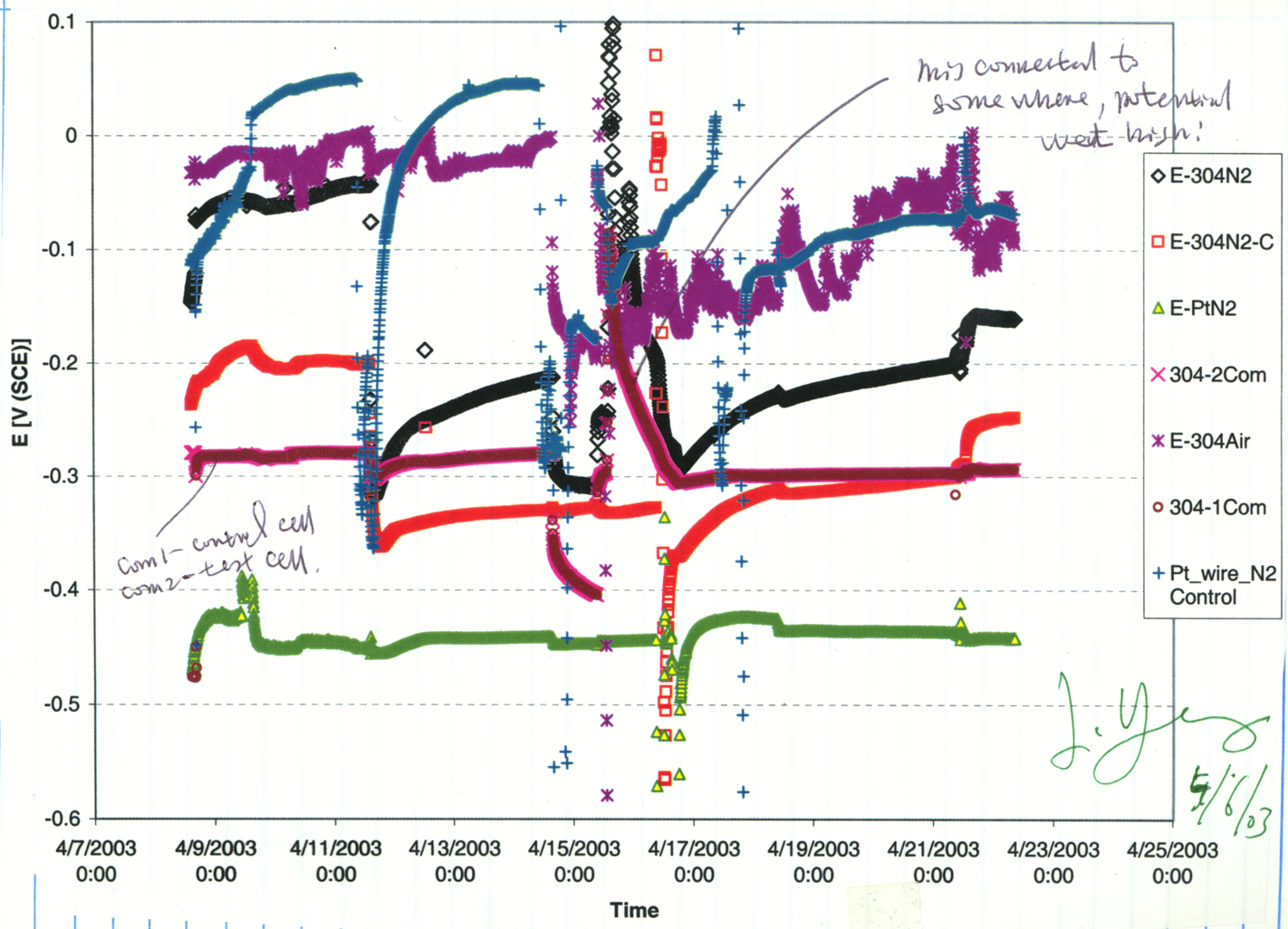
April 24. test stopped
See pg. 68.



J. Yang
5/6/03

test of coupling 3/14 – 4/24
40 days.

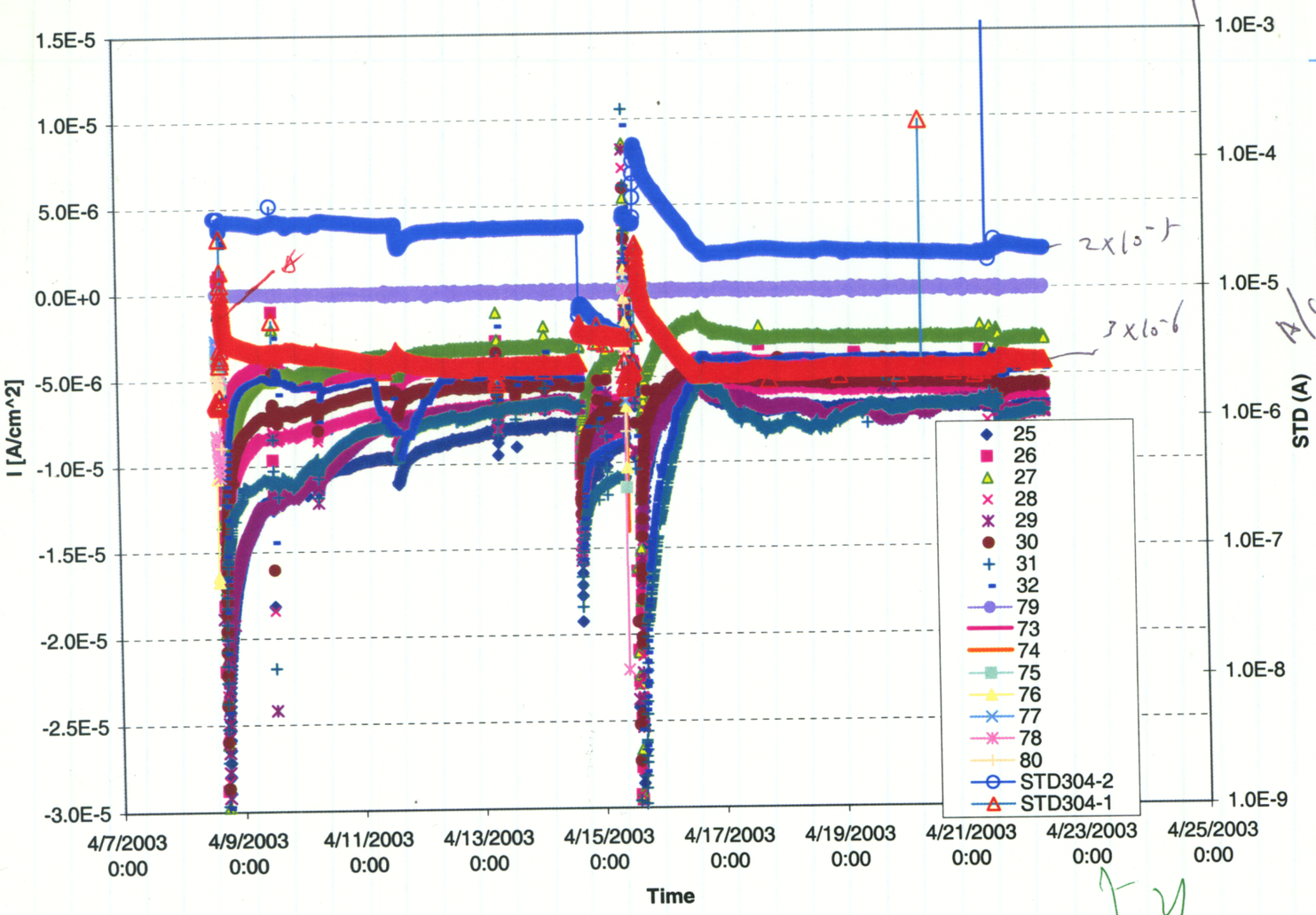
File: Mic_03_April08a00_a03 / Tab: Potential



J. Yang
5/6/03

File: Mic_03_April08a00_a03 / Tab: Chart_Sensor304_1_Currents

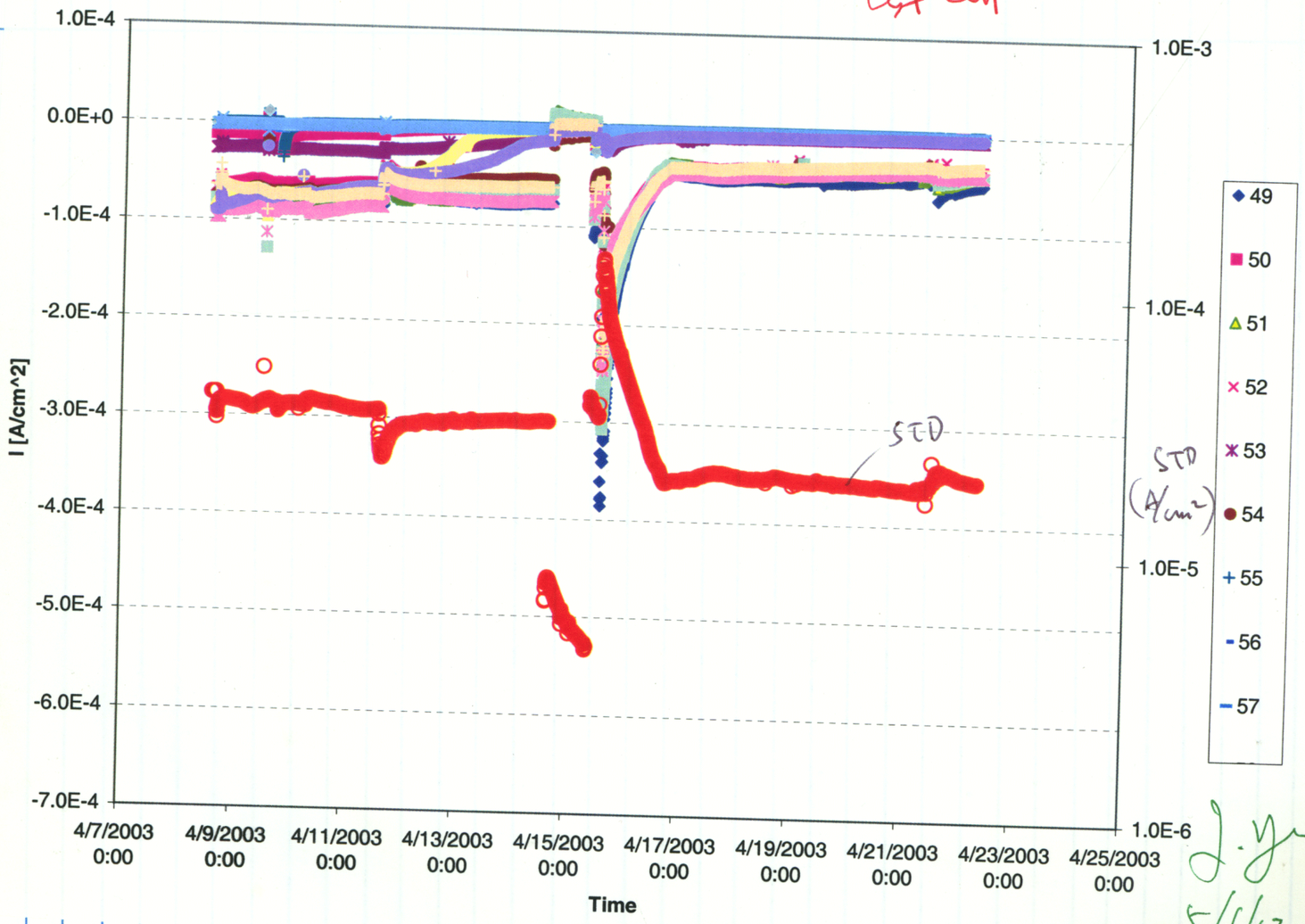
Control - cell



J. Yang
5/6/03

Mic_03_April08a00_a03 / Sensor_304_2_Current

test cell



J. Yang
5/6/03

5/6/03 9:22 Removed both sensor's from liquid
Reading

I-4	110.559	-1.679	-110.013	575.35	-10.419	-1709.338	27.057	29.757
	11.477	22.741	15.479	-37.139	-187.809	-1453.491	55.018	76.508
	391.098	239.069	97.858	-1122.81	-7.248	-2100.655	103.329	135.76
II-5	39.001	55.313	6.651	7.035	834.547	-1.834	-27.009	3.572
	116.643	162.175	171.996	19.114	983.583	130.245	92.929	7.694
	38.708	38.63	78.938	17.938	1081.137	15.123	52.933	8.775
II-2	-2746.109	-794.137	-1613.428	116.473	123754	-5648.789	61.822	144.733
	-3007.985	-622.348	-1577.474	133.058	1870.57	-5473.27	75.419	152.181
	3130.403	-637.648	-1583.90	122.795	134.825	-5264.526	84.593	155.53
II-3	-9.295	-0.101	244.319	1229.789	1181.904	-30.513	772.709	1334.231
	-6.33	4.403	250.21	1220.172	1134.512	-19.069	762.64	1366.33
	25.88	34.564	287.637	1186.447	1104.103	-9.56	752.12	1341.081

1209 Disconnected all wires to dry sensor's

I-4	-0.351	-2.38	-1.773	-0.524	-0.977	0.947	1.233	-1.264
II-5	-1.791	2.03	-0.602	0.996	1.843	0.067	1.277	-0.429
II-2	1.741	0.143	1.542	1.881	2.06	1.371	1.622	2.431
II-4	2.191	-1.568	-2.138	0.031	-5.3	1.39	3.169	-2.246

12:30 Reconnected sensor's => could not get good readings.
Decided to go with different sensor design.

10/3/03

5/9/03 Build new sensors and getting background checks in air

0931

I-4	-1.473	-1.406	-0.572	-1.921	-2.773	-2.796	-1.771	-0.749
	0.209	-1.001	-1.379	0.203	-1.086	-2.659	-1.314	-1.397
II-5	0.238	-2.158	-1.841	-0.473	-2.75	-0.143	-3.041	-1.942
	-1.543	-0.457	0.52	-1.243	0.089	0.332	-0.249	0.91
II-2	1.597	2.225	1.106	0.79	1.371	0.996	1.032	1.375
	1.927	2.826	1.775	1.961	0.765	1.688	-0.151	1.1443
II-3	-3.018	-2.158	-1.841	-0.473	-2.75	-0.432	-3.041	-1.942
	-2.016	-0.475	-2.557	-2.419	-3.846	-2.508	-1.536	-2.76

0940 Removed sensor to clean & assemble cell head.

1058 Attached sensors after cleaning

I-4	-2.149	-0.583	-1.925	-3.34	-0.709	-0.722	-0.985	-0.778
II-5	1.39	-0.462	-1.773	1.733	-0.43	1.122	-0.498	-0.548
II-2	1.522	1.475	-0.842	1.548	0.549	0.717	1.371	-1.94
II-3	-2.646	-2.641	-2.811	-1.875	-7.18	-1.534	-2.48	-2.077

214pm Add 0.5 m stack to test cells
getting back ground reading
liquid no N_2 purge

I-4	514.71	462.222	353.979	-530.899	-865.418
	689.121	717.68	621.654		
II-5	329.45	400.229	420.439	396.893	277.007
	-1424.33	298.559	-1185.535		

10/3/03

7/9/03 II-2 757.807 569.903 579.013 650.772
588.94 342.756 644.218 856.331

II-3 513.13 515.189 610.852 582.907
-3324.227 -396.536 -846.277 680.189

~~3:06pm Started N2 purge on both~~ RSD 5/9/03
n2 cells

~~I-4 279.452 198.548~~ RSD 5/9/03

~~II-5~~ N/A RSD 5/9/03

~~II-2~~ RSD 5/9/03

~~II-3~~ RSD 5/9/03

5/12/03 8:44.
SS304-13, test. $-I_{max} = 4.3$ nV
SS304-14, control; $-I_{max} = +1302$ nV! (16th electrode!).
$E_{SS304-13} = +25$ mV$_{SCE}$, too high!

8:
9:06 at start of # 2847, decoupled I-4 and II-5.
potential still with II-5.

9:23am I-4, -221 nV ; II-5, -1048 nV

9:30am Removed 60mL from both N2 cells to get sensors out of liquid. J. 10/3/03

5/12/03 I-4 -5.39 -3.724 7.48 68.992 -5.899 -3.371 -1.163 -3.13

II-5 -0.517 -0.765 -9.201 0.575 2.243 -3.966 3.369 4.525

II-2 -3.384 0.612 -2.971 -1.895 6.895 0.332 0.758 3.91

II-3 -2.523 1.562 -1.059 -0.889 -1.53 -1.339 -1.776 1.638

10:47am I-4 -1.833 -2.049 -1.17 -2.144 -1.967 -2.034 -1.417 -1.367

II-5 -0.895 0.499 -7.411 -0.402 0.115 -0.392 -1.025 -1.816

II-2 -2.768 1.365 -0.137 0.102 0.656 0.233 0.21 0.057

II-3 -2.496 -3.255 -0.981 -0.201 -0.795 3.288 -1.025 -1.816

11:00am Added 60mL of solution to both N2 cells to cover sensors.

12:00pm Readings for sensors in liquid (0.5mNaCl)

I-4 0.231 20.473 14.855 9.276 -42.435 -21.417 3.702 38.575

II-5 7.351 -5.472 -4.829 -17.96 -9.964 42.391 7.041 -25.417

II-2 0.099 -0.568 1.974 -1.445 -0.493 -0.45 0.12 1.461

II-4 -3.859 -4.985 -2.459 -4.5 -3.1 -1.235 -5.334 -0.848

12:41 Started N2 purge of both N2 cells

I-4 -1.286 26.235 14.905 2.397 -37.797 9.202 19.465 18.791

II-5 10.311 30.917 -96.775 1.763 -49.547 -4.765 -31.952

J. 10/3/03

5/12/03 II:2 1.224 -0.918 0.396 -3.649 -2.133 -1.824 -3.495 0.78

II:3 -0.057 -0.112 2.348 -3.737 -0.357 0.042 -1.772 1.324

5/13/03 9:41 potentials:

Test cell 304wire: -237 mV,
-237

	304wire	EN1	EN2	Pt-wire	Coupon	control	counter
Test cell	-237	-231	-230	-84 ?	-224	-204	-391
Air cell	+185	-50	-58	+211	-146 ?		+213
Control cell	-251	-271	-269	-310	-219	-262	-492

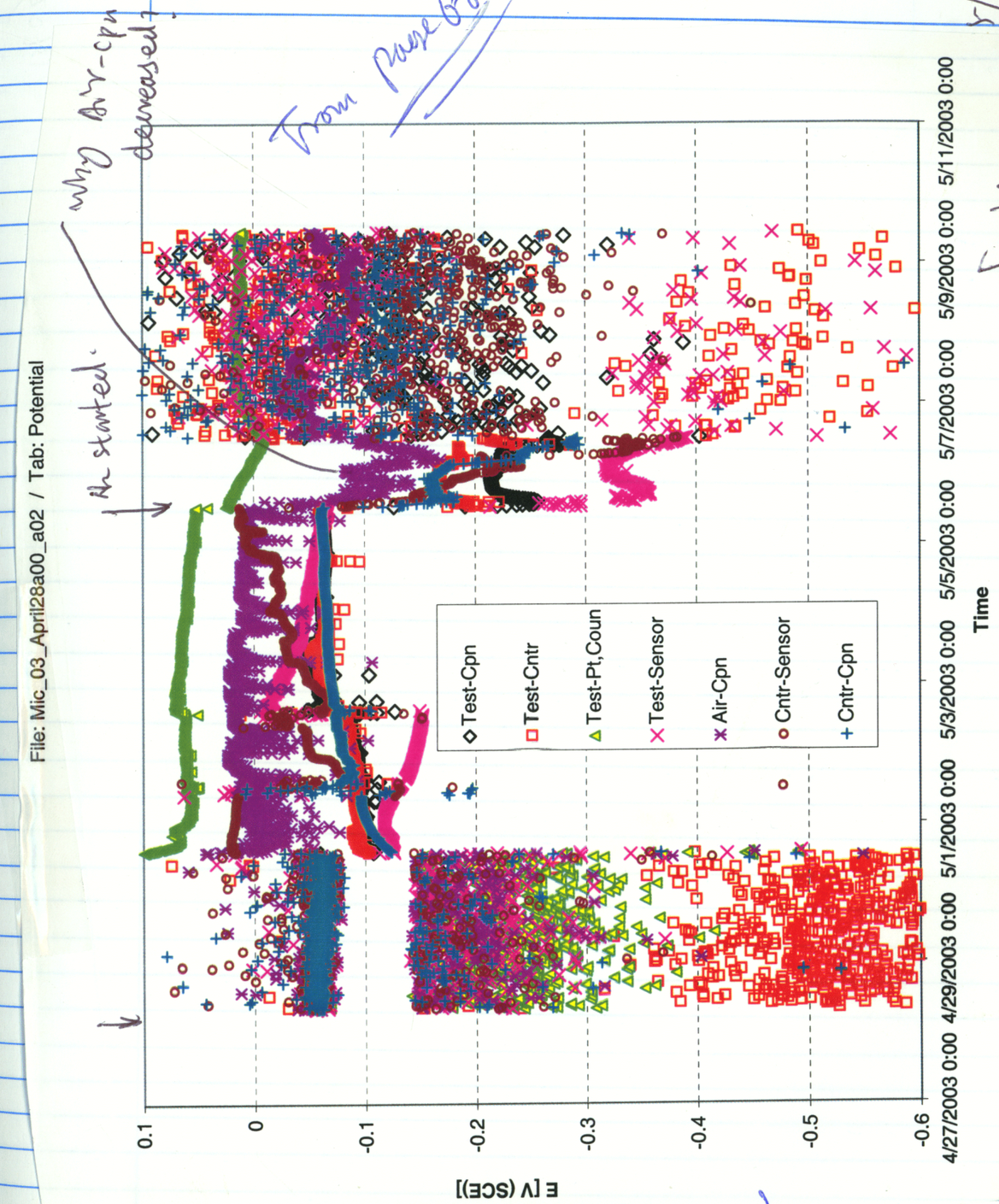
mV

Coil #1/#2 = -79 Coil #3, = -71 mV, Ref air - Ref test = -02

Ref control - Ref test = -1 mV

5/13/03

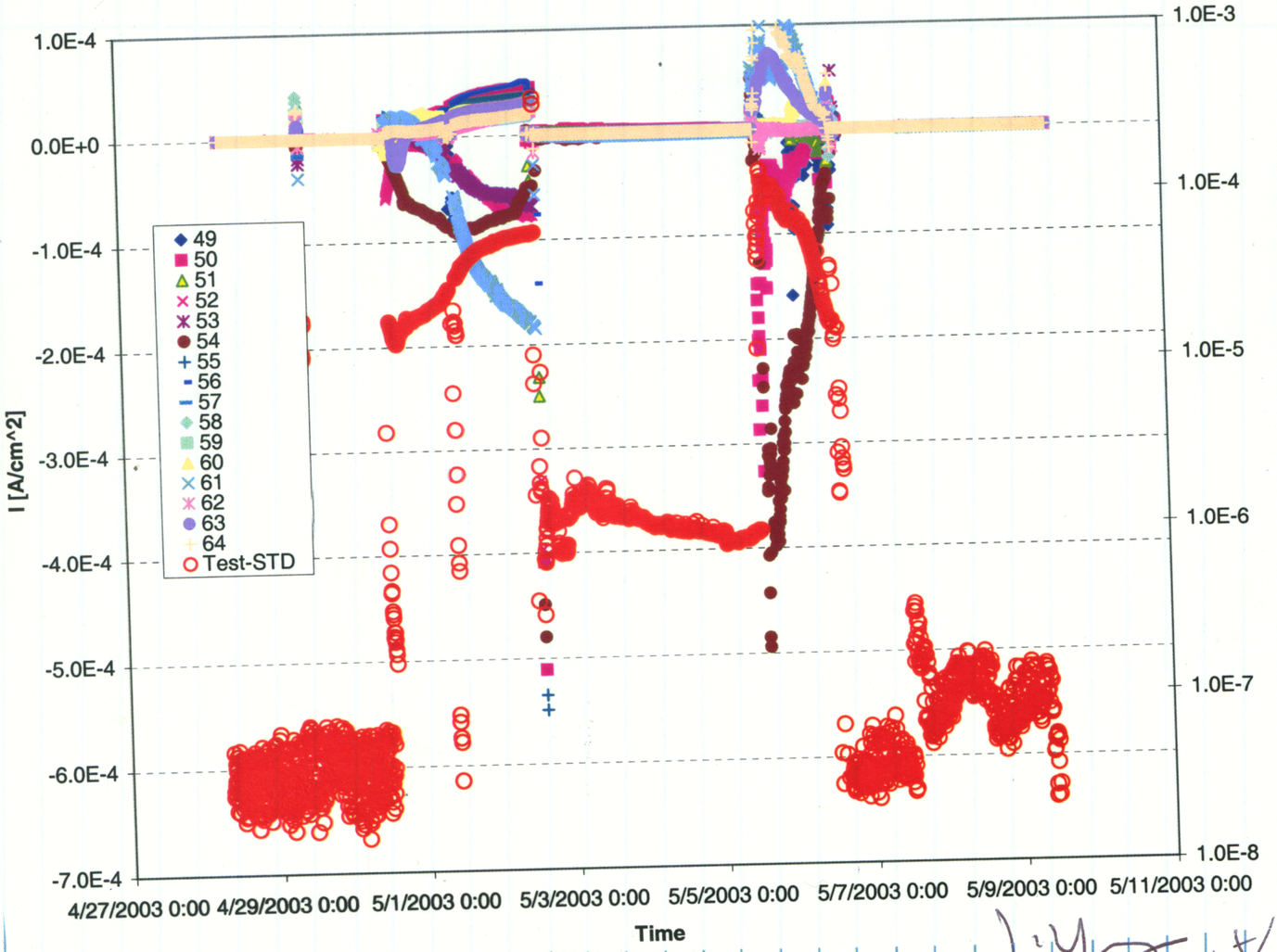
5/13/03



5/13/03

Mic_03_April28a00_a02 / Sensor_304_2_Current

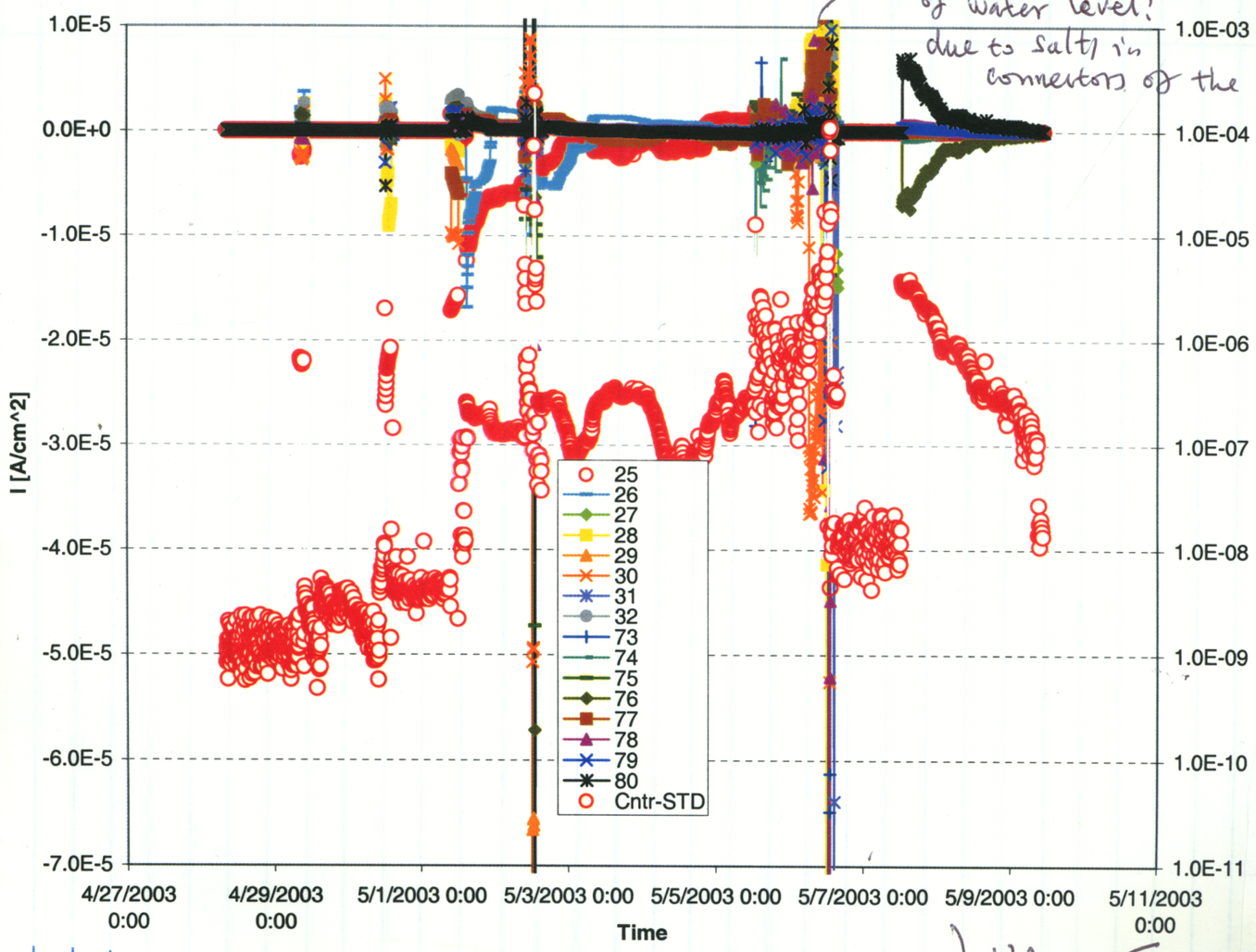
test cell



5/13/03

File: Mic_03_April28a00_a02 / Tab: Chart_Sensor304_1_Currents

signal was high even out of water level! due to salt in connectors of the sensor!

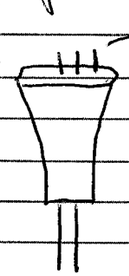


5/13/03

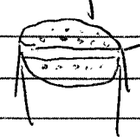
5/13/03 Sensors were fabricated @ SWRI in Division 20.

Started out with a MEC 10' DB9 Data Cable m/F mouse or Monitor Extension cable.

Cut the Female End down until just the interior plastic that encapsulates the pins were showing.



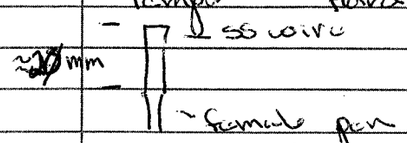
Placed two of these ~~blocks~~ PCB 5/13/03 back to back with Spins on inner



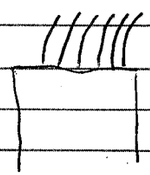
Cut 304 SS wire from Good Fellow lot # 1831325 LS 14715 BG Stainless Steel AISI 304 (Fe/Cr 18/Ni 10) wire

Diameter 1.0 m/m

Temper Hard



Because the wire was in a round bundle the sensor itself has a slight bend to it



The sensor was encapsilated in epoxy to eleminate the possibility of H_2O interfering with connections.

J. Yff 10/3/03

5/13/03 The finished sensor after a 24 cure time on the epoxy was then polished on the ends using a wheel with 240 grit finish. Used the blue spacers from the cut down process to keep the wires in line during polishing.

Used Teflon tubing and epoxy to enclose the sensor.

Sensor #SS304-21 is used in test cell

Sensor #SS304-22 is used in control cell.

late entry on earlier sensors made @ SWRI Division 20.

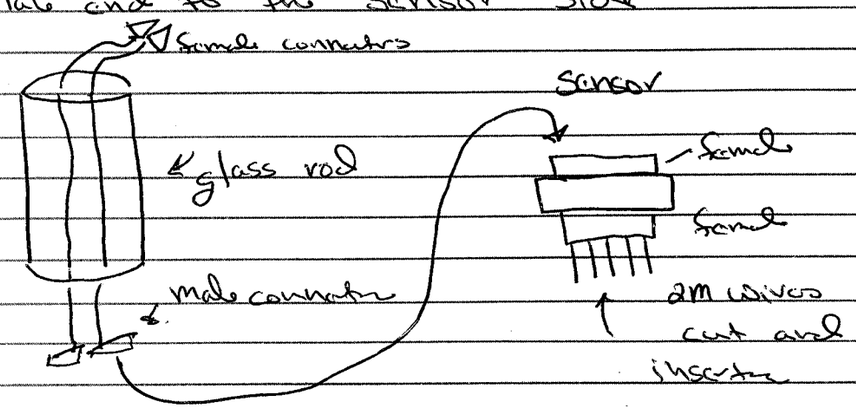
Sensors 304-11 & 304-12 were fabricated earlier @ SWRI

This design did not work very well but still may be used in the future.

Started out with glass rod and had a 24 wire bundle through the glass tube.

Soldered on male & female 9 pin connectors to each end.

male end to the sensor side



J. Yff 10/3/03