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Scientific Notebook No. 320: Effect of Environment on Localized Corrosion and Passive Dissolution of Ti-7 (03/26/1999 through 12/07/2001)

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CLST 20-1402-571

Ti CORROSION STUDIES

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Initial Scientific notebook entry for Titanium Grade 7 Corrosion Studies.

Title: Effect of Environment on Localized Corrosion and Passive Dissolution of Ti-7

Tests Performed by: Sean Brossia, Steve Clay, other personnel will be identified as they begin work on specific tests. – Jerry Siewert · Brian K. Derby · [illegible] · SKD

Objectives: Determine the conditions under which localized corrosion of Ti-7 takes place, including the effect of weldments. Examine the effect of environmental variables on the passive dissolution rate of Ti-7.

Equipment: Specific equipment lists provided in initial entries or in individual test entries. Equipment will be identified and calibrated prior to testing.

Materials: Titanium Grade 7 specimens procured from Metal Samples: TIMET Heat #R5835

Ti (wt%)	C (wt%)	Fe (wt%)	N (wt%)	O (wt%)	H2 (ppm)	Pd (wt%)
bal	0.009	0.115	0.007	0.140	50	0.155

Sean Brossia 3/26/99

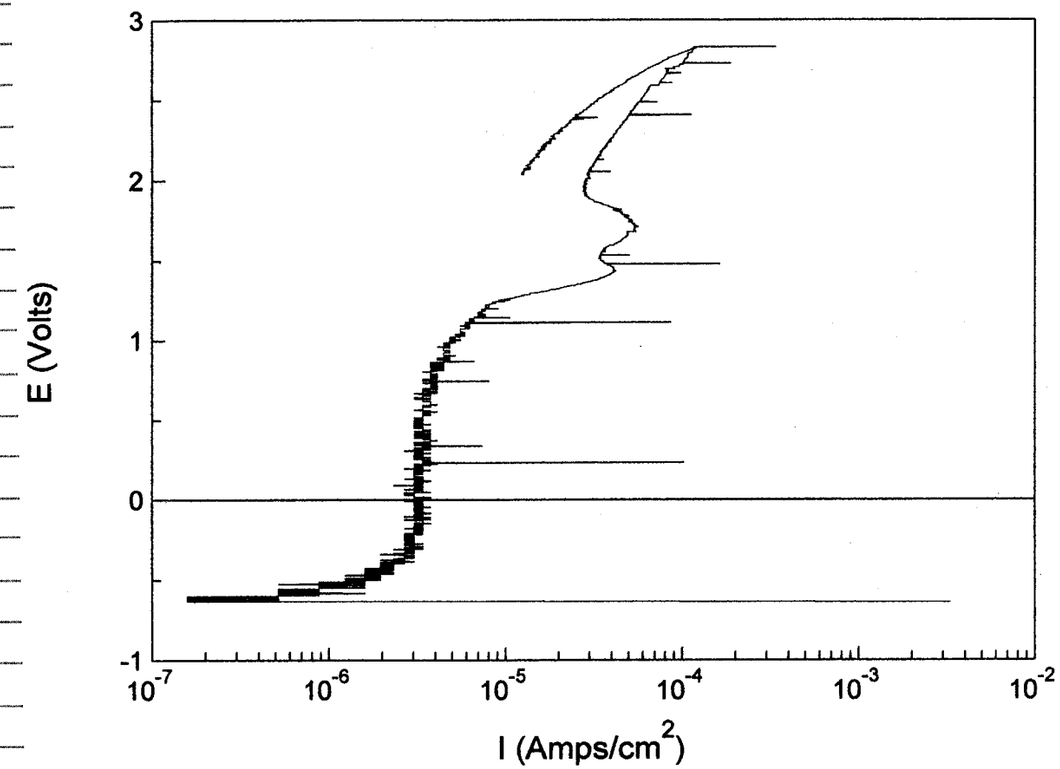
Effect of Environment on Localized Corrosion of Ti-7

Objective: Determine conditions conducive to localized corrosion of Ti-7 by performing cyclic potentiodynamic polarization tests as described in ASTM G61 using creviced specimens in accordance with ASTM G48. The main parameters of interest are the critical chloride concentration necessary for the onset of localized corrosion, the temperature and the critical potentials (E_{crev} and E_{rcrev}).

Equipment:

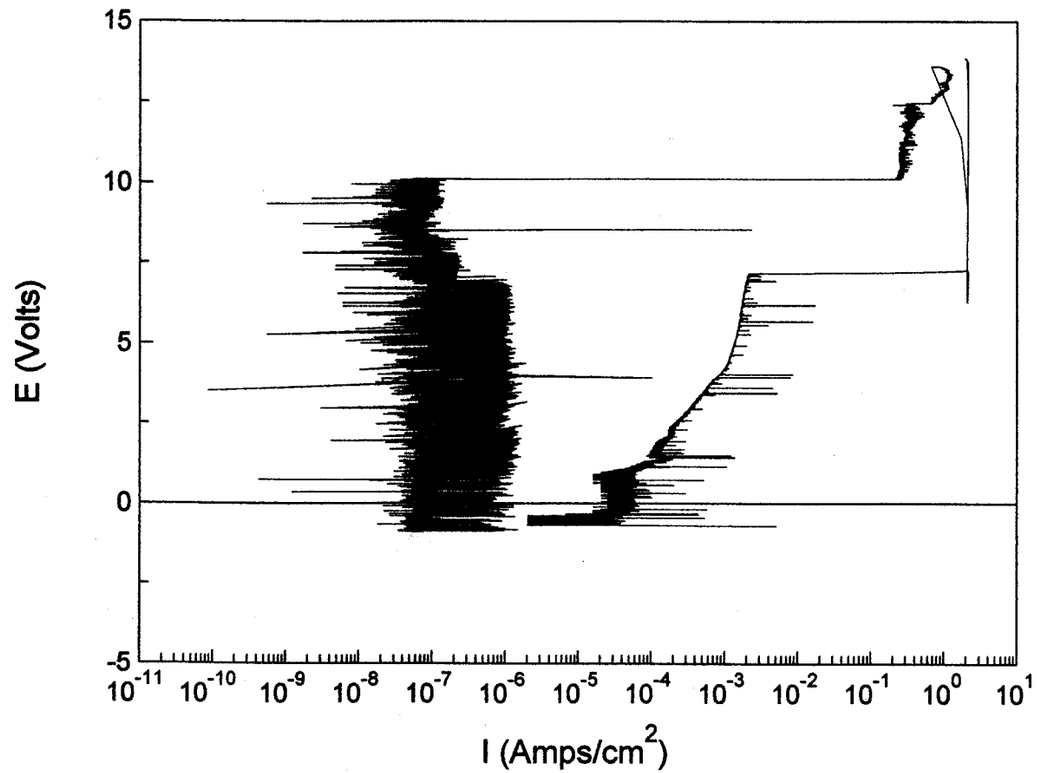
Solartron 1287 potentiostat = 00148500
Corrware for Windows NT software
Reference electrode (SCE) = Accumet 13-620-51 S/N 5N4349
Thermometer = Fisher S/N H98-182
3-26-99

TIPD001.DAT
T=95°C
Stock Solution
1 M → NaCl → 116.8844g/2Lt Fisher Lot# 985302
PH= 5.831
Specimen - crevice specimen of Titanium stock non welded.
Polished to 600 grit + ultrasonically cleaned in Acetone
Crevice foot ultrasonically cleaned in ethanol.
Init wt = 16.84665g
Final wt = 16.847225g 3-29-99
Final PH = 8.118 3-29-99
Observations - discolored but no pitting / test run twice computer locked up



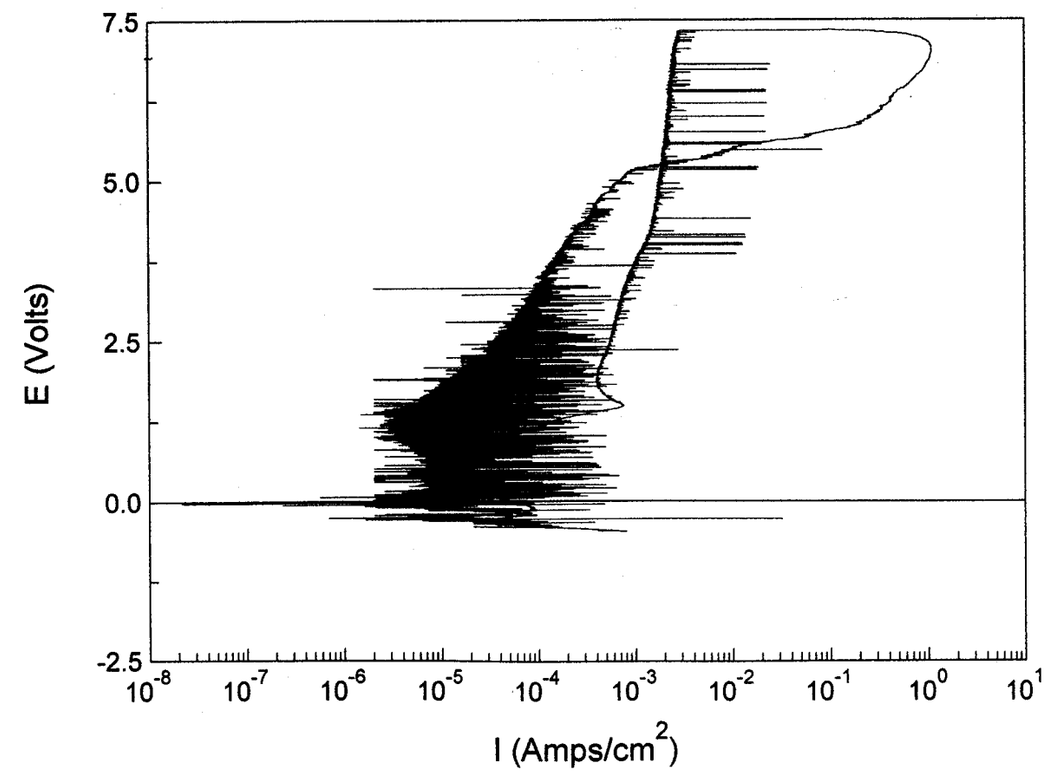
3-26-99

TIPD002.DAT
T=95°C
Stock Solution
4M → NaCl → 467.5191g/2Lt Fisher # 985302
PH= 5.610
Specimen is pitting specimen polished to 600 grit + ultrasonically cleaned in Acetone
Init wt= 6.39112g
Final wt: No sample to weigh, dissolved in solution [illegible] 3-30-99
Final PH= 4.03 [illegible] 3-30-99
Observations
Sample dissolved in solution [illegible] 3-30-99



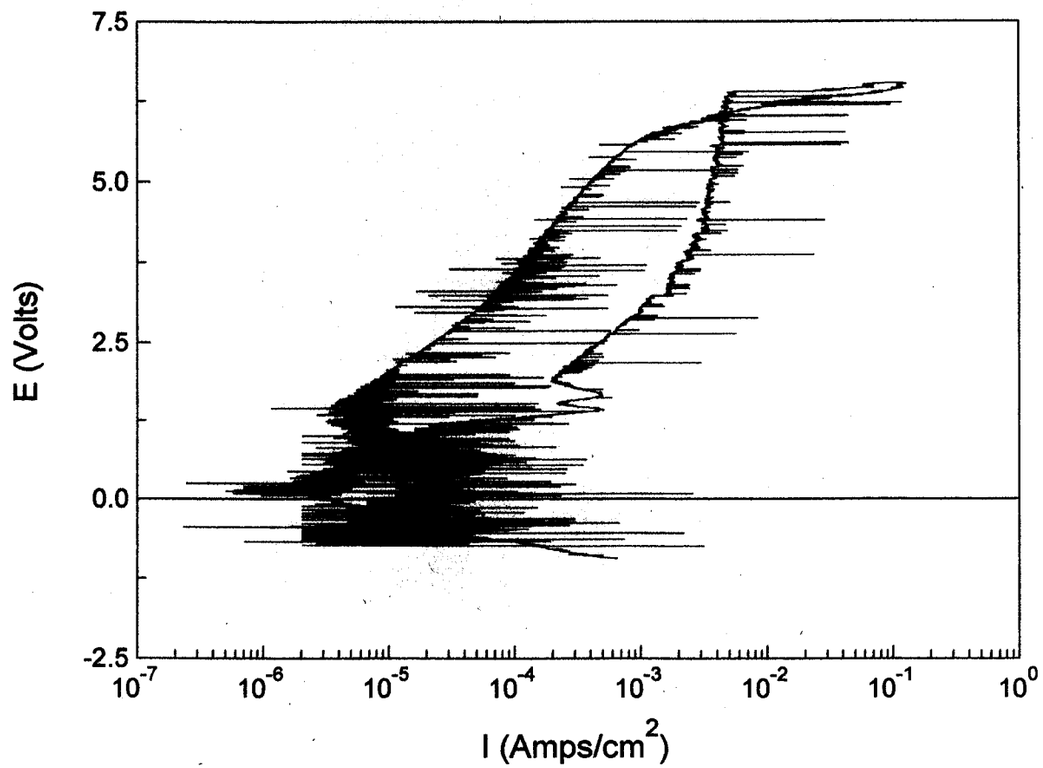
[illegible] 3-29-99

TIPD003.DAT
Stock Solution
1M → NaCl → 116.8856/2Lt Fisher # 985302
PH= 5.373
T=95°C
Specimen is pitting specimen polished to 600 grit + ultrasonically cleaned in Acetone [illegible] 8/16/2000 date on line
Init wt= ~~6.40757g~~ 6.39936g [illegible] 3-30-99
Final wt= 5.93086 [illegible] 3-31-99
Final pH= 4.230 [illegible] 3-31-99
Observations:
Pitting occurred on lower 2/3 of area exposed to solution. Oxide was formed on pitted area.
[illegible] 3-31-99



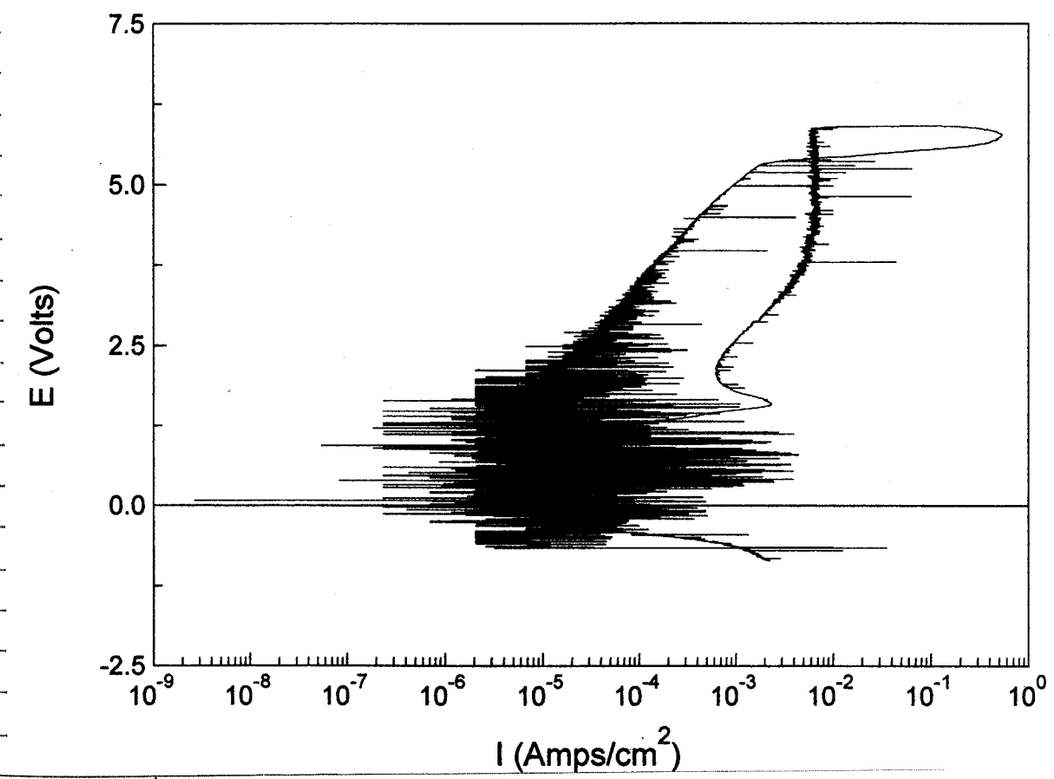
[illegible] 3-30-99

TIPD004.DAT
T = 95°C
Stock Solution
1M → NaCl → 116.8805 g/2Lt Fisher # 985302
pH = 5.190
Specimen is creuice non welded polished to 600 grit + ultrasonically cleaned in Acetone
Init wt = 16.74525g
Final wt = 16.7394g [illegible] 4-1-99
Final pH = 5.430 [illegible] 4-1-99
Observations
No apparent creuice pitting. Some attack on edges and on one corner of specimen [illegible] 4-1-99



[illegible] 3-31-99

TIPD005.DAT
T = 95°C
Stock Solution 584.4 SB 4/2/99
5 M → NaCl → ~~467.5200~~ g/2Lt Fisher # 972274
pH = 5.450
Specimen is creuice non welded polished to 600 grit ultrasonically cleaned in Acetone
Init wt = 16.78772g [illegible] 4-2-99
Final wt = 16.71996g [illegible] 4-2-99
Final pH = 4.102 [illegible] 4-2-99
Observations
No apparent creuice pitting, Attack occurred on edges of both bottom sides of specimen [illegible] 4-2-99



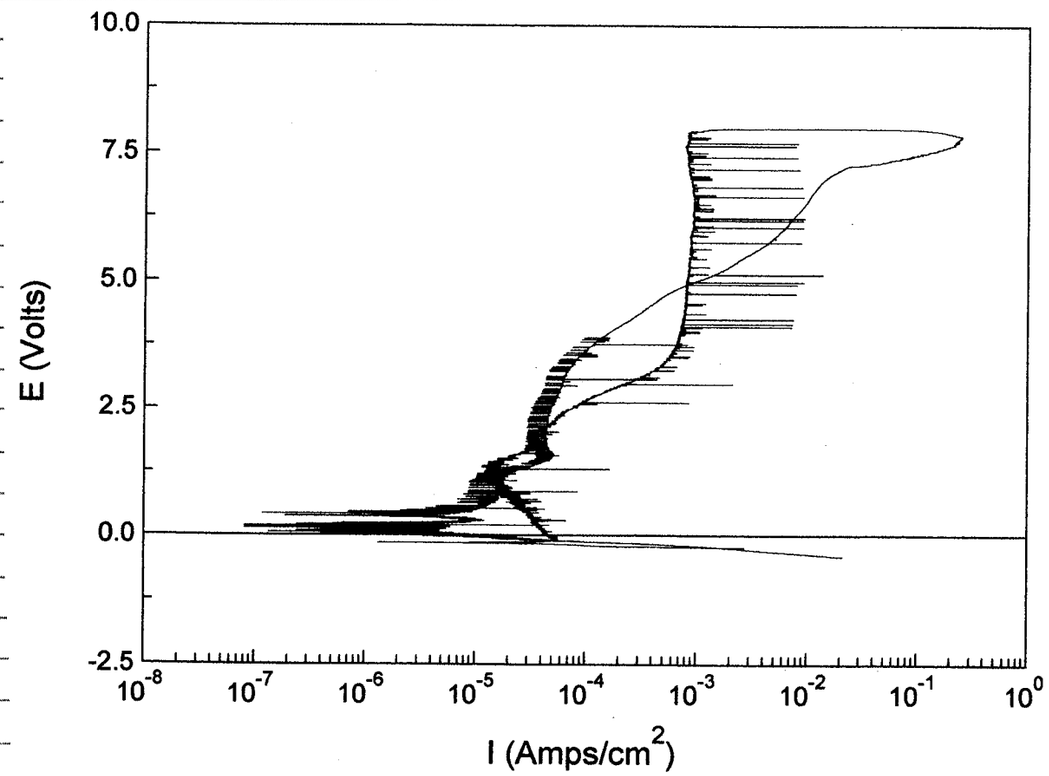
[illegible] 4-1-99

TIPD006.DAT
T=95°C
Stock Solution
10M → LiCl → 847.8025g/2Lt Fisher #987641
PH: 2.850
Specimen is crevice non welded, polished to 600 grit with edges + corners polished and ultrasonically cleaned in Acetone
Init wt: 16.74523g
Final wt: 16.33738g 4-6-99
Final PH: 1.810 4-6-99
Observations
Localized attack at edges and corners. Local attack at area between feet and at crevice hole. No pitting under feet 4-6-99

4-5-99

TIPD007.DAT
T=95°C
Stock Solution Init PH= 0.363
3.9m → NaCl → 455.8320g/2Lt
.1m → HCl → 16.5ml/2Lt
Specimen is non welded, polished to 600 grit with edges + corners polished and ultrasonically cleaned in Acetone
Init wt: 16.70236g
Final wt: 16.70159g 4-7-99
Final PH: .124 4-7-99
Observations
Mild crevice staining. No Local Attack 4-7-99

TIPD008.DAT
T=95°C
Stock Solution — Fisher #
9.9M → LiCl → 839.3220 g/2Lt — 987641
.1M → HCl → 16.5ml/2Lt
pH = -2.630
Specimen polished to 600 grit with edges rounded and polished then ultrasonicallycleaned in Acetone
Initwt = 16.72634g
Finlwt = 16.19834g [illegible] 4-15-99
Final pH = -2.280 [illegible] 4-15-99
Observations
Local attack at edges & corners. Dark Staining of surface below water line. No crevice pitting. [illegible] 4-15-99



[illegible] 4-14-99

~~Tiocpo1.DAT~~ SB 6/4/99 — 6/4/99

Tips001x.DAT, where x = a (-250 mV), b (0 mV), c (+250 mV), d (+500 mV)

J-13 + 1M Cl⁻ @ 95 °C.

Ti pitting specimen

E: -250, 0, +250, +500 mV sce

Solution (2 L)

50 mL J-13 stock soln A
50 mL J-13 stock soln B
116.88 g NaCl (Lot #~~990437~~) 986519 SB 6/4/99
SB 6/4/99
→ ocp monitored ~~for up to~~ 10 min (tips01ocp.dat)

initial pH = 8.255
initial spec wt = 6.3761 g

- note: @ end of "a" (-250 mV), no attack in submerged region but brown/black/green discoloration/corrosion product obs in vapor phase
ultrasonically cleaned in acetone, dried, wt = 6.37340

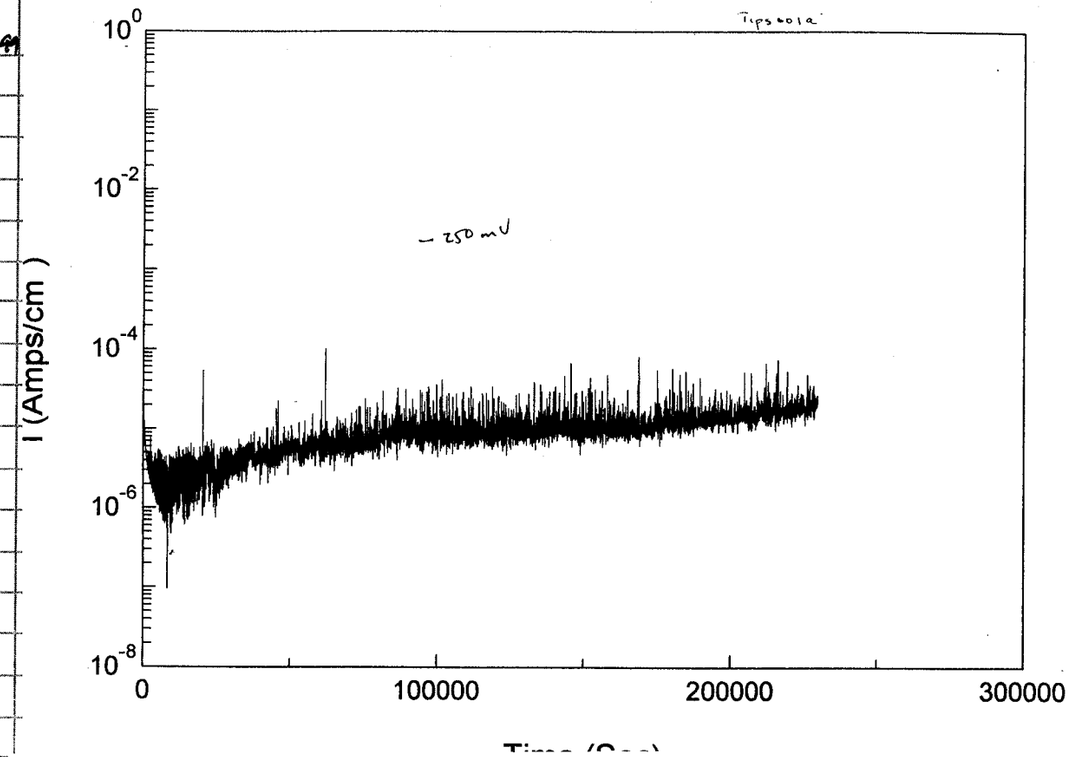
- expt restarted @ E = 0 Vsce (TIPS001b.dat) SB 6/7/99
at end of "b", wt = ~~6.39811~~ SB 6/9/99 6.39811 — SB 6/9/99

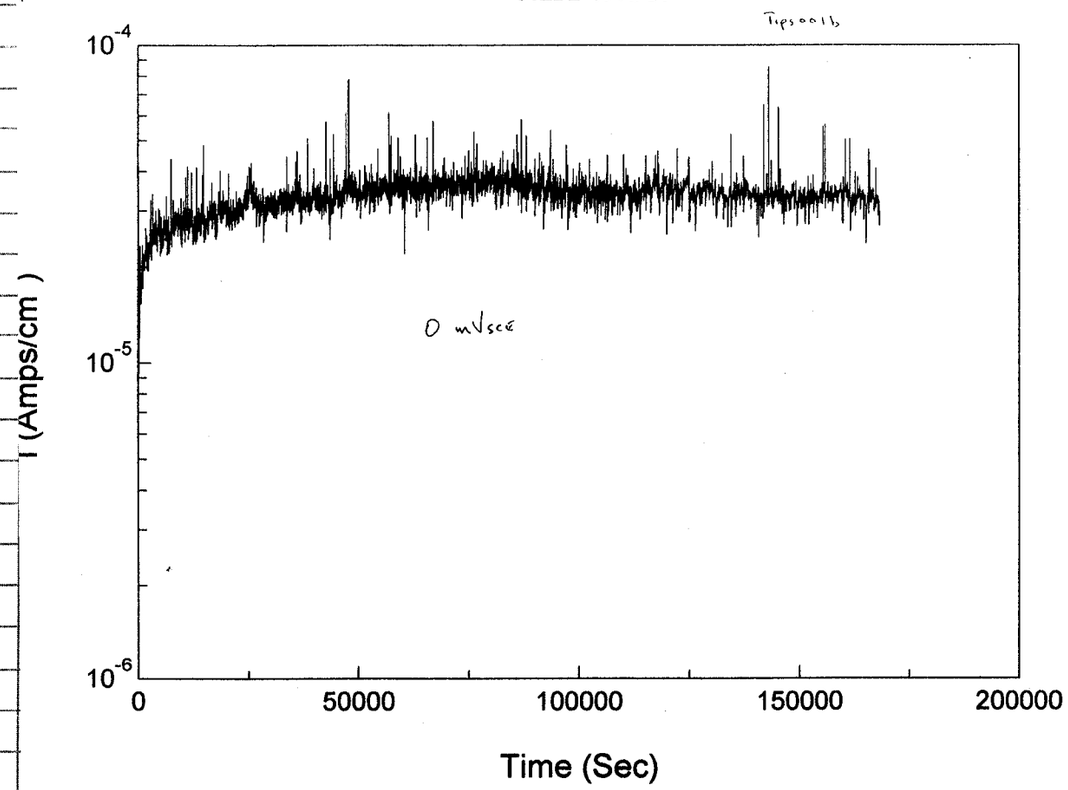
- expt restarted @ E = +250 mV (TIPS001c.Dat)

final wt = 6.37443 g — SB 6/14/99
final pH = 8.531

SB 6/4/99

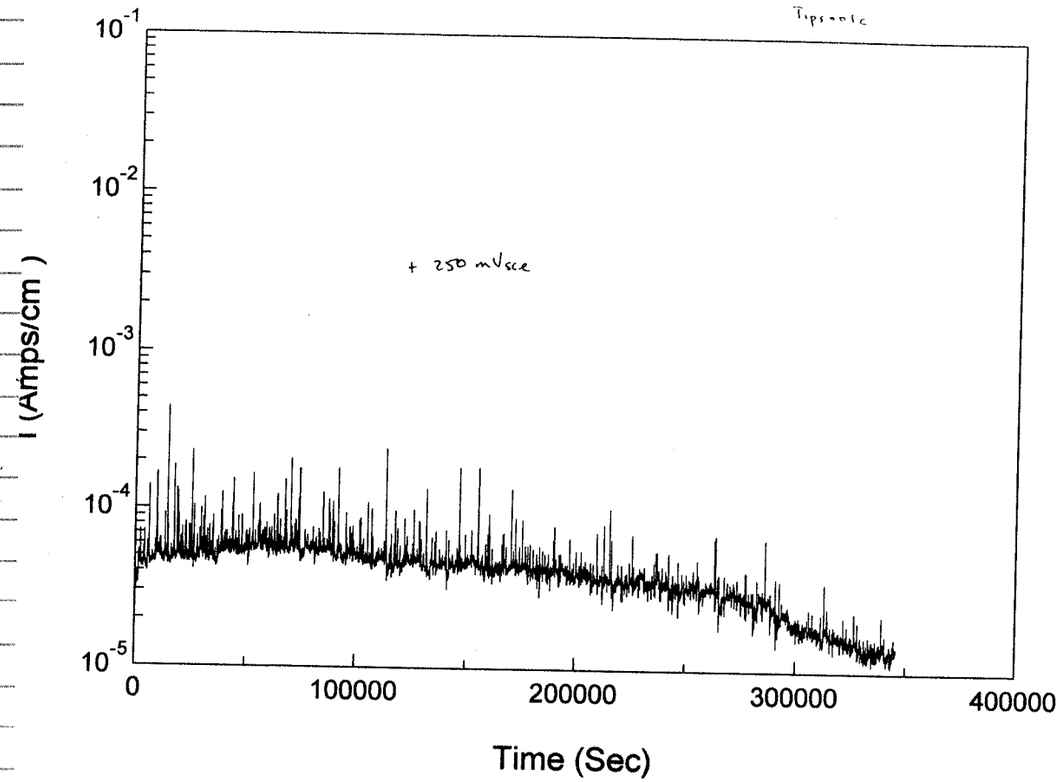
6/4/99





SB 6/4/99

Tips001c



SB 6/4/99

6/7/99 Long-term pstat testy

Cell 1 - J-13 (25 mL stock A & 25 mL stock B per L) + 1 M Cl, 95°C, E = +750 mVsce
Cell 2 - J-13 + 1 M Cl, 95°C, E = +500 mVsce
Cell 3 - J-13 + 1 M Cl, 95°C, E = +250 mVsce
Cell 4 - J-13 + 1 M Cl + 20 mM CO_3^{2-}, E = +500 mVsce
Cell 5 - J-13 + 1 M Cl + 0.01 M HCl, E = +500 mVsce
Cell 6 - J-13 + 1 M Cl, aerated, ocp

3 SB 6/7/99

all Cl = NaCl lot # 986519
all CO_3^{2-} = Na_2CO_3 lot # 960685
all HCl = HCl lot # 971828

sample wts and	initial pH	file name	RG S/N
Cell 1 = 16.67356	8.312	Tips001.asc	8238325
Cell 2 = 16.51419	8.319	Tips002.asc	7079123
Cell 3 = 16.61432	8.281	Tips003.asc	8238334
Cell 4 = 16.71241	10.393	Tips004.asc	8238333
Cell 5 = 16.57801	2.053	Tips005.asc	7079122
Cell 6 = 16.66067	8.283	Tips006.asc	8210502

→ all samples are crevice samples (11.35 cm^2 area) w/ torque to 50 in-oz.

Cell 1 (J-13 + 1M Cl, 95°C, +750 mV) 6/7/99

observations:

Tips001.asc
Final pH = 8.633
Final wt = 16.64667 g
No pitting or local corrosion

7-7-99

6/7/99 Cell 2 (J-13 + 1 M Cl, 95°C, +500 mV)

observations:

Ti PS002.asc

Final pH = 8.878

Final wt = 16.50392

Specimen has no pitting or local corrosion. Yellow coloring below vapor line except under crevice area.

7-7-99

Cell 3 (J-13 + 1 M Cl, 95°C, +250 mV) 6/7/99

observations:

Ti PS003.asc

Final pH = 8.665

Final wt = 16.61357

No pitting or corrosion

7-7-99

6/7/99 Cell 4 (J-13 + 1M Cl + 20 mM CO_3^{2-}, 95°C, +500 mV)

observations

Ti PS 004 . asc

Final pH = 9.573

Final wt = 16.71157

No pitting or local corrosion. Some white film at vapor line.

7-7-99

Cell 5 (J-13 + 1M Cl + 0.01 M HCl, 95°C, +500 mV) 6/7/99

observations:

Ti PS 005 . asc

Final pH ~ 2.305

Final wt = 16.57264

Some rusting appearance under crevice feet. Specimen stained yellow except under crevice area which has blue ring around crevice. Color normal under crevice area.

7-9-99

6/7/99 Cell 6 (J-13 + 1 M Cl, 95°C, air-saturated, ocp)

observations

Tips 006, asc

potentiostatic hold → i_{pass} 6/14/99

Tips002a, b, c = −250, 0, +250 mVsce

95°C, J-13 + 1 M Cl + 20 mM CO_3^{2-}, deaerated

→ 2L : 50 mL stock A

50 mL stock B

116.88 g NaCl (Lot # 986519)

4.239 g Na_2CO_3 (Lot # 960685)

spec wt a = 6.43982 g

init pH = 10.294

spec wt end of a = 6.43893 g 6-17-99 @ 8:30 am

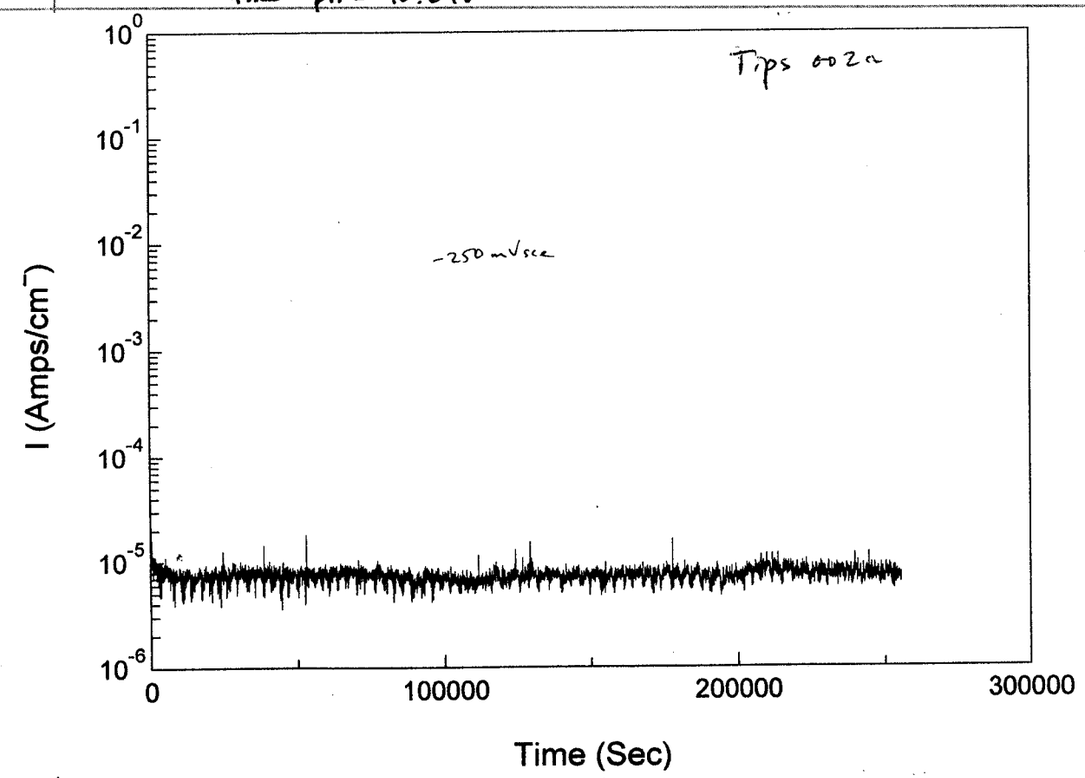
observation – no pitting or local attack 6-17-99 @ 8:30 am

spec wt end of b = 6.43894 g 6-23-99 @ 8:00 am

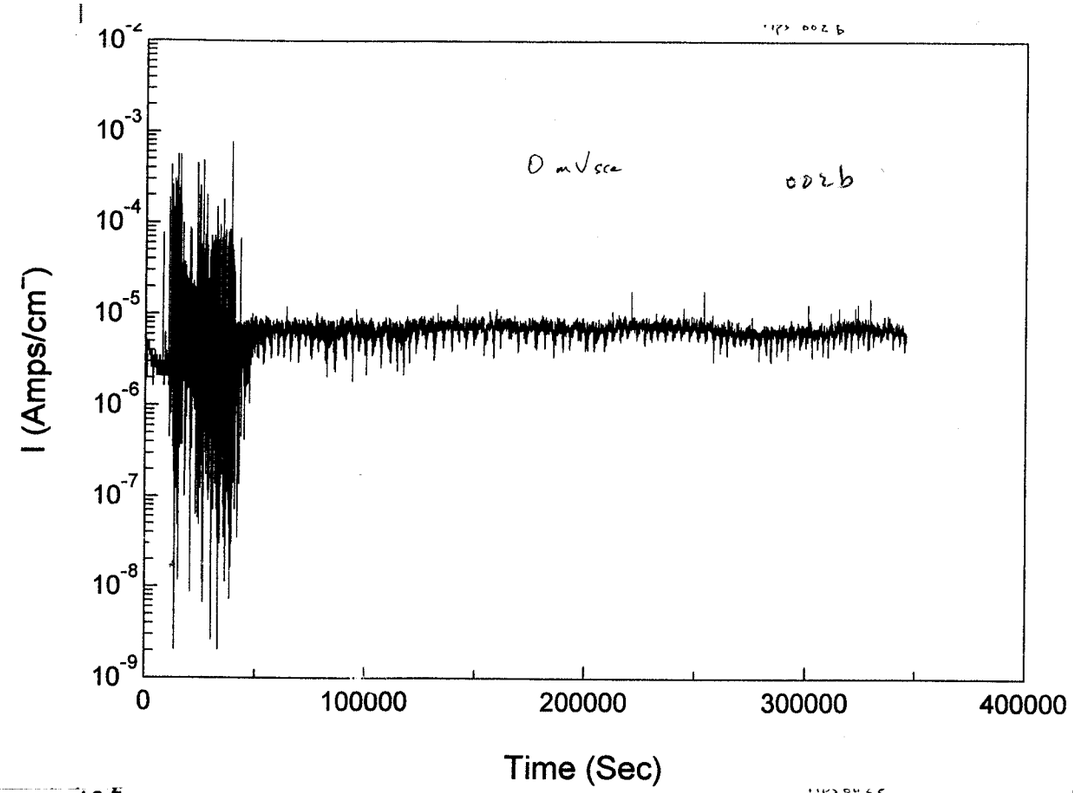
observation – no pitting or local attack

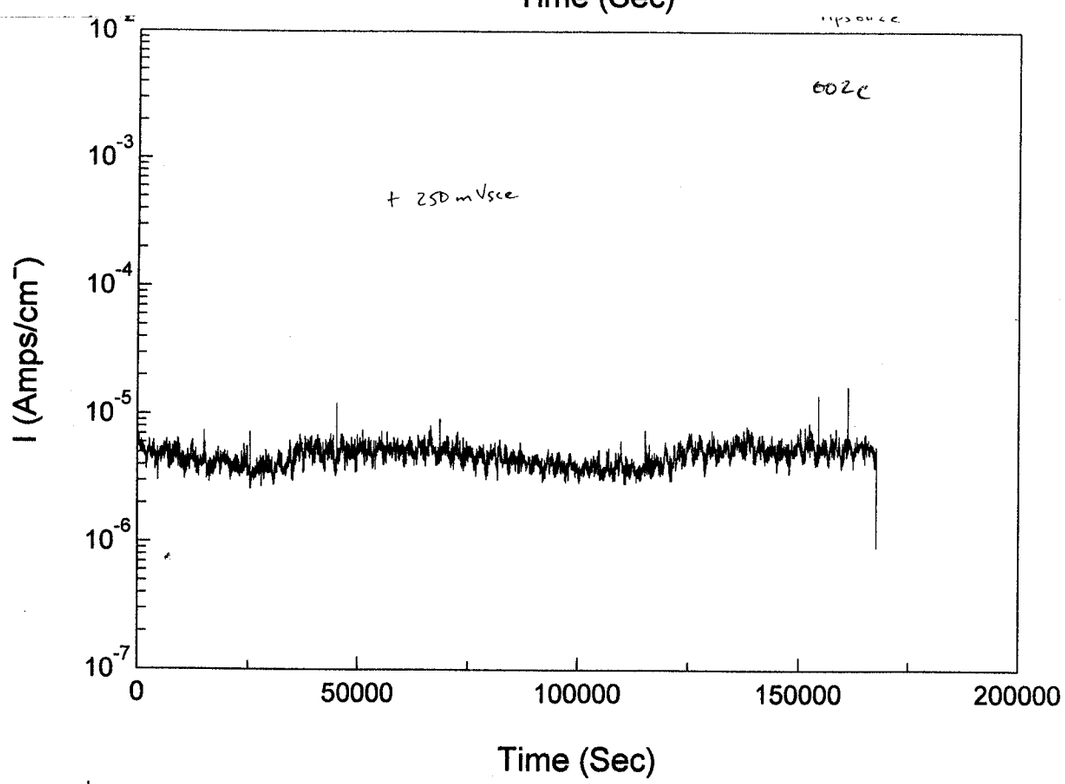
final wt = 6.44181 g

final pH = 10.298



6/14/99





cont on p57 SB 2/14/00

SB 6/14/99

potentiostatic igas measurements 6/25/99

→ J-13 + 1 M Cl + 0.01 M HCl, 95°C

Tips 003a, b, c = -250, 0, +250 mVsce

2 L: 50 mL stock A

50 mL stock B

116.88 g NaCl lot # 986519

1.65 mL HCl lot # 971828

initial pH = 2.142

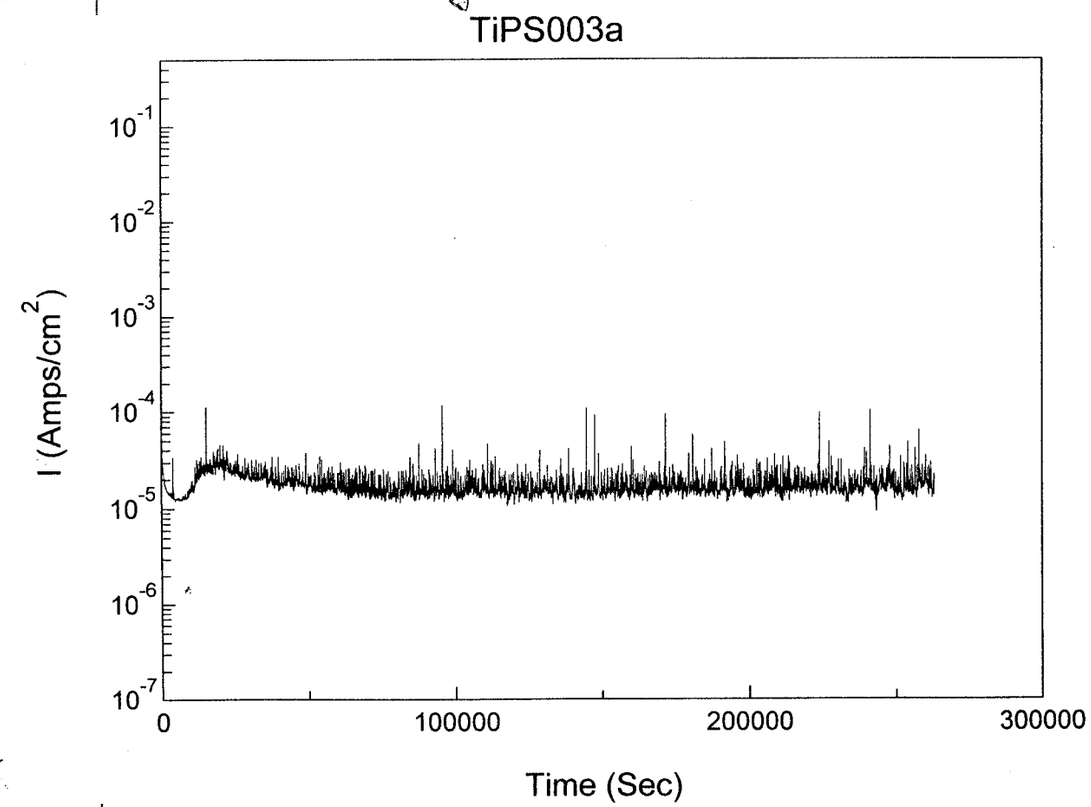
initial sample wt: 6.38384 g

6/28/99 wt final @ a = 6.37136 g — sample cleaned in MeOH ultrasonically

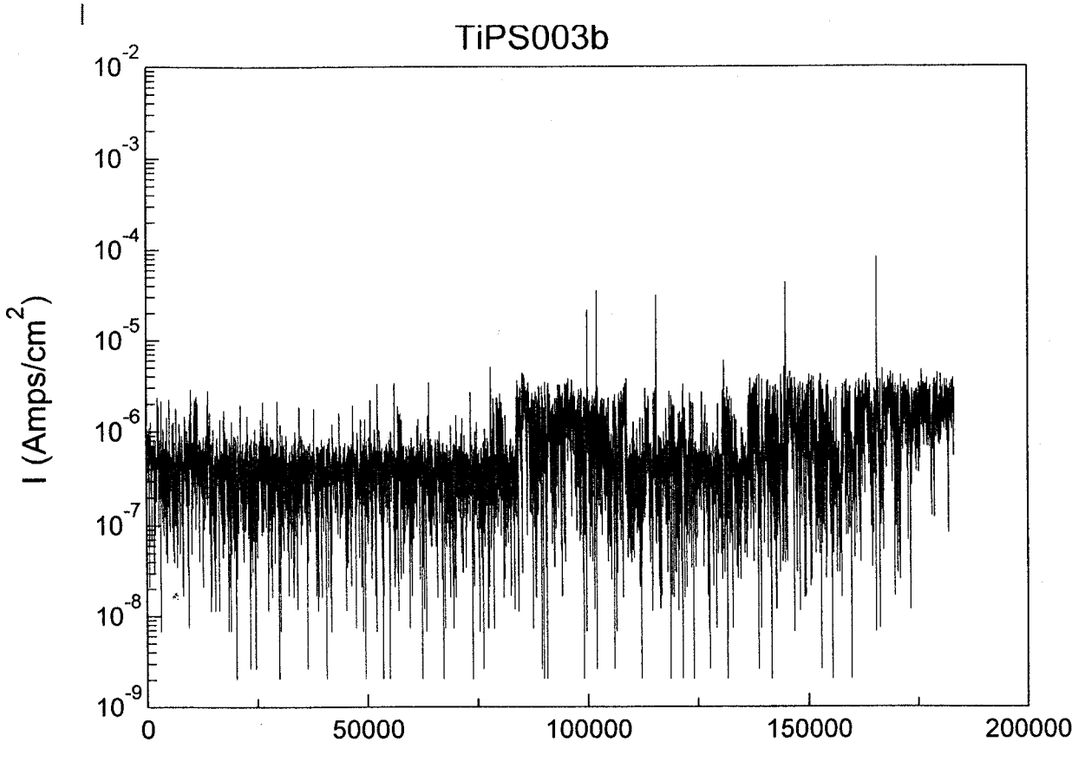
6/30/99 specimen wt @ b = 6.37128 g — sample cleaned in methanol ultrasonically

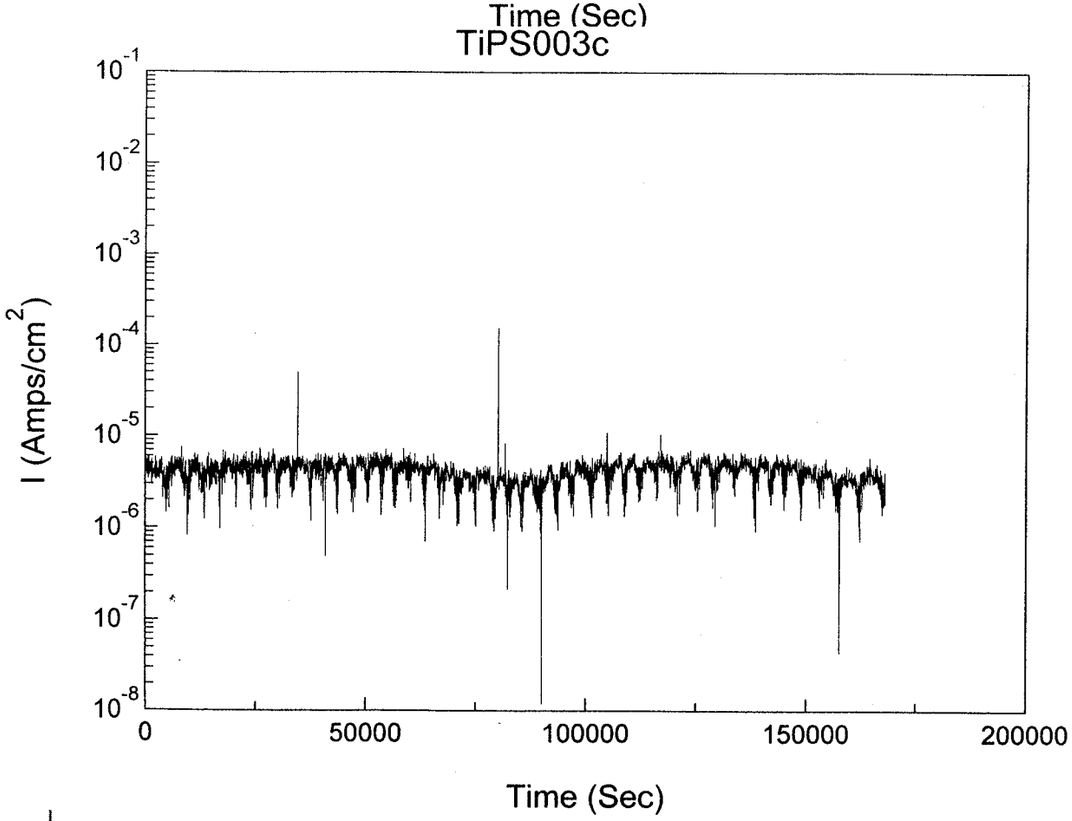
7/2/99 specimen wt @ c = 6.37142 g — sample cleaned in methanol ultrasonically

Final pH = 2.161 7-2-99



CSB 6/25/99





6/25/99

cont to pg 57. SB

TIPD009.DAT
T=95°C
Stock Solution
10 M → LiCl → 847.8025g / 2Lt Fisher 987641
PH= 4.325
Specimen is welded both sides, polished to 600 & methanol ultrasonically cleaned.
Init wt= 20.79988g
Final wt= 20.20785g 7-9-99
Final PH= 3.635 7-9-99
Observations
No Crevice pitting. Local corrosion occurred on bottom and edges of specimen and on one side at approx weld location that is rather deep. 7-9-99

7-9-99

TIPD010.DAT
T=95°C
Stock Solution
5 M ⇒ NaCl ⇒ ~~467.52~~ 578.1g /2Lt SB 7/14/99 # 985302
PH= ~~6.623~~ 6.230 7-12-99 - date on line SB 8/16/2000
Specimen is welded both sides, polished to 600grit + ultrasonically cleaned in methanol
Init wt= 20.77479g
Final wt= 20.73065g
Final PH= 4.206
7-13-99
Observations
Some overall discoloration. Local corrosion on one edge/corner of specimen @ approx location of weld.
7-13-99

7-13-99

TIPD011.DAT
T=95°C
Stock Solution
1 M ⇒ NaCl ⇒ 116.8805g /2Lt # 985302
PH= 5.928
Specimen is welded both sides, polished to 600grit + ultrasonically cleaned in methanol
Init wt= 20.80934g
Final wt= 20.79550g
Final PH= 5.520
7-14-99
Observations
Overall discoloration. Local corrosion on two edge corners @ approx weld location. Not as severe as 4M test TIPD010
7-14-99

7-14-99

T1Ø95BØØ-.DAT & T1Ø95BØ1-.DAT
1.0M SOLUTION ~~X~~ 1 AT 95°C
7/26/99
IRE/SCE = 44.4 mV S/N 5087374
INIT. WT 16.7397 g FINAL WT 16.7192 g JB 7/28/99

INIT PH: 7.507 @ 22.5°C FINAL PH: 8.750 @ 22.9°C JB 7/28/99

8:18 AUTOCLAVE LOADED
8:23 E_{CORR} = -418 mV, E_{PT} = -55 mV
8:26 START DEAERATE, 10:26 STOP - TOTAL TIME 2 HRS
10:29 START HEATING
7/27/99
7:14 INTERNAL TEMP 93.0°C
E_{CORR} = -235 mV, E_{PT} = -199 mV
7:38 START CPP
13:04 WE DISCONNECTED - TRIPPED AUTO REVERSE
NEW FILE: T1Ø95BØ1-.DAT
SCAN RATE CHANGED TO 1.0 mV/S
13:08 RESTART

16:11 STOP - START COOL DOWN

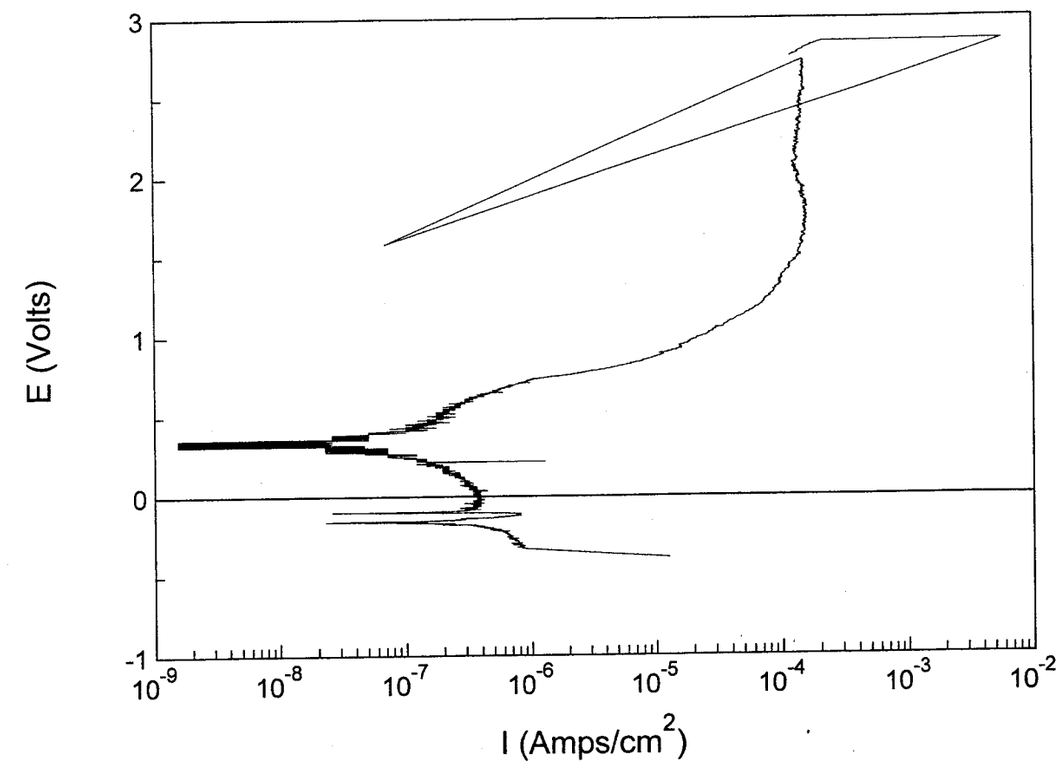
7/28/99 INTERNAL TEMP: 28.4°C
E_{CORR} = 98 mV, E_{PT} = -89 mV

IRE/SCE = 36 mV S/N 5087374

OVERALL DISCOLORATION - ALL CORROSION AT TOP OF STEM

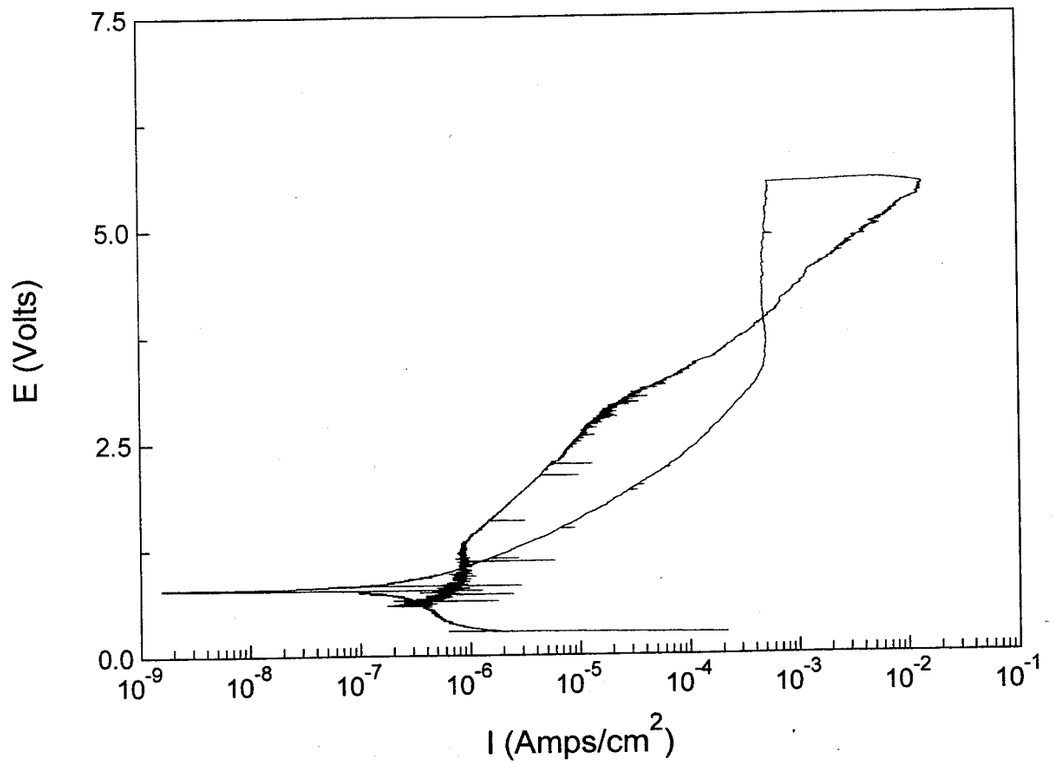
Jerry Sturt 7/28/99

T1Ø95BØØ-.DAT



Jerry Sturt 7/28/99

T1Ø95BØ1_.DAT



[signature] 7/28/99

T1125BØ2_.DAT
1.0 M SOLUTION No. 1 AT 125°C
7/28/99
IRE/SCE = 44.9 mV S/N 5087374

INITIAL WT. 16.7901 g, FINAL WT. 16.7904 g JS 8/2/99

INITIAL pH 7.816 @ 22.9°C, FINAL pH 9.391 @ 23.7°C JS 8/2/99

7/29/99
7:57 E_{CORR} = -454 mV, E_{PT} = -53 mV
7:53 START DEAERATE, 9:53 STOP - TOTAL TIME 2 HRS
E_{CORR} = -263 mV, E_{PT} = -126 mV
9:55 START HEATING - SET POINT 118°C

7/30/99 7:14 INTERNAL TEMP. 119.1°C
VALVE ON DIP TUBE IS LEAKING - CAPPED
RAISE S.P TO 122°C
8:18 INTERNAL TEMP 121.7°C
E_{CORR} = -179 mV E_{PT} = -170 mV
8:34 E_{CORR} = -187 mV
8:35 START CPP

7/31/99 10:21 INTERNAL TEMP 122.9°C
E_{CORR} = -196 mV, E_{PT} = -208 mV

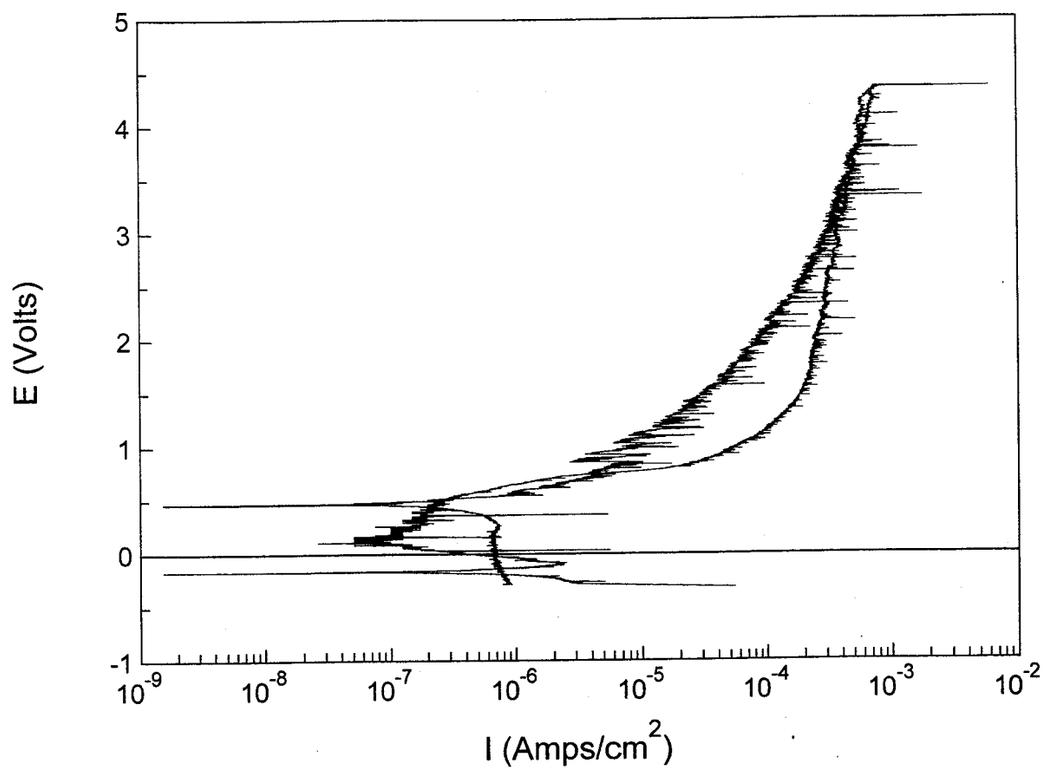
COMPUTER IS LOCKED UP - START COOL DOWN
8/2/99
7:18 INTERNAL TEMP 23.9°C
E_{CORR} = -226 mV, E_{PT} = -76 mV

LOST MORE LIQUID THAN FIRST THOUGHT - ONLY
~68% OF SPECIMEN WAS COVERED

[signature] 8/2/99

T1125B02_.DAT

IRE/SCE = 20 mV S/N 5087374



Kenny Sewell 8/2/99

T1125B03_.DAT

1.0M SOLUTION NO. 1 AT 125°C

IRE/SCE = 45.5 mV S/N 5087374

RE-POLISHED SAMPLE FROM PAGE 35

INITIAL WT: 16.7812g, FINAL WT: 16.6167g KS 8/19/99

INITIAL pH: 7.741 @ 23.0°C, FINAL pH: 6.853 @ 23.9°C KS 8/19/99

8:52 E_{CORR} = -220 mV, E_{PT} = -42 mV

8:52 START DEAERATE, 12:10 STOP - TOTAL TIME 3 HRS 14 MIN -
E_{CORR} = -122 mV, E_{PT} = -53 mV

12:13 START HEATING SET POINT 118°C

8/17/99 7:18 INTERNAL TEMPERATURE 120.4°C
E_{CORR} = -180 mV, E_{PT} = -53 mV

7:25 START CPP

8/18/99 7:16 INTERNAL TEMP 120.8°C
COMPUTER LOCKED UP -
E_{CORR} = -60 mV, E_{PT} = -71 mV

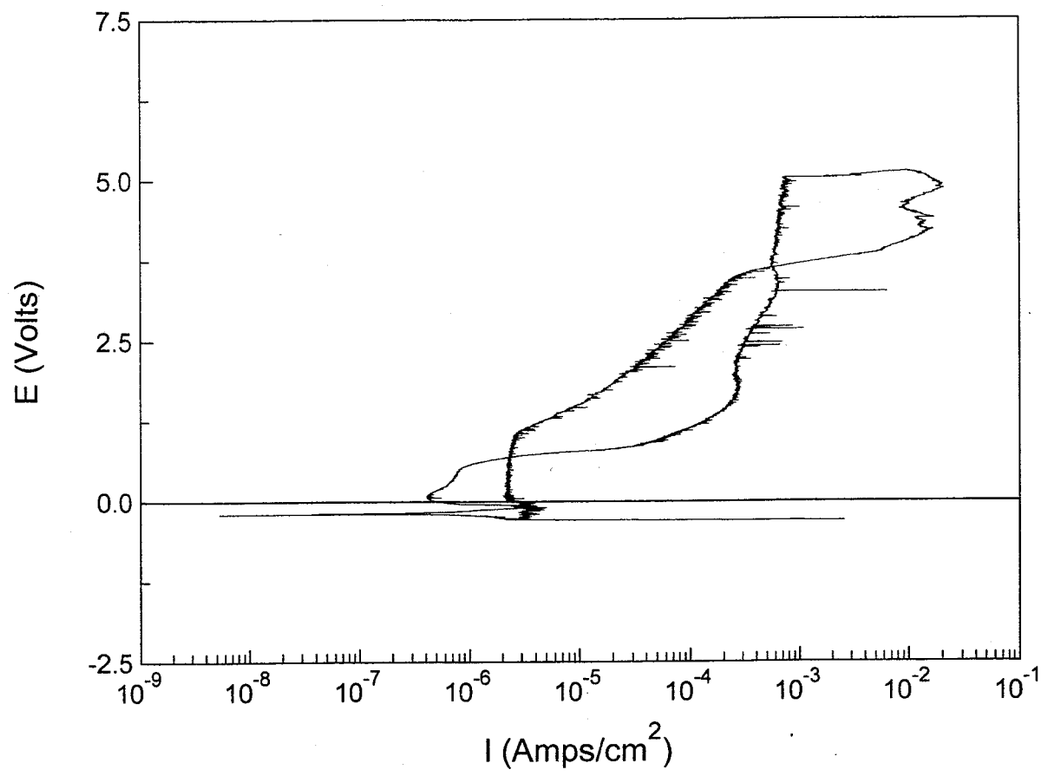
8:16 START COOL DOWN

8/19/99 7:18 INTERNAL TEMP: 24.2°C
E_{CORR} = -58 mV, E_{PT} = -58 mV

IRE/SCE = 14 mV S/N 5087374

Kenny Sewell 8/19/99

T1125B03_.DAT



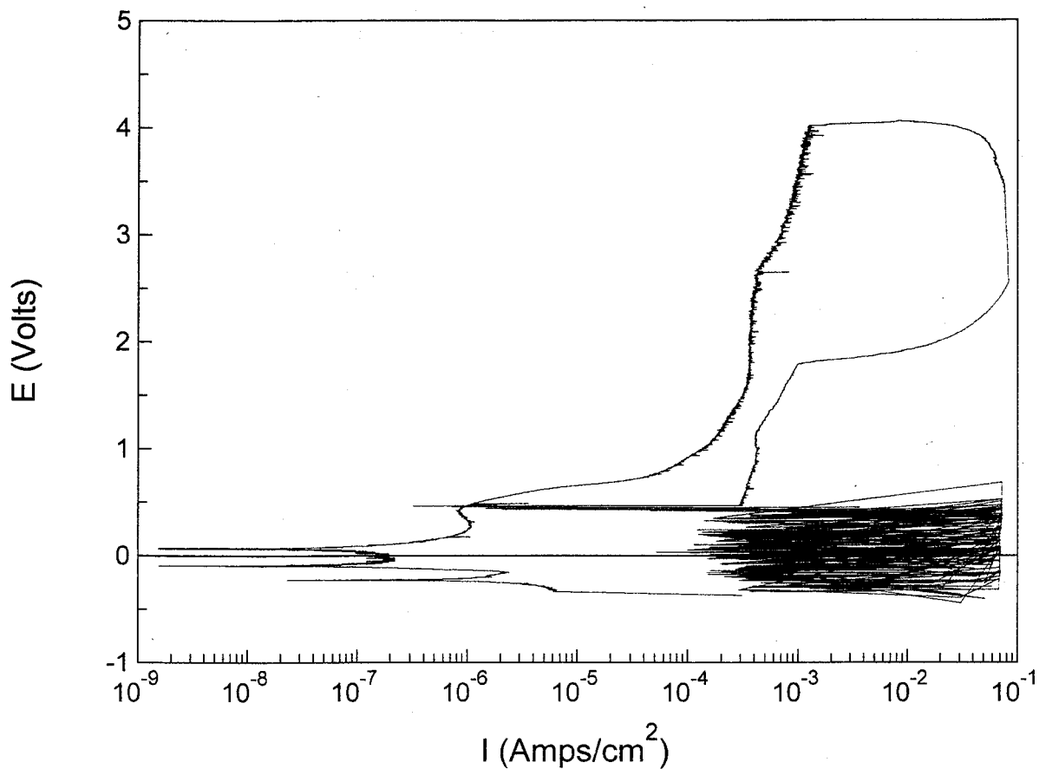
OBSERVATIONS:
NO CREVICE PITTING UNDER TEFLON WASHER —
LOCAL CORROSION ON SIDES CLOSEST TO COUNTER
ELECTRODE - SOME CRACKS IN CORROSION PRODUCTS —

Jerry Stewart 8/19/99

T1140B04_.DAT
1.0 M SOLUTION No-1 AT 140°C
$E_{REF/SCE}$ = 45.7 mV S/N 6087374
8/20/99
INITIAL WT. 16.7407 g, FINAL WT. 14.3161 8/23/99
INITIAL pH: 7.670 @ 22.5°C - NO FINAL pH TAKEN 8/23/99
8:34 E_{CORR} = -414 mV, E_{PT} = -58 mV
8:36 START DEAERATE 10:48 STOP. TOTAL TIME 2 HR 12 MIN.
E_{CORR} = -314 mV, E_{PT} = -138 mV
10:50 START HEATING SP 138°C
8/21/99 9:43 INTERNAL TEMP 137.7°C
E_{CORR} = -234 mV, E_{PT} = -210 mV
9:49 START CPP
8/22/99 10:41 INTERNAL 23.1°C ??
COMPUTER HUNG — ELECTROMETER FLASHING
TC WELL HAS BLOWN OUT OF AUTOCLAVE —
AUTOCLAVE IS STILL HOT —
START COOL DOWN
8/23/99 MAJOR DAMAGE TO SPECIMEN WHICH
PROBABLY HAPPENED NEAR END OF CPP RUN

Jerry Stewart 8/23/99

TI140B04_.DAT



Amy Sewell 8/23/99

TI165B05_.DAT

1.0M SOLUTION #1 AT 165°C

IRE/SCE = 44.2mV S/N 5087374

8/31/99

INIT. WT 16.8206 g, FINAL WT 16.7577 AS 9/2/99

INITIAL PH 7.722 @ 22.4°C, FINAL PH 7.216 @ 25.0°C AS 9/2/99

12:05 E_{CORR} = -297mV, E_{PT} = 199mV
1208 START DEAERATE 2:12 STOP - TOTAL TIME 2HR 4MIN
2:14 START HEATING SP 165°C

9/1/99 7:25 INTERNAL 155°C SP↑ 175°C E_{CORR} = -221mV
9:15 INTERNAL 162°C E_{CORR} = -221mV, E_{PT} = -68mV
SOLARTRON CONNECTED E_{CORR} = -217mV
9:25 START CPP ENDED AFTER 2083 PTS
9:28 RESTART - NO CHANGES TO PARAMETERS -
3:05 RUN HALTED
3:07 E_{CORR} = -438mV, E_{PT} = -712mV
3:08 START COOL DOWN

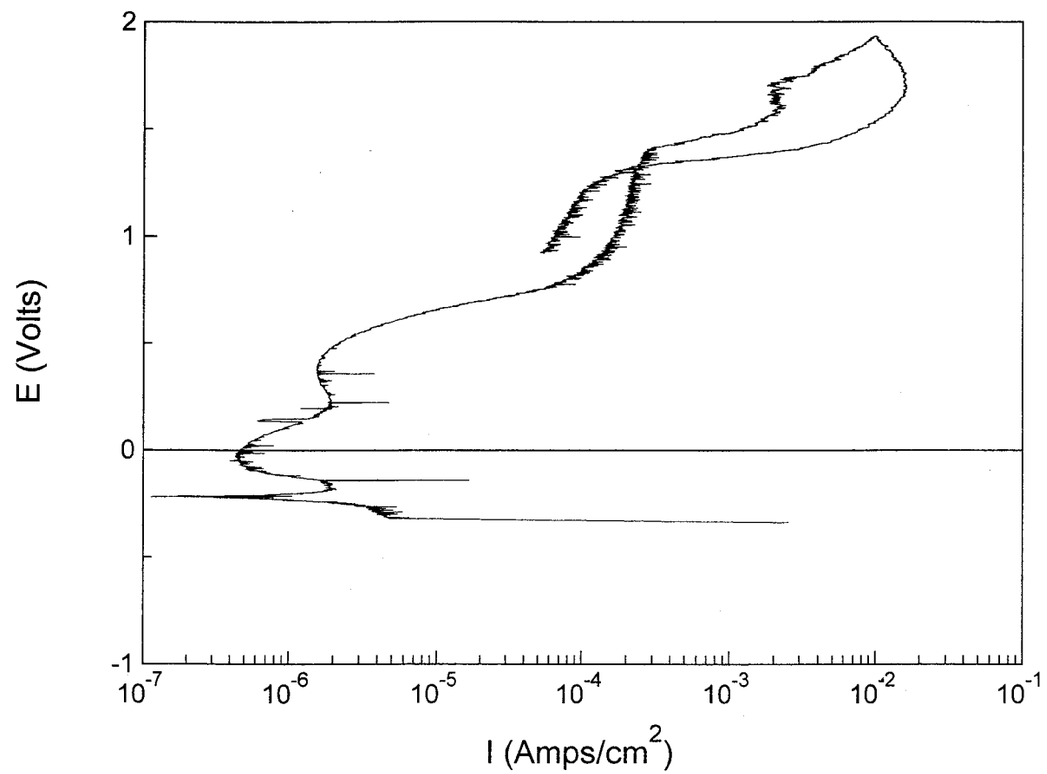
9/2/99 7:21 INTERNAL 25.9°C
E_{CORR} = -83mV E_{PT} = -44mV

IRE/SCE = 14mV S/N 5087374

NO PITTING UNDER TEFLON WASHER -
GENERAL CORROSION ON SIDES AND BOTTOM

Amy Sewell 9/2/99

TI165B05-.DAT



Jerry Stewart 9/2/99

TI165B06W.DAT

1.0M SOLUTION # 1 AT 165°C WELDED SPECIMEN

TRB/SCB = 43.6mV S/N 5087374

9/2/99

INITIAL WT 20.8398g, FINAL WT 20.8226g JS 9/9/99

INIT pH 7.755 @ 22.7°C, FINAL pH 6.723 @ 24.9°C JS 9/9/99

9:34 E_{CORR} = -340mV, E_{PT} = -41mV

9:42 START DEAERATE, 12:05 STOP – TOTAL TIME 2HR 23MIN

12:07 START HEATING E_{CORR} = -118mV

9/8/99 7:16 INTERNAL TEMP 164.3°C

E_{CORR} = -204mV, E_{PT} = -151mV

7:20 START CPP

10:28 SOLARTRON FLASHED "ERROR" AT REVERSAL

1:07 STOP

1:09 START COOLDOWN

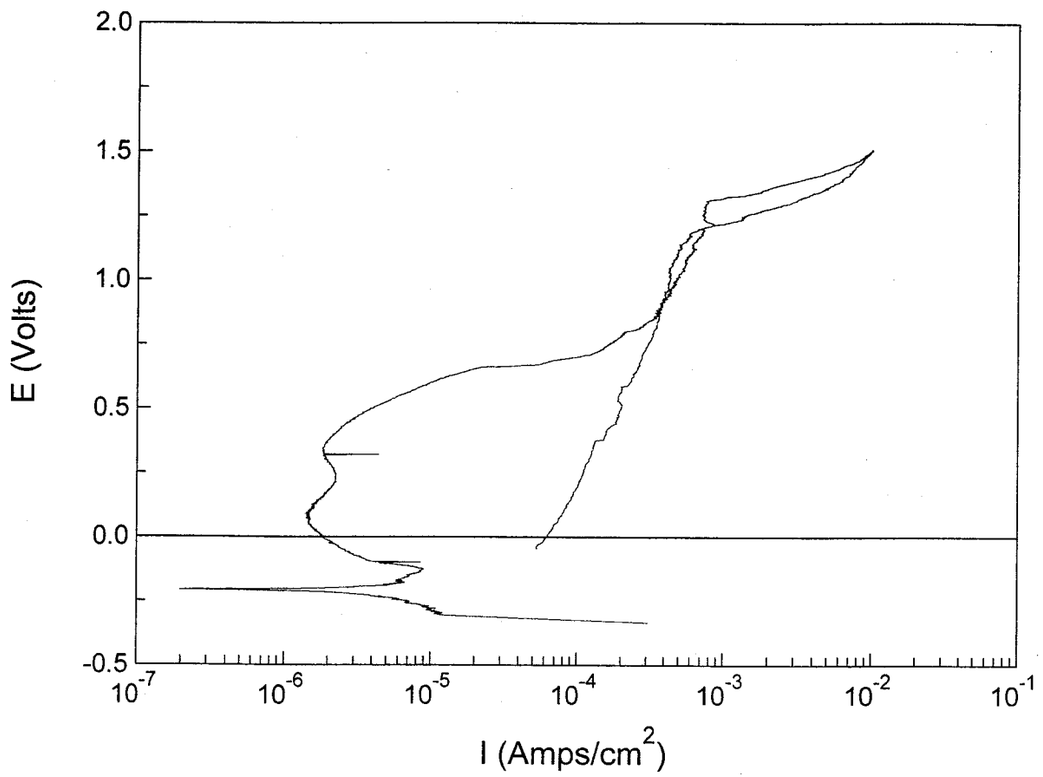
9/9/99 7:30 INTERNAL TEMP 25.3°C

E_{CORR} = -652mV, E_{PT} = -155mV

GENERALIZE CORROSION ON STEM AND UPPER EDGES – ALSO ON DIP TUBE –

Jerry Stewart 9/9/99

1116SBØØW.DAT



Jerry Sewell 9/9/99

TI140BØ7W.DAT

1.0M SOLUTION No. 1 AT 140°C - WELDED SPECIMEN

IRE/SCE = 45.5mV S/N 5087374

9/16/99

INITIAL WT 20.8311g, FINAL WT 18.5090g JWS 9/20/99

INITIAL pH 7.767@22.7°C, FINAL pH 6.721@22.4°C JWS 9/20/99

E_{CORR} = -395mV, E_{PT} = -38mV

10:09 START DEAERATE, 12:31 STOP. TOTAL TIME 2 HRS 22 MIN.

E_{CORR} = -82mV, E_{PT} = -61mV

12:33 START HEATING SP 138°C

9/17/99 7:08 INTERN'AL 120°C SPT 157°C

9:00 133°C

9:30 134°C SPT 162°C

10:13 138°C

E_{CORR} = -266mV, E_{PT} = -252mV

SOLARTRON CONNECTED E_{CORR} = -345mV

10:18 START CPP RUN

9/18/99

9:57 UNLOCK COMPUTER & SAVE DATA

E_{CORR} = 178mV, E_{PT} = 112mV

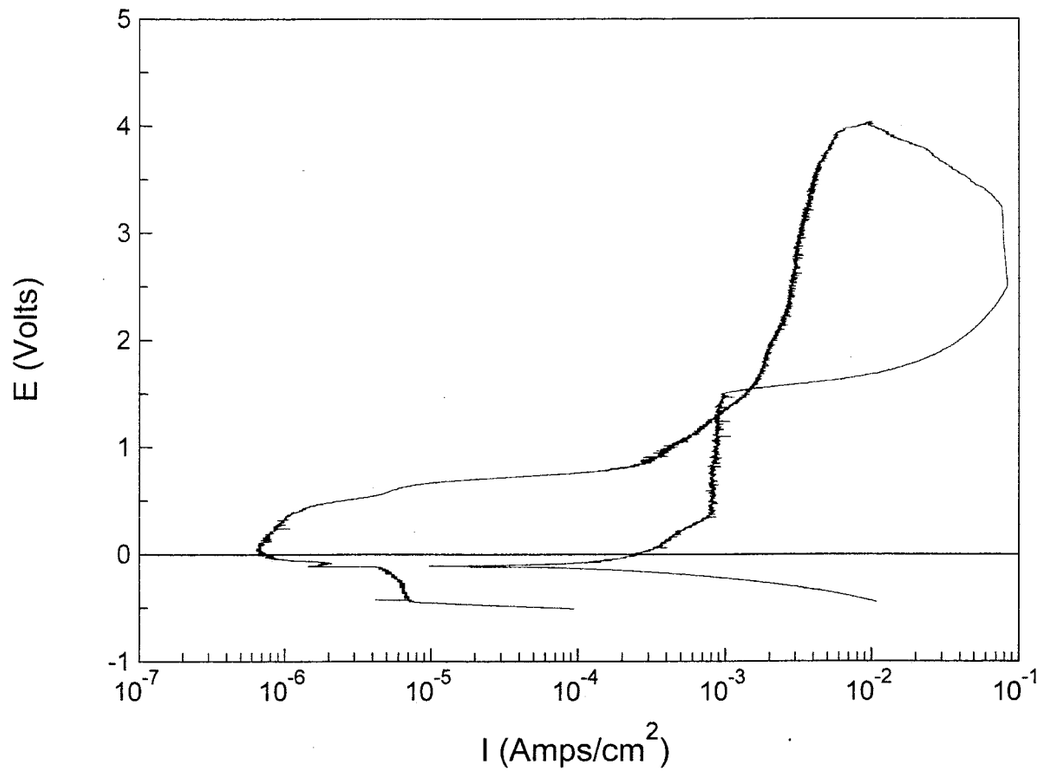
9:59 START COOL DOWN

9/20/99 7:31 INTERNAL TEMP 22.7°C

E_{CORR} = -549mV, E_{PT} = -505mV

IRE/SCE = -52mV S/N 5087374

Jerry Sewell 9/20/99



Terry Sumrall 9/20/99

T# 125B08W.DAT

2.0M SOLUTION No. 1 AT 125°C - WELDED SPECIMEN

TRE/SCE = 482mV S/N 5087374

10/4/99

INITIAL WT. 20.7666g, FINAL WT. 20.7154g ATS 10/6/99

INITIAL pH 7.641 @ 22.6°C, FINAL pH 6.899 @ 22.9°C ATS 10/6/99

E_{CORR} = -308mV, E_{PT} = 62mV

8:11 START DEAERATE, 10:11 STOP TOTAL TIME 2 HRS

E_{CORR} = -110mV, E_{PT} = 52mV

10:12 START HEATING SP 122°C

302 INTERNAL TEMP 124.3°C - START CPP

10/5/99 7:17 125.2°C - STILL RUNNING

7:19 STOP RUN

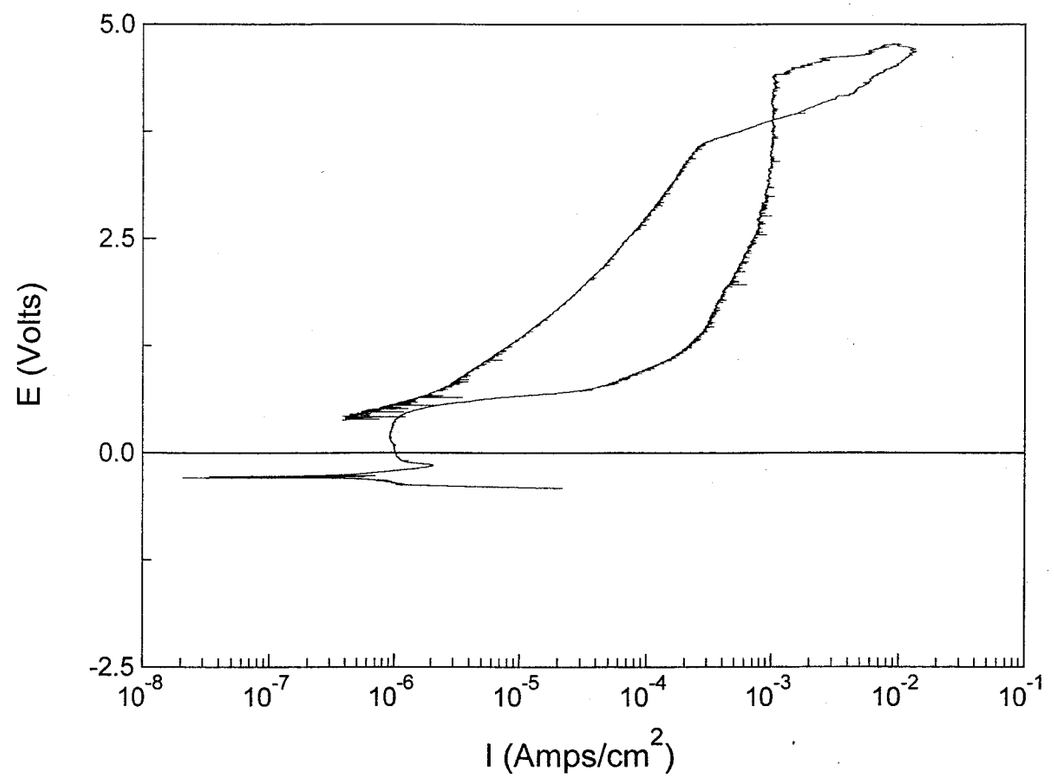
7:22 START COOL DOWN

10/6/99 7:26 INTERNAL TEMP 23.1°C

E_{CORR} = -630mV, E_{PT} = -3mV

TRE/SCE = 20mV S/N 5087374

Terry Sumrall 10/6/99



LOCAL CORROSION ONLY – NO PITTING UNDER TEFLON WASHER –

~~Jerry Stewart~~ 10/6/99

T1Ø95BØ9W.DAT

2.0M SOLUTION No. 1 AT 95°C – WELDED SPECIMEN

SRE/SCE = 44.4 mV S/N 5087374

10/19/99

INITIAL WT. 20.8467g, FINAL WT. 20.2988g 10/22/99 ALS

INITIAL pH 7.589 @ 19.9°C, FINAL pH 6.365 @ 21.5°C 10/22/99 ALS

E_{CORR} = -258 mV, E_{PT} = 109 mV

8:27 START DEAERATE, 10:27 STOP – TOTAL TIME 2 HRS
E_{CORR} = -97 mV, E_{PT} = 70 mV

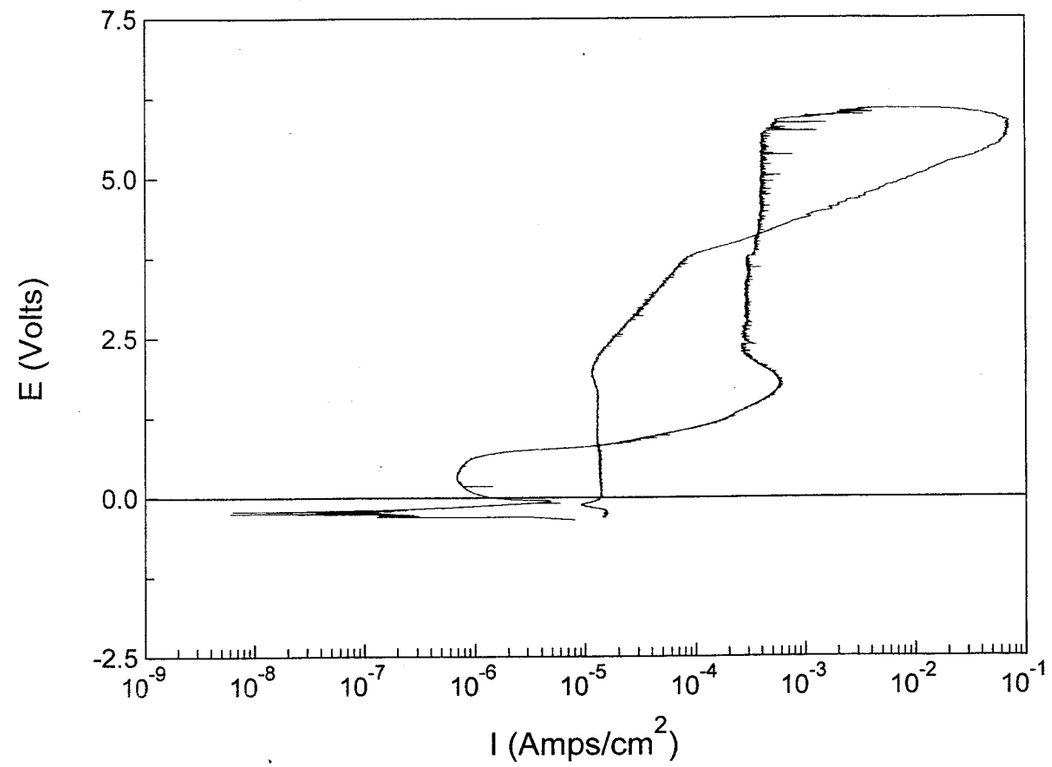
10:29 START HEATING SP 92°C
2:41 INTERNAL 96.4°C SP + 91°C
10/20/99 7:09 INTERNAL TEMP. 96.1°C
E_{CORR} = -205 mV, E_{PT} = -4 mV

7:18 START CPP
10/21/99 7:09 INTERNAL TEMP 97.1°C COMPUTER HUNG
E_{CORR} = -576 mV, E_{PT} = -714 mV
START COOL DOWN

10/22/99 7:16 INTERNAL TEMP 18.7°C
E_{CORR} = -1.157 V, E_{PT} – NO STEADY READING
SMALL LEAK THRU SRE FITTING

SRE/SCE = 15 mV S/N 5087374

~~Jerry Stewart~~ 10/22/99



Jerry Schwab 10/22/99

T1 133 B10 W.DAT

1.0M SOLUTION NO-1 AT 133°C - WELDED SAMPLE

Δ REF/SCE = 43.1 mV S/N 5087374

10/26/99

INITIAL WT. 20.8193g FINAL WT. 20.8192g 10/28/99 JS

INITIAL pH 7.631 @ 21.1°C FINAL pH 6.838 @ 24.5°C 10/28/99 JS

E_{CORR} = -431 mV , E_{PT} = -30 mV

8:16 START DEAERATE, 10:16 STOP TOTAL TIME 2 HRS
E_{CORR} = -144 mV , E_{PT} = -102 mV

10:17 START HEATING SP 130°C
3:04 133.6°C SP + 129°C

10/27/99 INTERNAL TEMP 134.3°C
E_{CORR} = -250 mV, E_{PT} = -99 mV

7:19 START CPP
12:55 133.3°C STOP RUN - NOT SURE WHAT'S GOING ON -

10/28/99 7:13 INTERNAL TEMP 24.5°C
E_{CORR} = 345 mV , E_{PT} = -194 mV

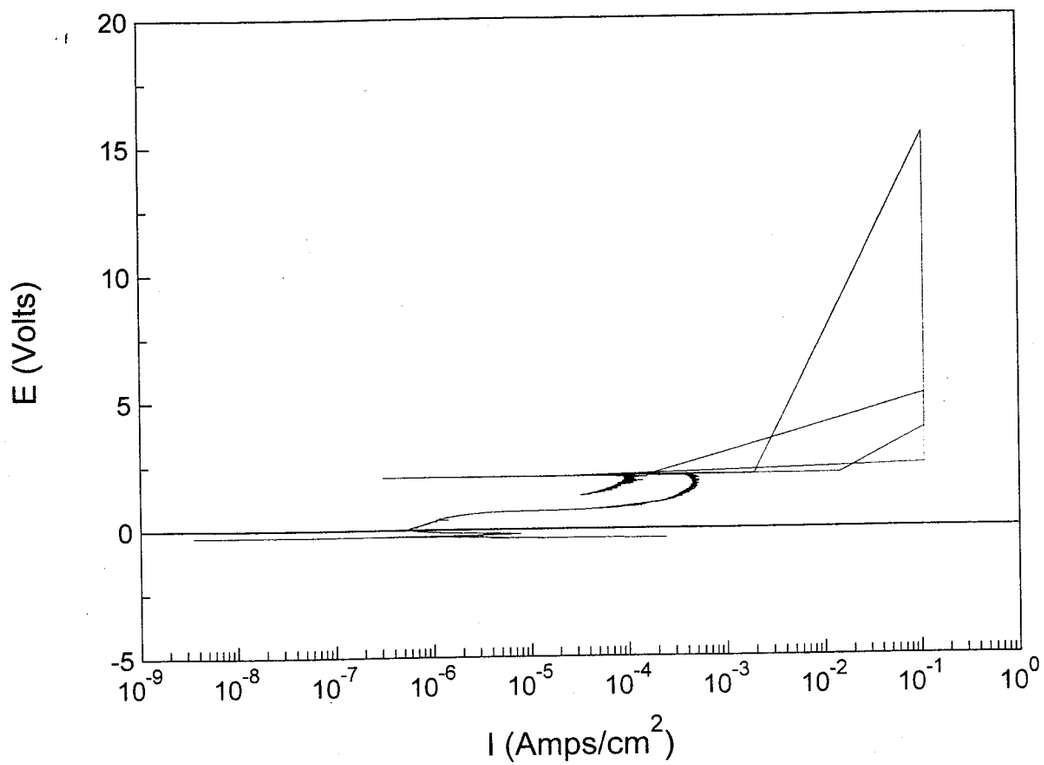
RUBBER WASHER SPLIT - SAMPLE IS LOOSE ON HOLDER - NO DAMAGE TO SPECIMEN OTHER THAN SLIGHT TEXTURE CHANGE IN AFFN AREAS -

RE POLISH & RERUN

Δ REF/SCE = 4 mV S/N 5087374

Jerry Schwab 10/28/99

TI133B10W.DAT



Jerry Stewart 10/28/99

TI133B11W.DAT

1.0M SOLUTION No. 1 AT 133°C - WELDED SPECIMEN - REPEAT
RE POLISHED SPECIMEN - SEE PAGE 51.

IRE/SCE = 45.0 mV S/N 5087374

11/1/99

INITIAL WT. 20.8111g, FINAL WT. 20.6995g 11/4/99

INITIAL pH 7.601 @ 21.1°C, FINAL pH 6.790 @ 21.4°C 11/4/99

E_{CORR} = -385 mV, E_{PT} = -46 mV

10:02 START DEAERATE, 12:02 STOP - TOTAL TIME 2 HRS
E_{CORR} = -157 mV, E_{PT} = -118 mV

1203 START HEATING SP 129°C
1517 128.1°C

11/2/99 7:06 INTERNAL TEMP 133.8°C
E_{CORR} = -241 mV, E_{PT} = -154 mV
7:10 START CPP
15:04 REVERSAL

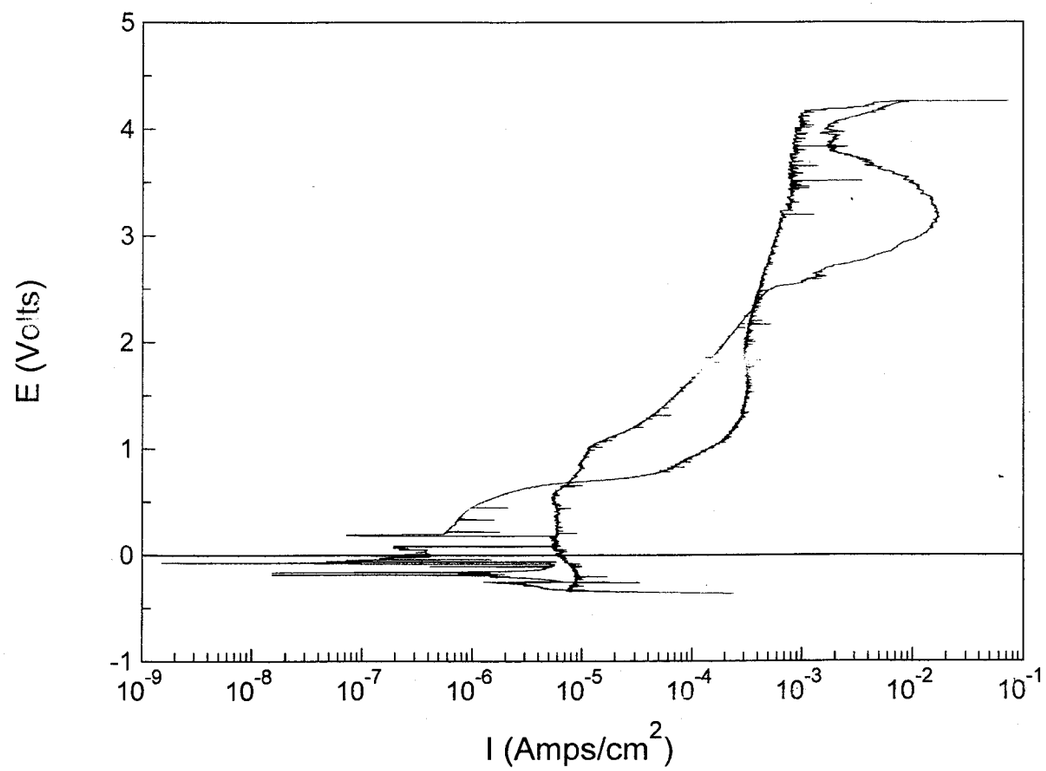
11/3/99 7:12 INTERNAL TEMP 132.8°C
E_{CORR} = -746 mV, E_{PT} = -769 mV
START COOL DOWN

11/4/99 7:56 INTERNAL TEMP 21.8°C

E_{CORR} = -674 mV, E_{PT} = -590 mV

IRE/SCE = 6 mV S/N 5087374

Jerry Stewart 11/4/99



LOCAL ATTACK LOWER HALF AND BOTTOM
ALL SITES ARE OUTSIDE WELD

Jerry Sewell 11/4/99

TI 129 B 12W.DAT
1.0M SOLUTION No. 1 AT 127°C - WELDED

FRE/SCE = 45.2 mV S/N 5087374

11/16/99

INITIAL WT 20.8370g FINAL WT 20.7904g JGS 11/19/99

INITIAL PH 7.691 @ 20.6°C FINAL PH 6.793 @ 22.7°C JGS 11/19/99

E_{CORR} = -362 mV, E_{PT} = 54 mV

8:00 START DEAERATE 10:30 STOP - TOTAL TIME 2 HRS 30 MIN
E_{CORR} = -284 mV, E_{PT} = -133 mV

10:34 START HEATING SP 125°C
14:26 128.6°C SP 122°C

11/17/99 7:07 INTERNAL TEMP 127.3°C
E_{CORR} = -199 mV, E_{PT} = -32 mV

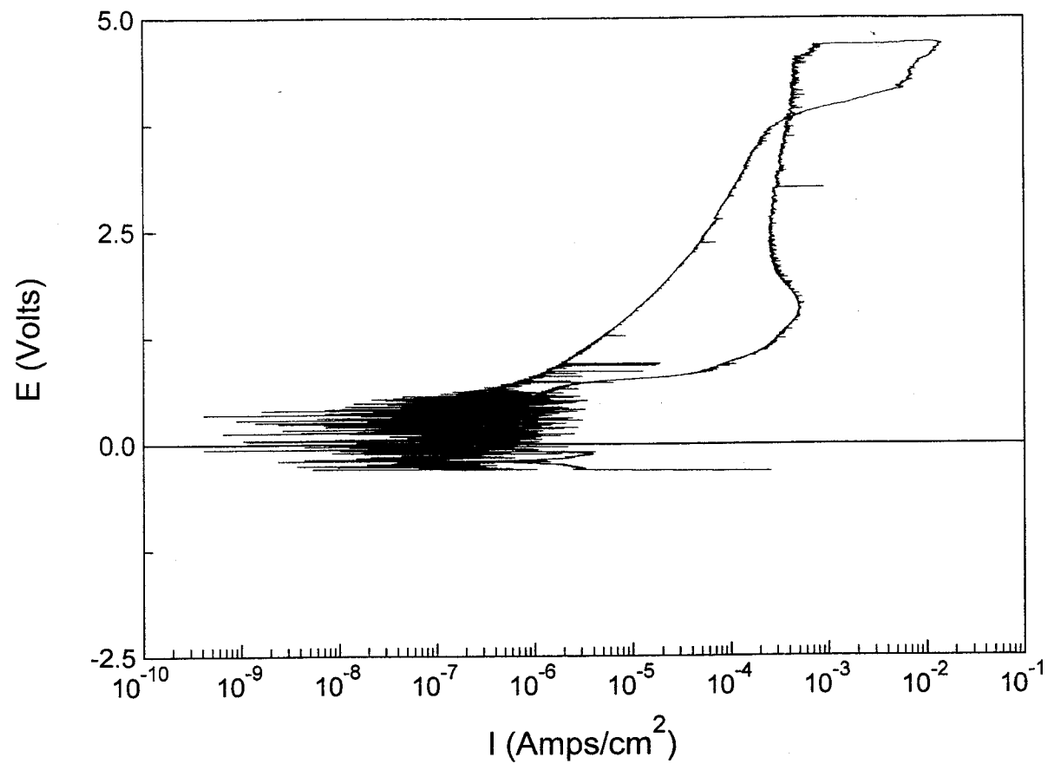
7:13 START CPP
15:30 REVERSE

11/18/99 7:04 INTERNAL TEMP 127.4°C
E_{CORR} = -637 mV, E_{PT} = -706 mV
START COOL DOWN

11/19/99 12:47 INTERNAL TEMP 22.8°C
E_{CORR} = -208 mV, E_{PT} = -83 mV

FRE/SCE = 14 mV S/N 5087374

Jerry Sewell 11/19/99



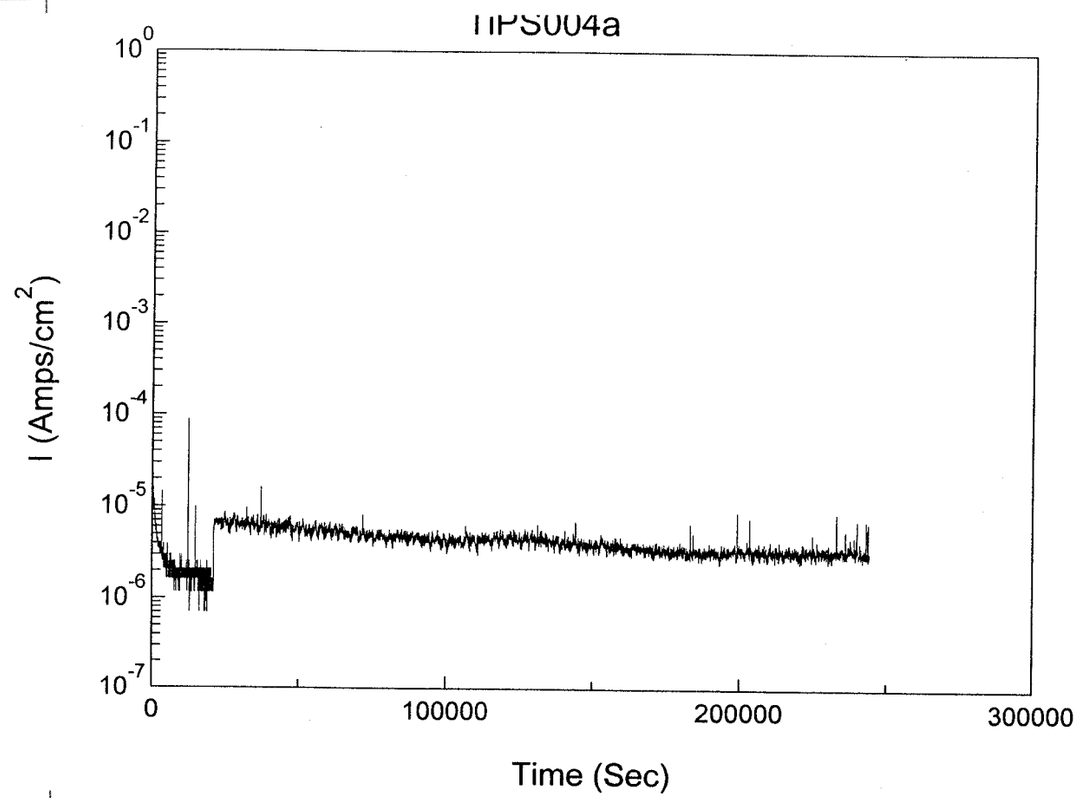
Kenny Stewart 11/19/99

Continuation of passive current density measurements discussed on pg ~~26~~ 28 SB 2/14/00

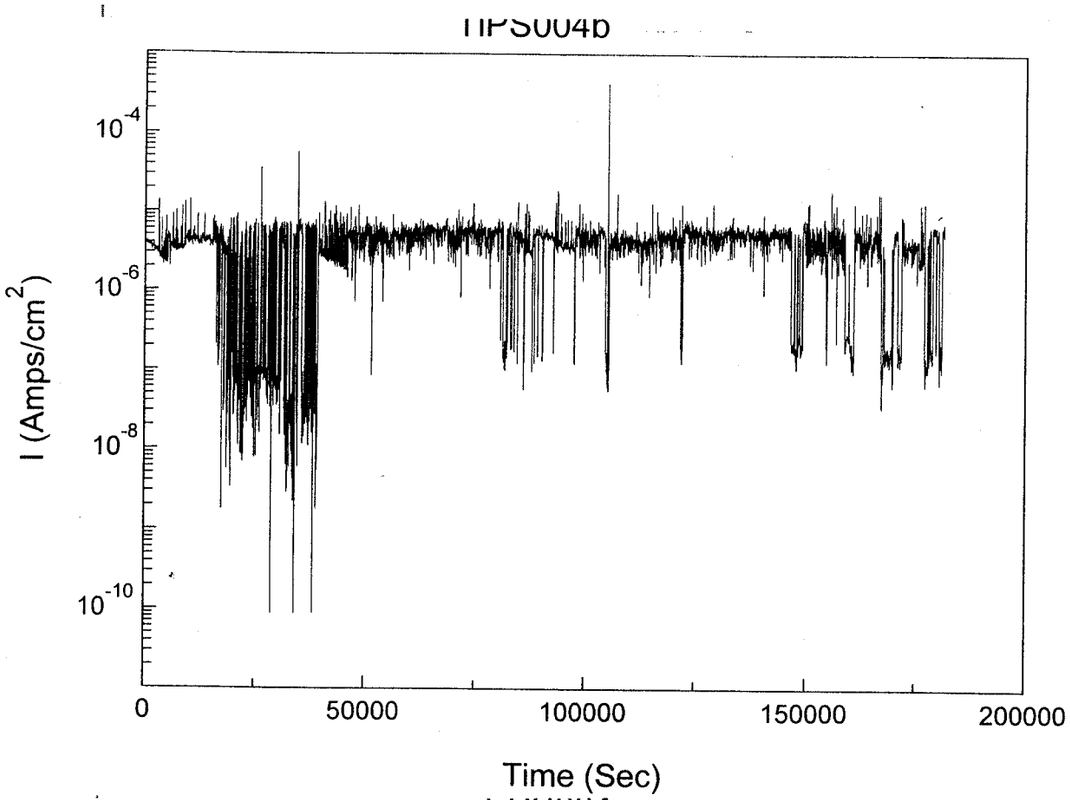
0.1 M NaCl 95°C Lot #985302 $pH_i = 6.092$

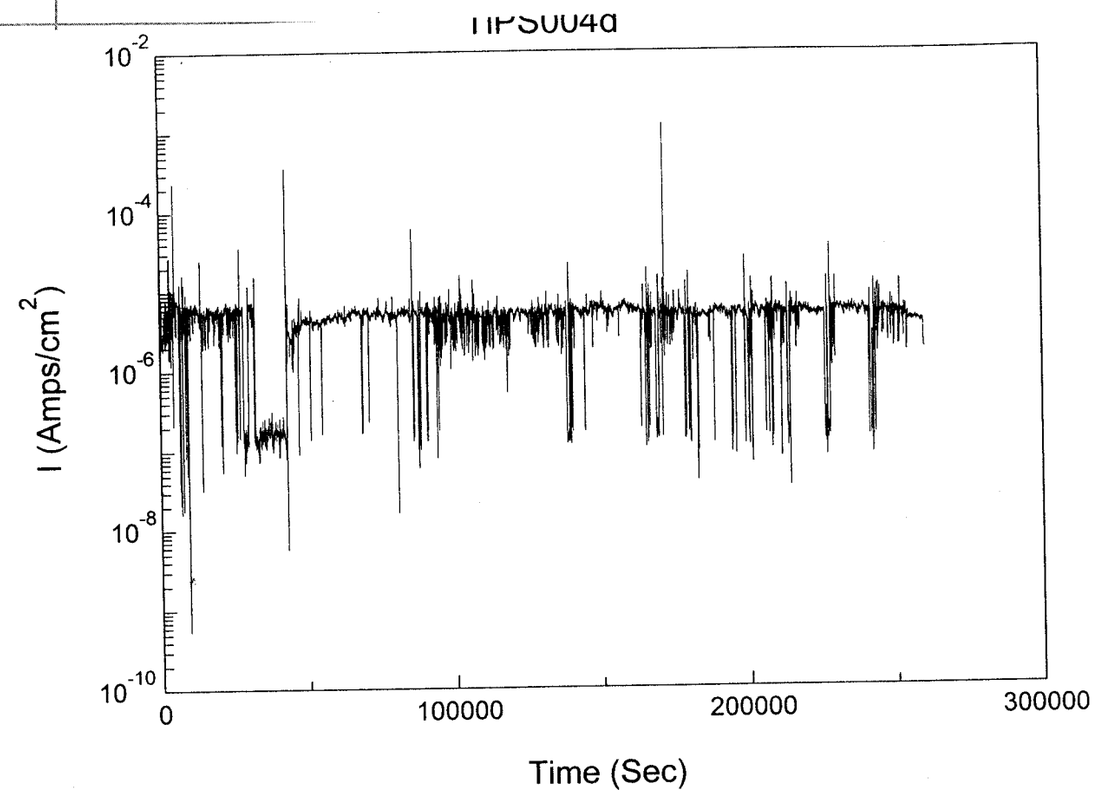
$wt_i = 6.38830$ g $pH_f = 5.983$

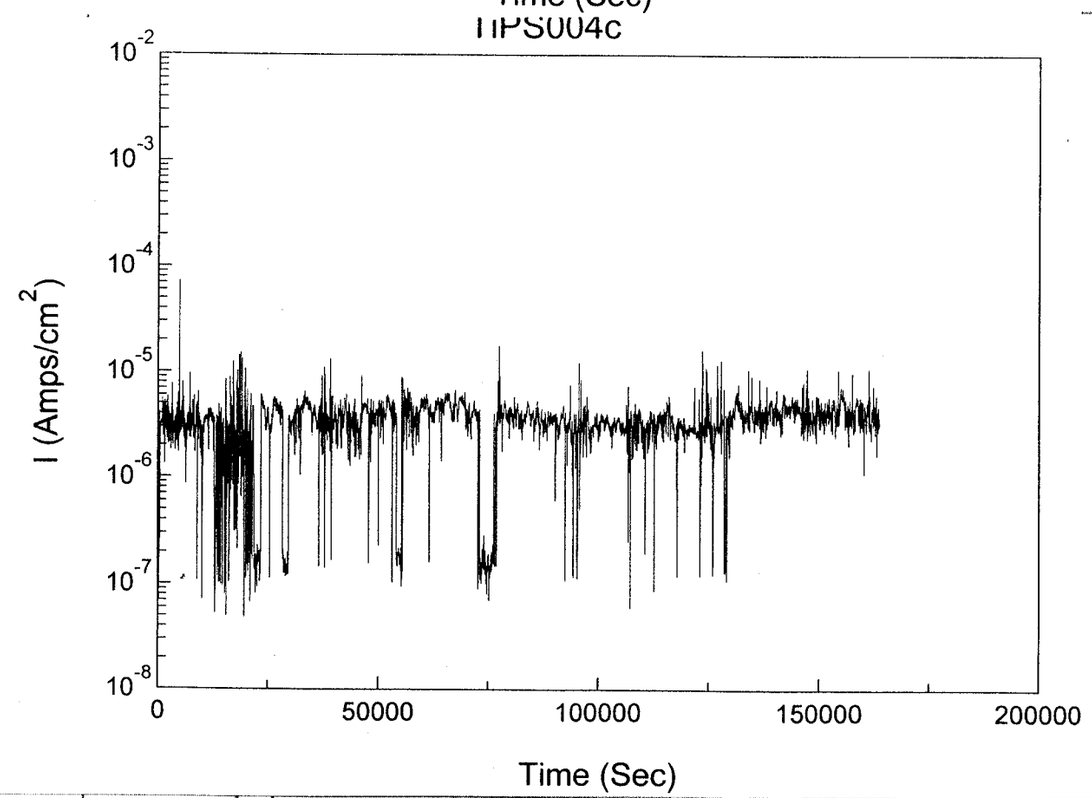
Eappl.	i_{ss} ($\mu A/cm^2$)	wt_f	file name
-250 mV	1.6-3.3	6.38828	tips004a
0	5	6.38823	— " — b
+250	5.4	6.38829	— " — c
+500	4.8-5.2	6.38897	— " — d



SB 8/16/99







SB 8/16/99

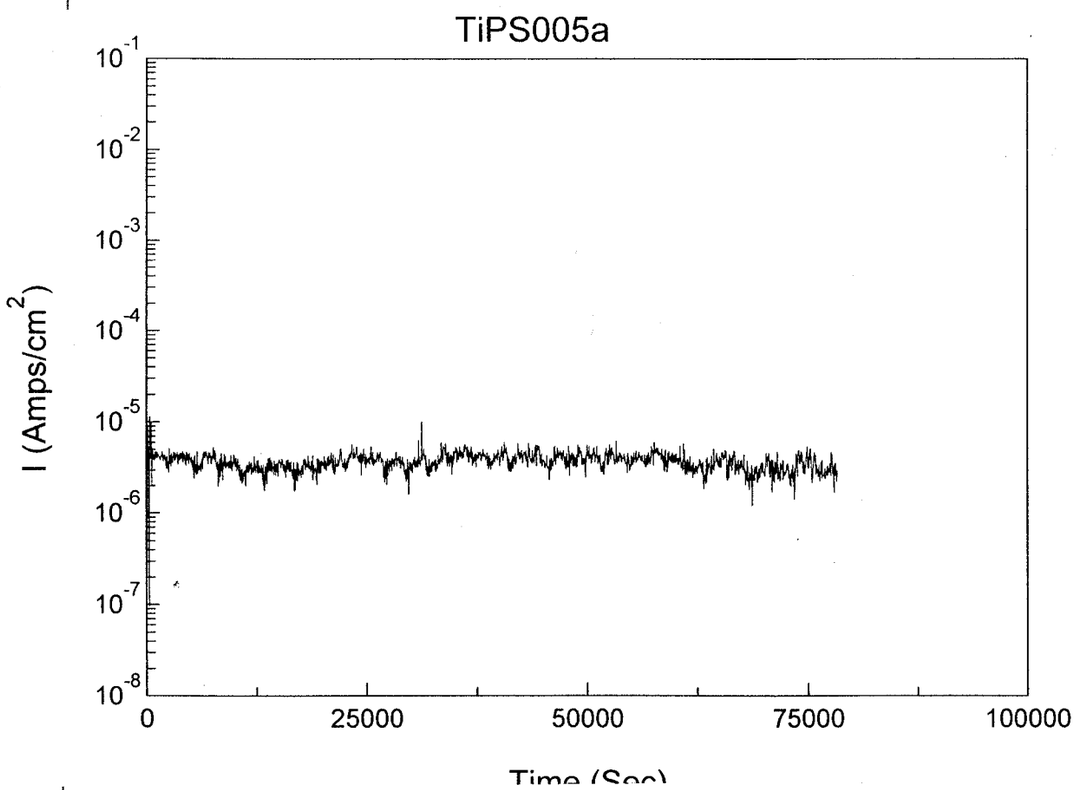
SB 8/16/99

Pstat ipor measurement of Ti-Grade 7

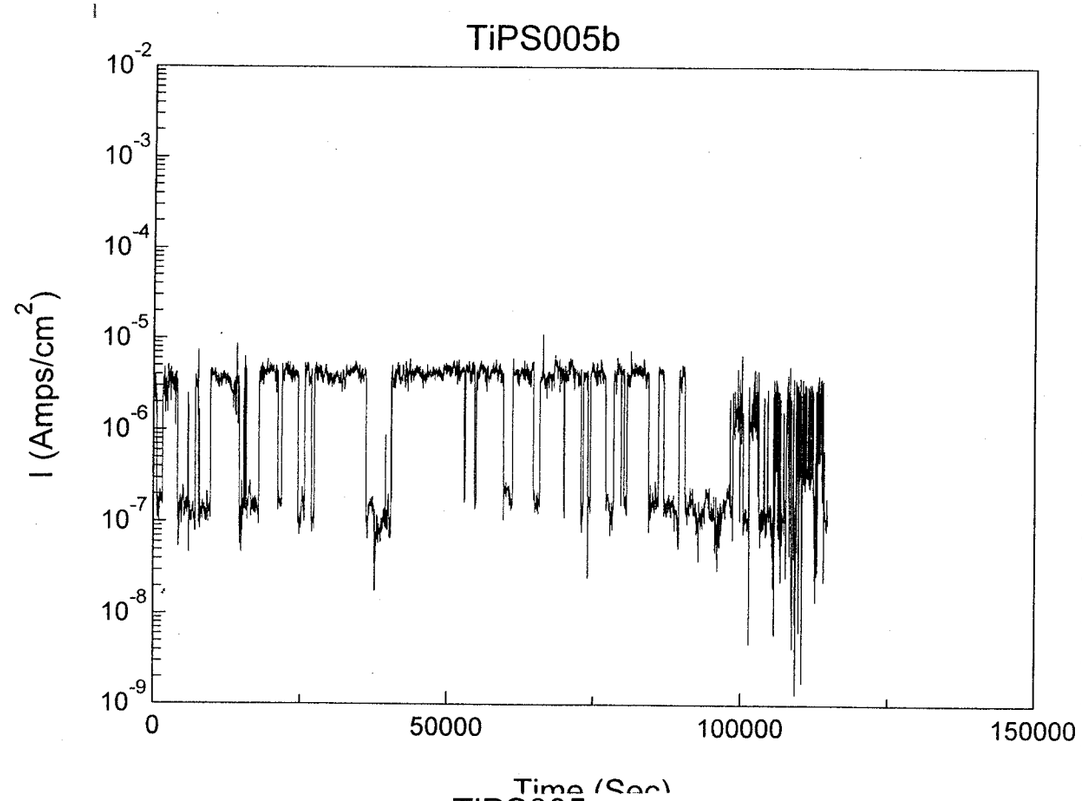
0.1 M NaCl + 20mM Na_2CO_3 95°C pHi: 10.980
#985302 #968685 pHf = 10.400
(deaerated)

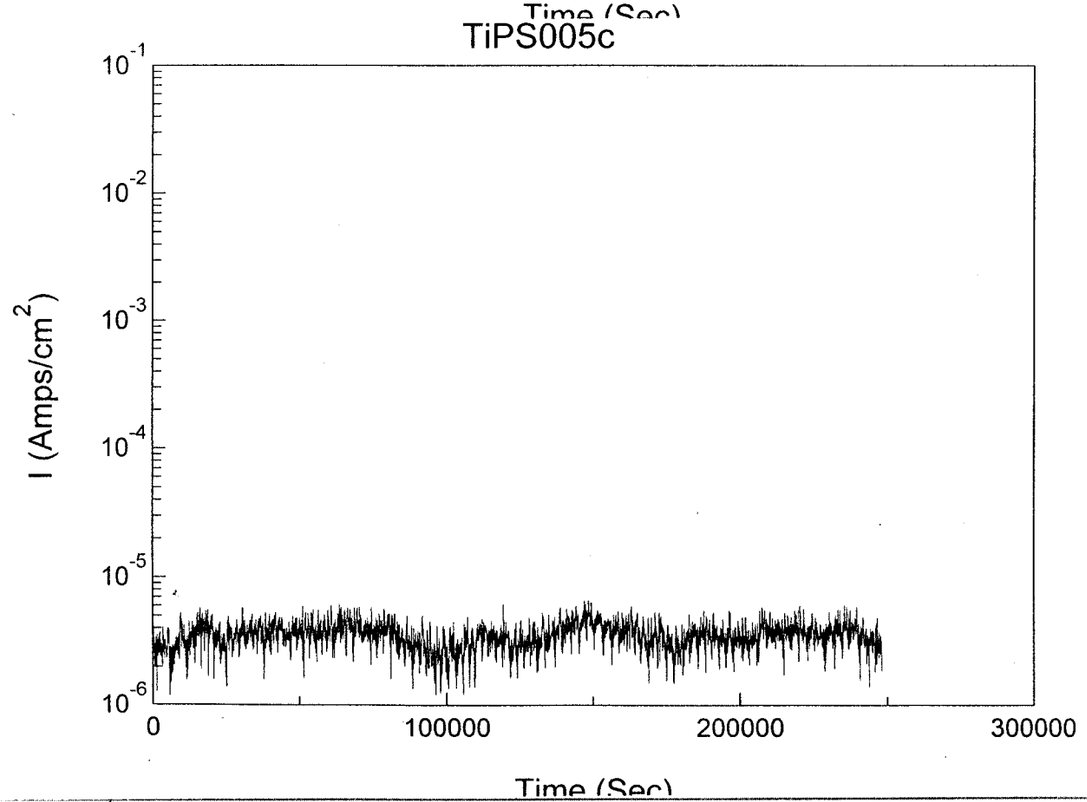
wti = 6.42762
SB SB 8/16/2000

Eappl.	iss (μA/cm²)	~~wtf~~ wtf	file
-250	2.6-5.6	N/A	tips005a
0	3.1-5.4	N/A	—"— b
250	2.2-5.8	6.42687	—"— c
500	5.2-8.1	N/A	—"— d
750 mVsce	0.23-7.8	N/A	—"— e

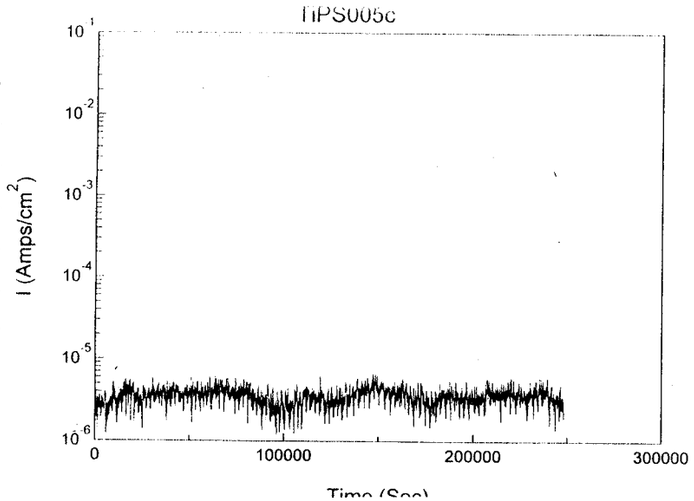


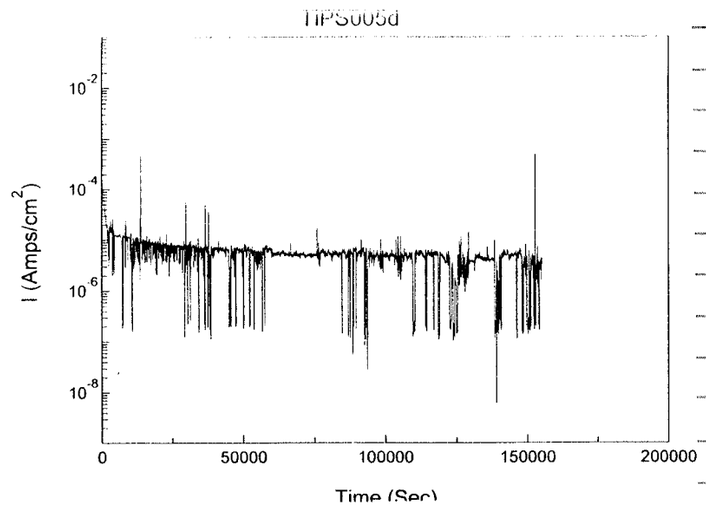
SB 8/25/99

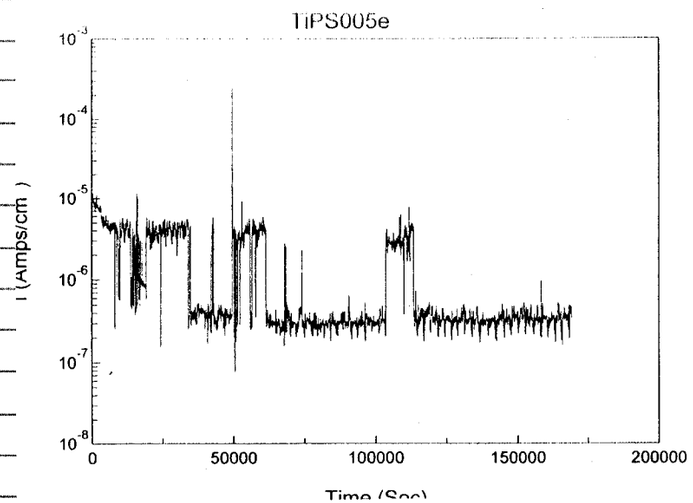




SB 8/25/99



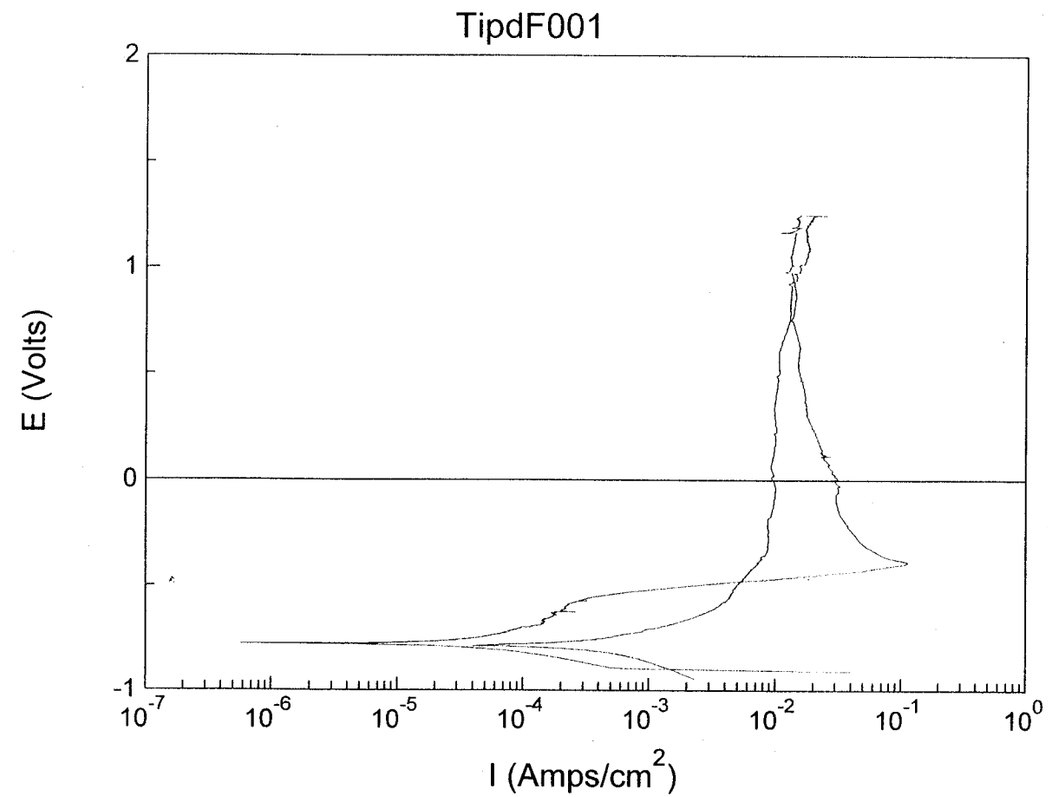




SB e 8/20/99

Potent SB Polarization of Ti-Gr 7 in ~~F$^-$~~ SB F^- solutions

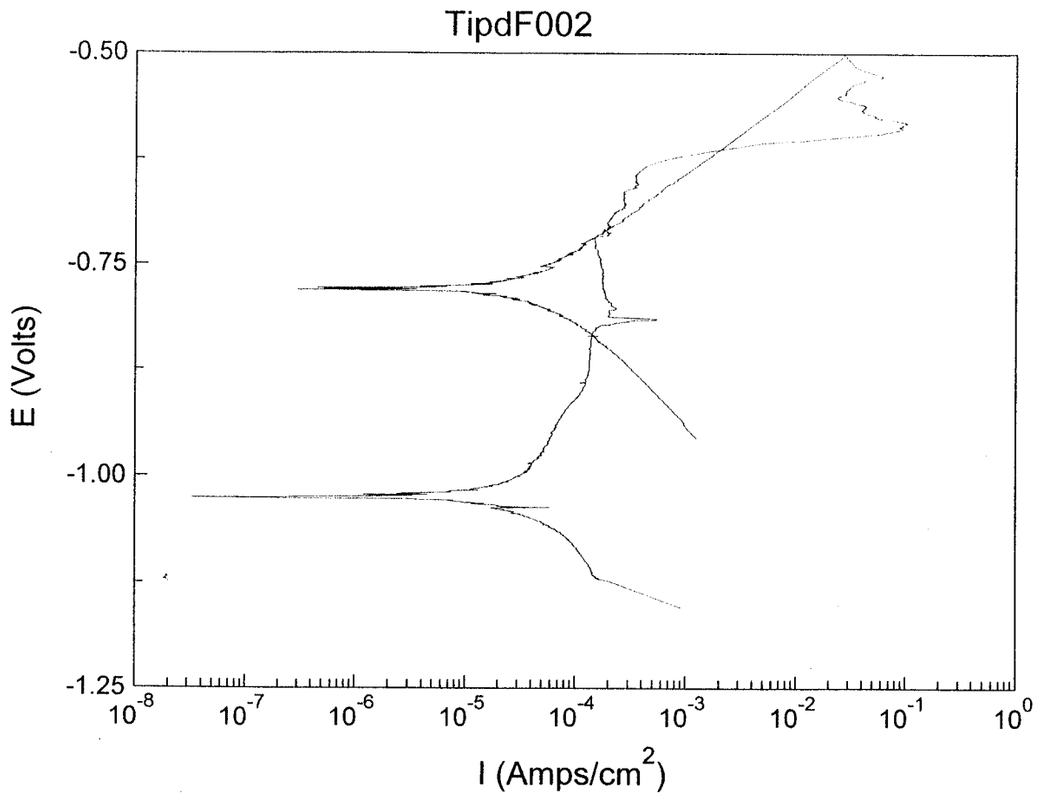
0.01 M NaF lot # 896405 0.8398 g - deaerated
T: PdF001.dat - 95°C
pH$_i$ = 6.46
pH$_f$ = 8.840
wt$_i$ = 16.70537
wt$_f$ = 16.6863



SB 9/15/99

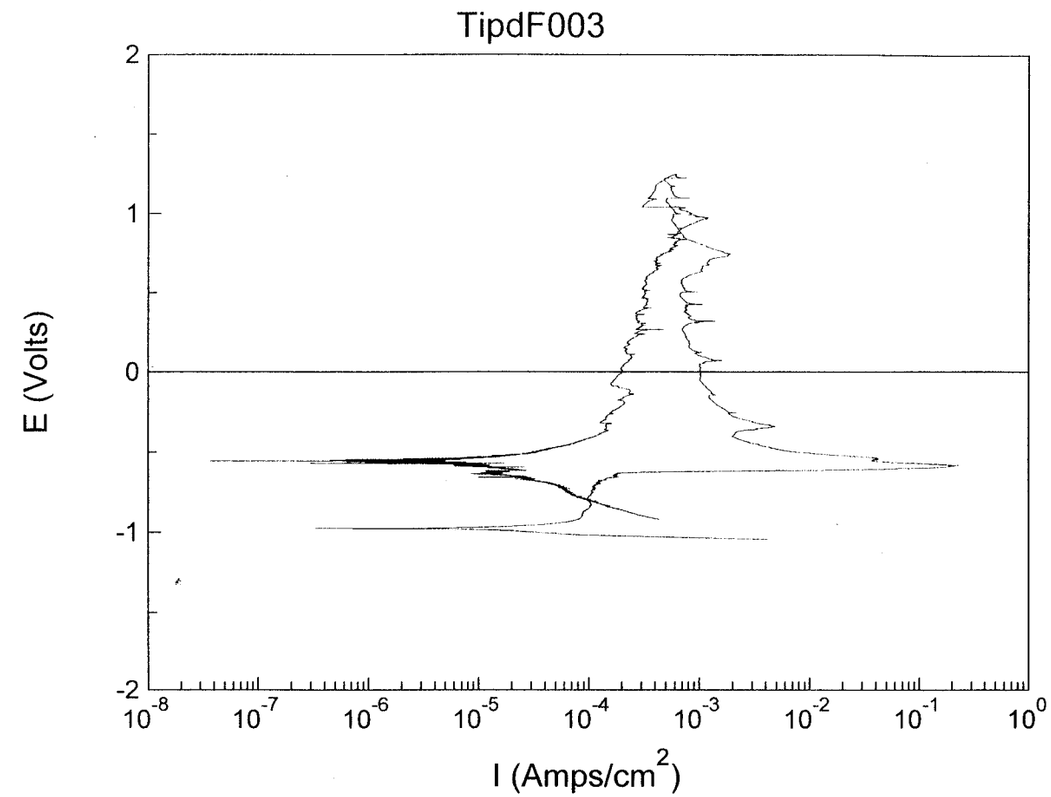
Ti-Gr7 in F^- solutions con't

1 M NaF, 95°C same lot as on pg 63
pHi 10.152
pHf 8.808
wti 6.40490
wtf 6.39558
TipdF002.dat



SR 9/28/99

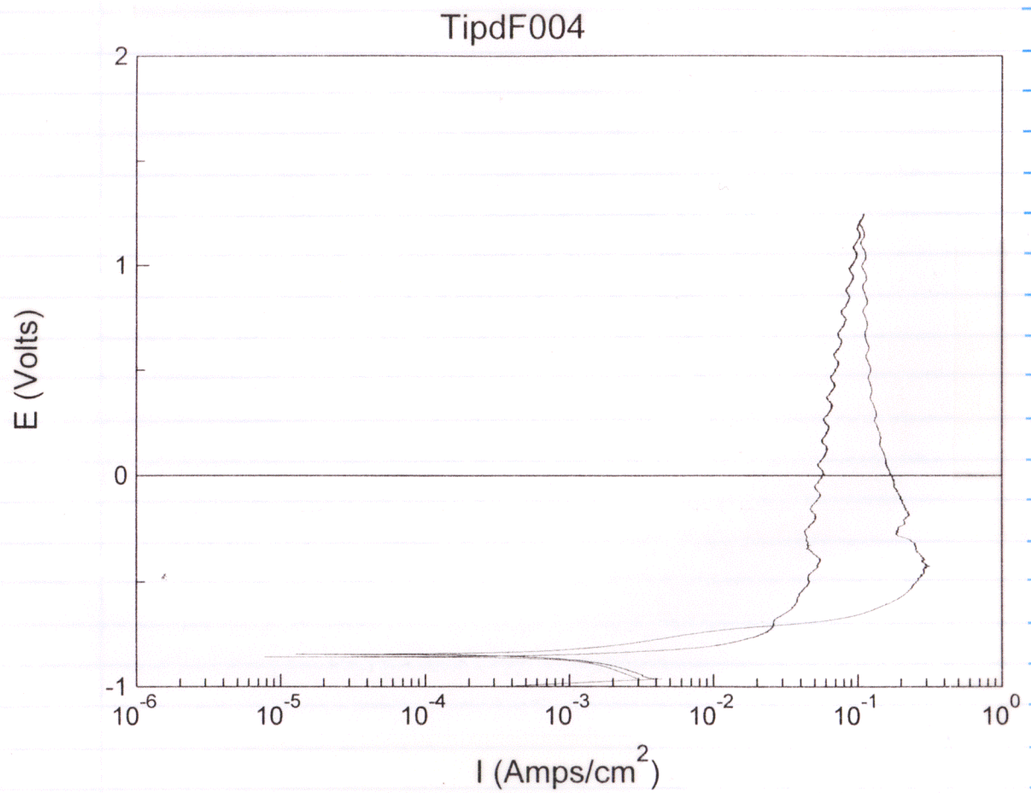
1 M NaF + 1 M NaCl
same as p63 #972274
95°C, deaerated
pHi 9.447
pHf 8.568 SB SB 8/26/2000
wti 6.44746
wtf 6.45142
TipdF003



SR 9/28/99

1M NaF + 0.1 M HCl - Lot # 993517
same as pg 63 (8.3 mL/L)

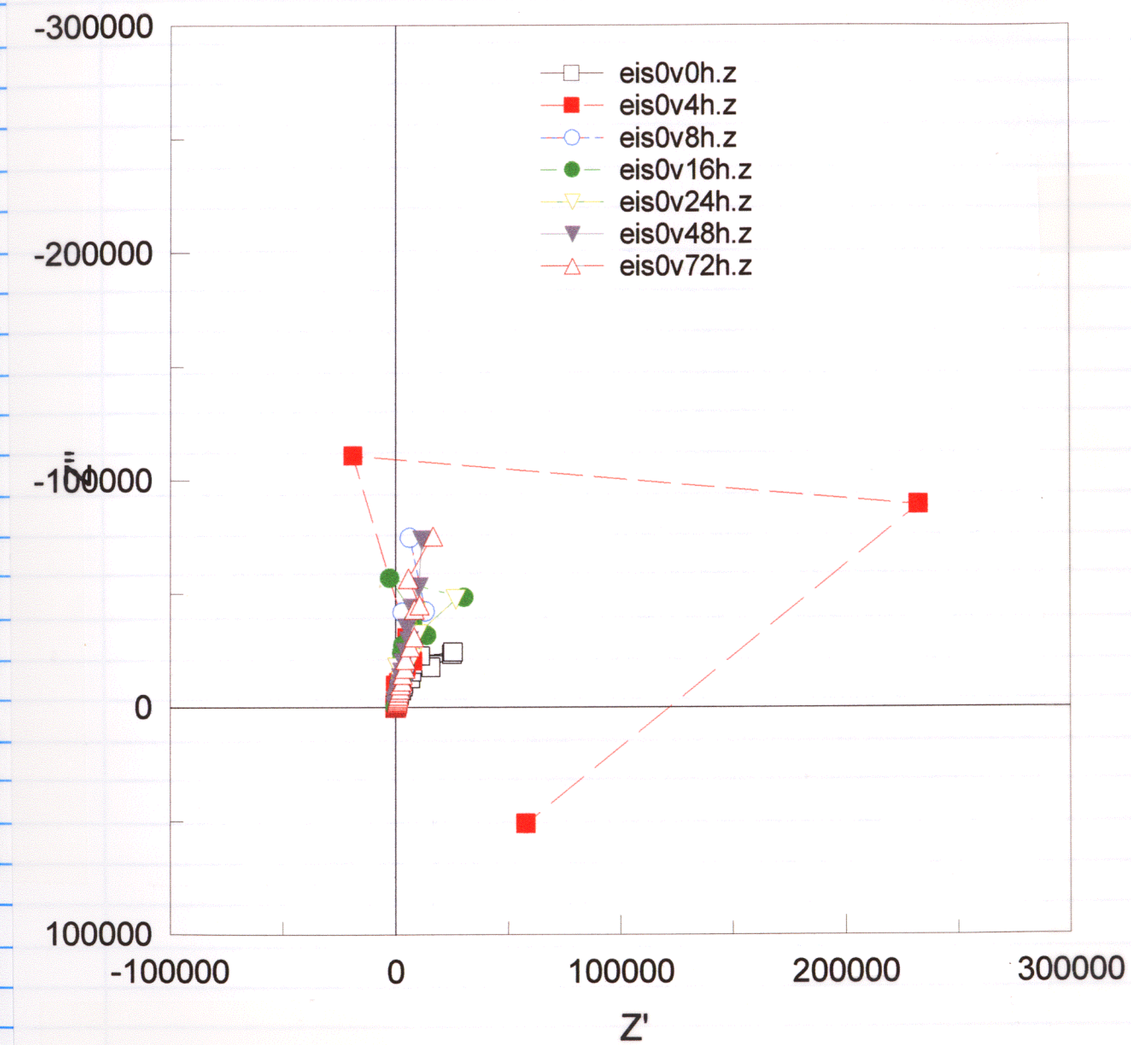
95°C, deaerated
pH_i 4.571
pH_f 7.199
wt_i 6.40863
wt_f 6.19869
TipdF004 SB



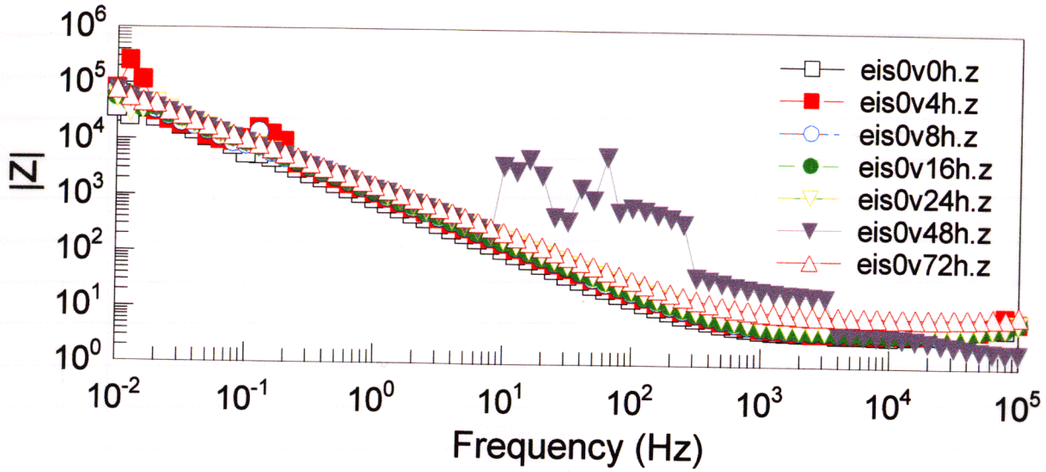
SB 9/30/99

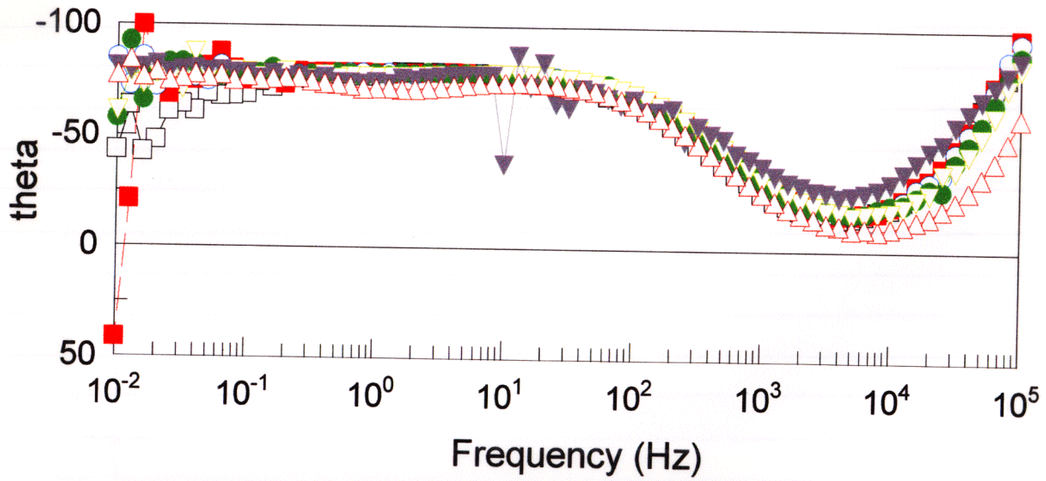
EIS to study oxide properties @ 0 VSCE vs time

0.1 M NaCl (995718)
95°C deaerated
pH_i = 6.855



SB 12/28/99





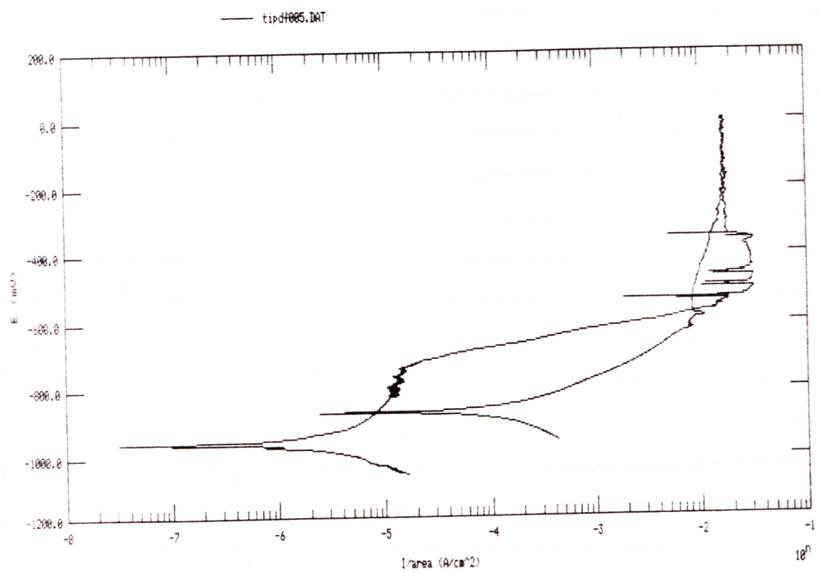
SB 12/21/99

12/16/99

Ti-Gr7 crevice specimen SB ~ 1M NaCl + 1M NaF
995718 896405

wt_i = 16.75370
wt_f = 16.73488
pH_i = 9.865
pH_f = 9.013
some pitting noticed under crevice feet
Tipd F005

Model 352/252 Corrosion Analysis Software, v. 2.30
CP CYCLIC POLARIZATION
CF PASS vs. R
SI 1.000E-03
FL 1 0.5Hz
IT 0.500E-02
Comment: ti-gr7 1M NaCl 1M NaF, 95C, crevice
File Status: EDITED
IP -0.100 vs. OC
ST 1.000E+00
REF 0.00000 User
EW 0.000E+00
Filename: c:\ti\tipd#005.DAT
Date Run: 12-16-99
ID PASS
CR AUTO
WRK SOLID
DEN 1.000E+00
Time Run: 00:54:04
Vi 0.000 vs. R
NF 2008
AR 1.700E+01
AU NO
Pstat: VStat[] Ver 2
FP 0.000 vs. OC
IR NONE
LS YES
OC -0.954

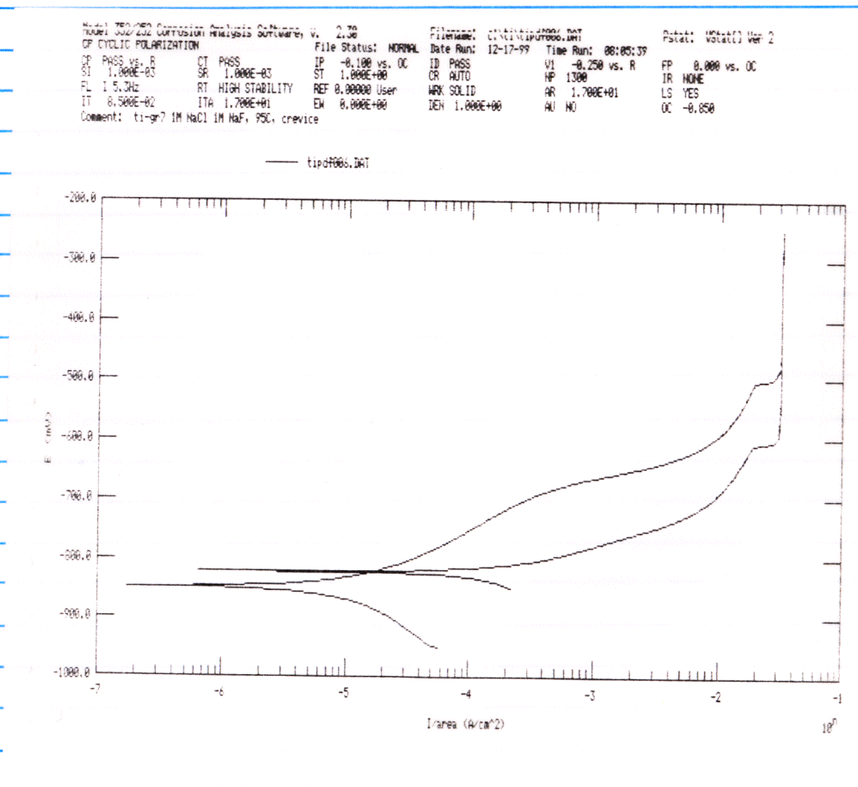


SB 12/16/99

Ti PdF006 Ti-Gr7 Crevice in 1M NaF + 0.1M HCl
~~896405~~ 993517

pHi 4.808
pHf 5.588
wti 16.78810
wtf ~~16.74~~ 16.73453 SB SB 8/16/2000

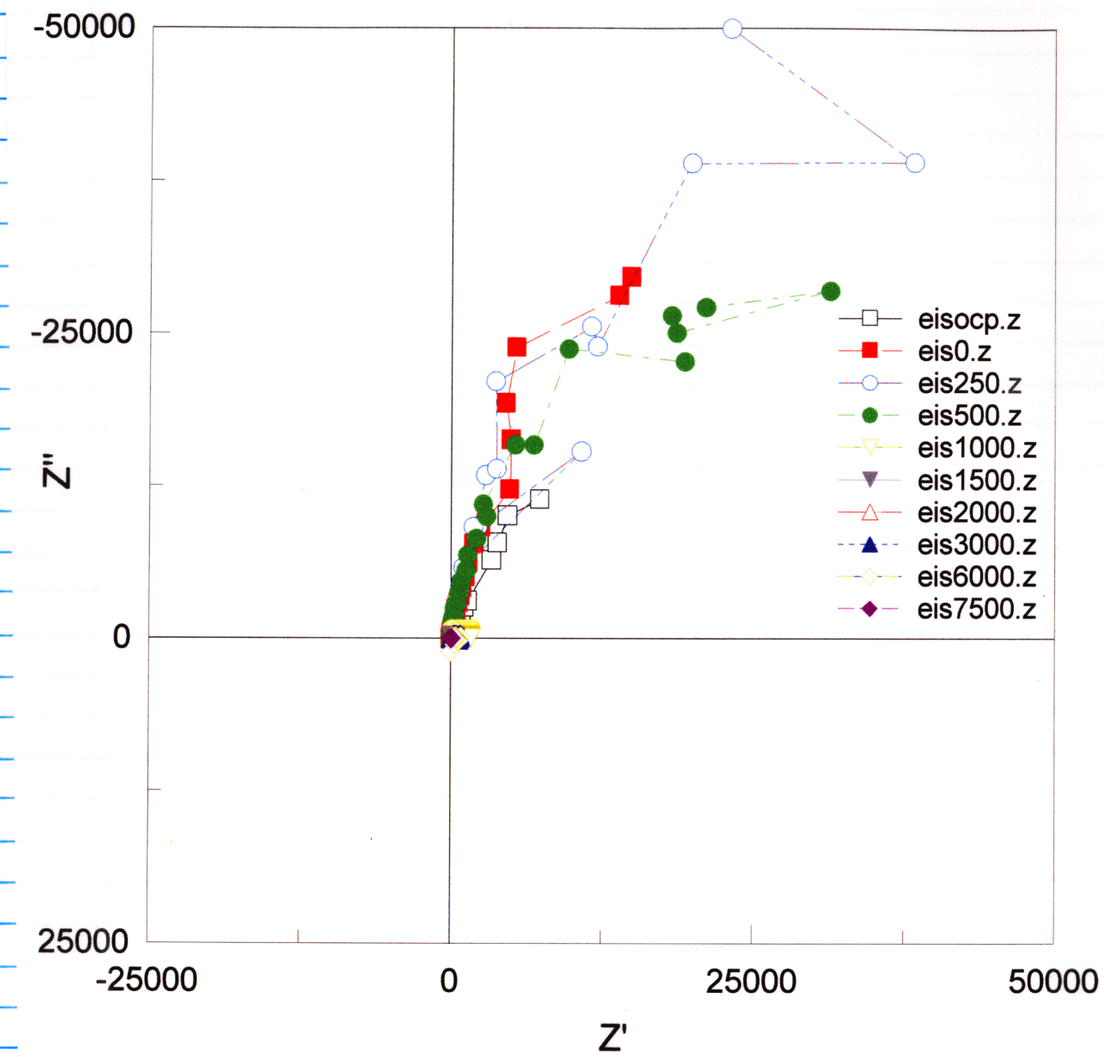
sample dark, gas evolution @ ocp, pits under crevice



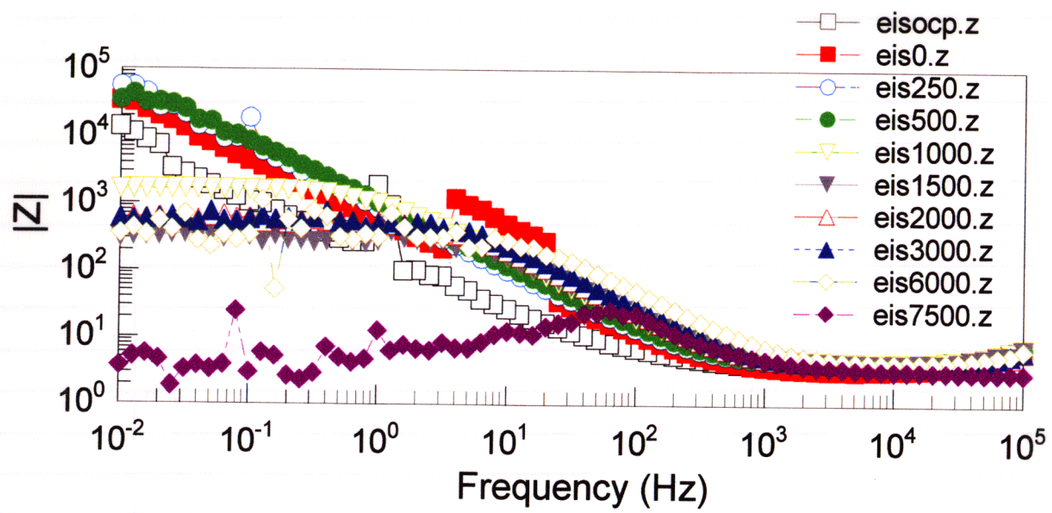
SB 12/17/99

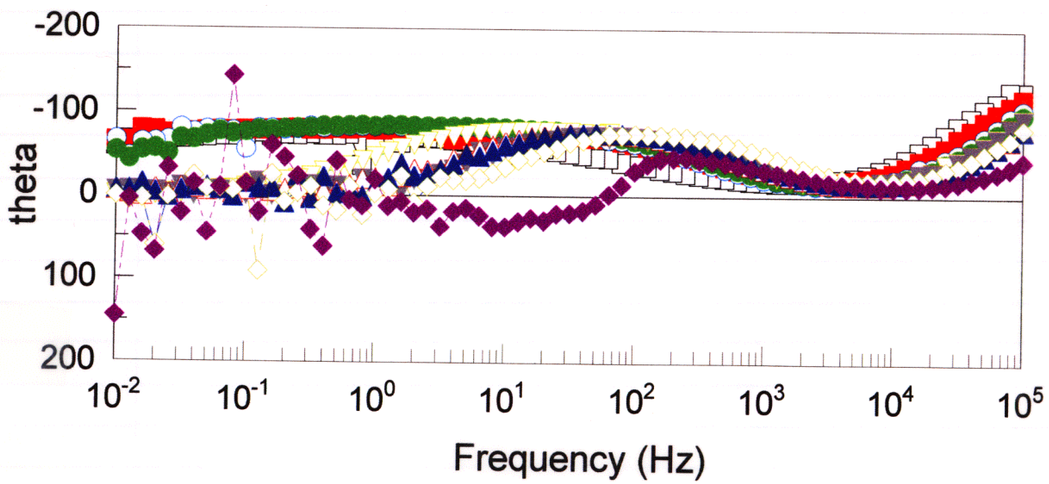
EIS/oxide props of Ti-Gr 7 @ Diff. E

- same conditions at p 67 except Eappl.
24 hr hold btwn potential changes (except 7500 - only 4 hrs)



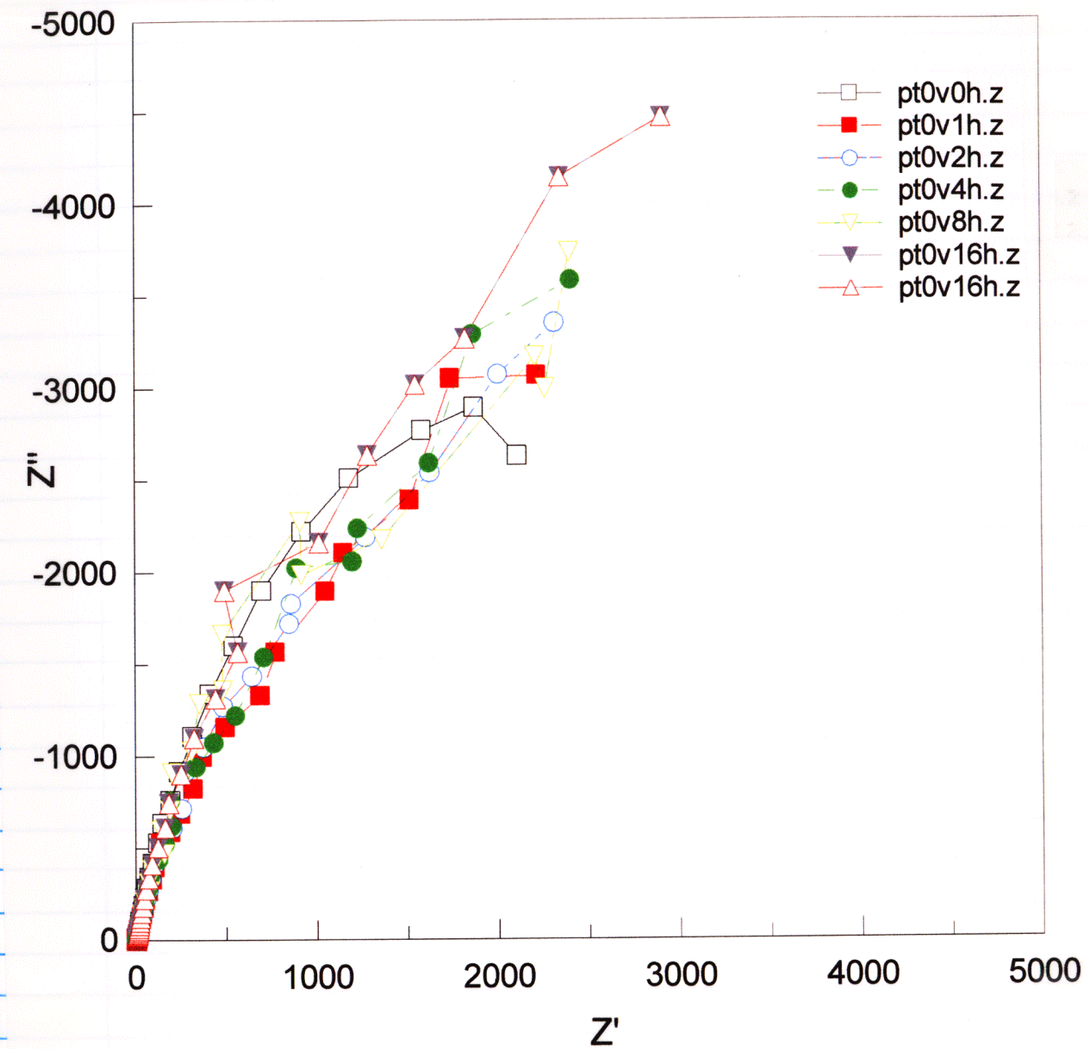
SB 1/4/00



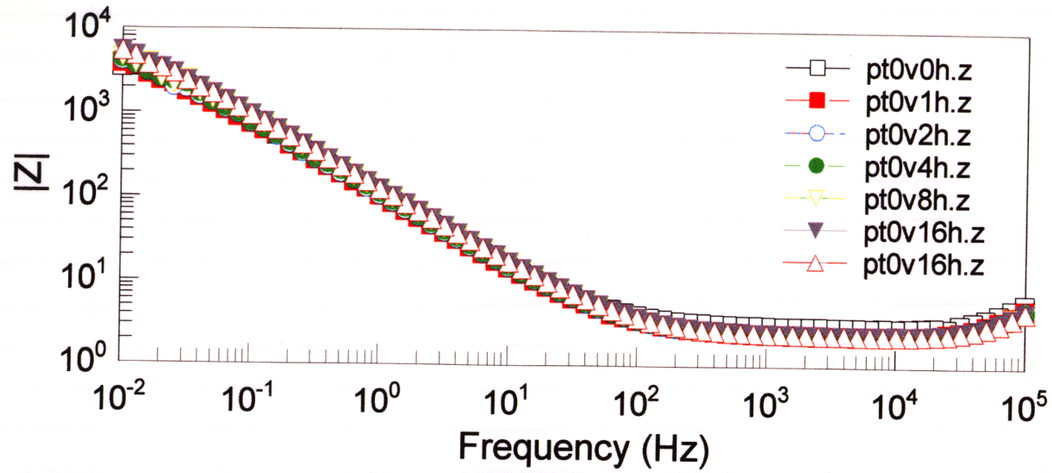


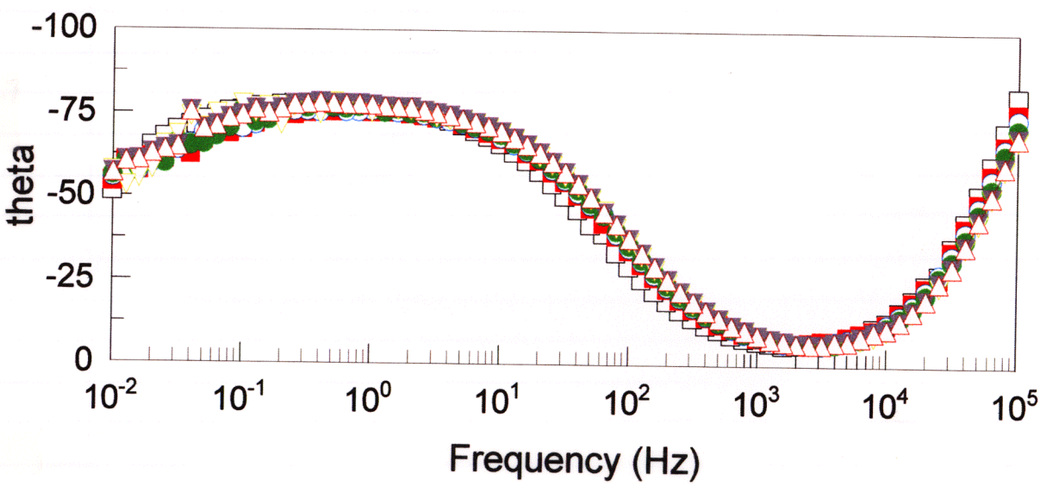
SB e 1/4/00

EIS of Pt in same conditions as p67
6V sce vs time



SB e 1/13/00

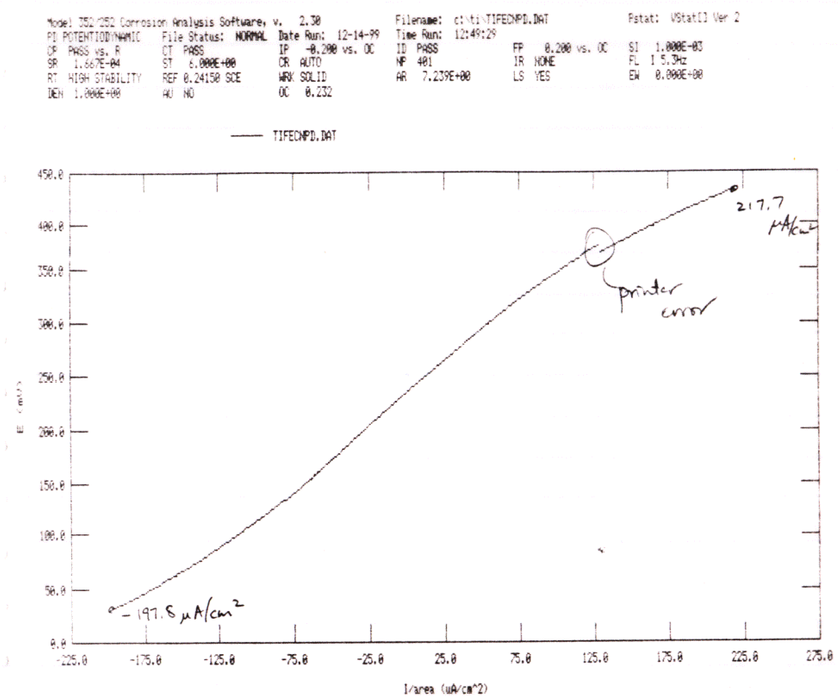




SB 1/13/00

12/14/99

Used 0.1 M Na_2SO_4 + 0.1 M $K_3Fe(CN)_6$ + 0.1 M $K_4Fe(CN)_6$ to study electronic conduction through Ti-Pd oxide
$-E = -200 \rightarrow 200$ mV vs ocp



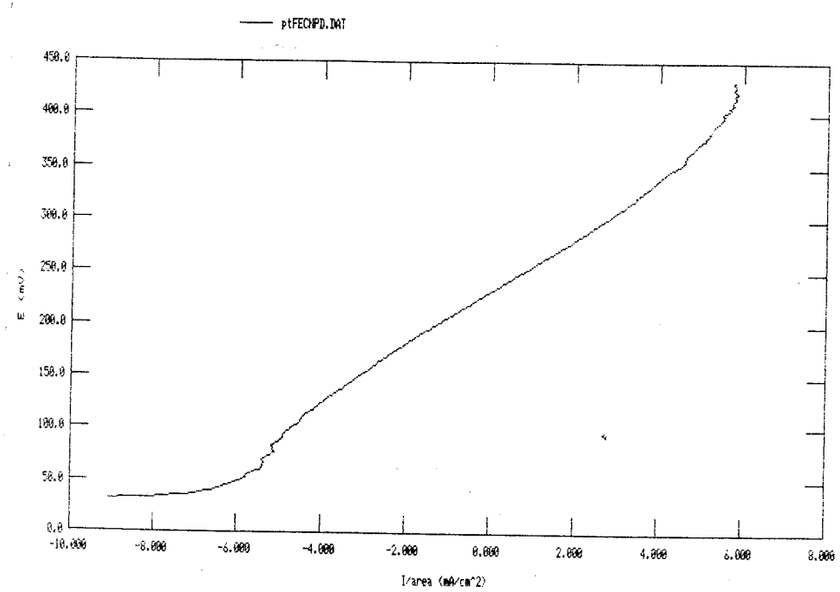
SB 12/14/99

same conditons as p 75 but w/ Pt flag electrode

Model 352/252 Corrosion Analysis Software, v. 2.30
PD POTENTIODYNAMIC File Status: NORMAL Date Run: 12-14-99
CP PASS vs. R CT PASS IP -0.200 vs. OC
SR 1.000E-03 ST 1.000E+00 CR AUTO
RT HIGH STABILITY REF 0.24158 SCE WRK SOLID
DEN 1.000E+00 AU NO OC 0.231

Filename: c:\ti\ptFECNPD.DAT
Time Run: 13:43:13
ID PASS FP 0.200 vs. OC
NP 401 IR NONE
AR 1.060E+01 LS YES

Pstat: VStat[] Ver 2
SI 1.000E-03
FL I 5.3Hz
EN 0.000E+00



12/14/99

Ti - F

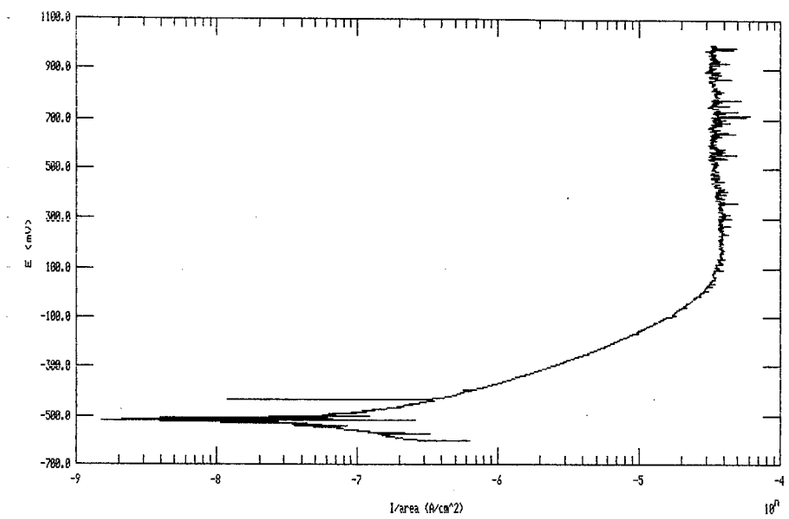
Lot 993517 Lot 896405

Ti Gr 7 95°C, 0.1 M Cl, 0.1 M F

Model 352/252 Corrosion Analysis Software, v. 2.30
PD POTENTIODYNAMIC File Status: NORMAL Date Run: 02-29-00
CP PASS vs. R CT PASS IP -0.100 vs. OC
SR 1.670E-04 ST 5.988E+00 CR AUTO
RT HIGH STABILITY REF 0.00000 User WRK SOLID
DEN 0.000E+00 AU NO OC -0.585

Filename: \ti\TIPDF007.DAT
Time Run: 09:42:53
ID PASS FP 1.000 vs. R
NP 1686 IR NONE
AR 3.300E+00 LS NO

Pstat: VStat[] Ver 2
SI 1.000E-03
FL NONE
EN 0.000E+00



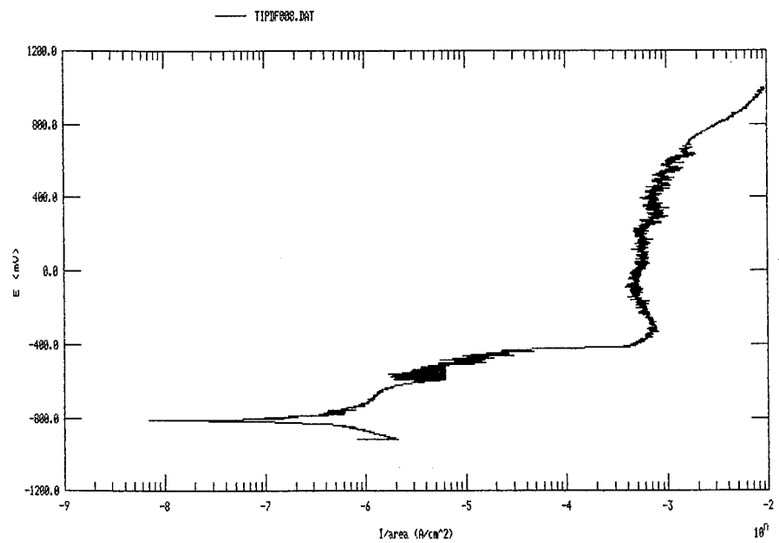
2/29/00

Fluoride: Ti Gr 7 95 C 0.1MCl 1MF
same lots as p77

Model 352/252 Corrosion Analysis Software, v. 2.30
PD POTENTIODYNAMIC File Status: NORMAL Date Run: 03-01-00
CP PASS vs. R CT PASS IP -0.100 vs. OC
SR 1.670E-04 ST 5.988E+00 CR AUTO
RT HIGH STABILITY REF 0.00000 User WRK SOLID
DEN 0.000E+00 AU NO OC -0.813

Filename: \ti\TIPDF008.DAT
Time Run: 18:01:00
ID PASS FP 1.000 vs. R
NP 1914 IR NONE
AR 3.300E+00 LS NO

Pstat: VStat[] Ver 2
SI 1.000E-03
FL NONE
EW 0.000E+00



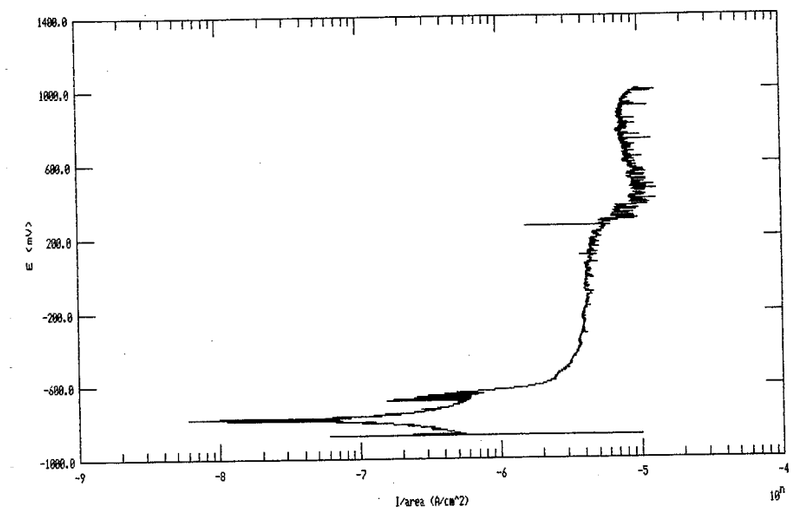
3/1/00

Ti 7, 0.1M Cl, 0.01M F 95°C
same as p77
Fluoride

Model 352/252 Corrosion Analysis Software, v. 2.30
PD POTENTIODYNAMIC File Status: NORMAL Date Run: 03-02-00
CP PASS vs. R CT PASS IP -0.100 vs. OC
SR 1.670E-04 ST 5.988E+00 CR AUTO
RT HIGH STABILITY REF 0.00000 User WRK SOLID
DEN 0.000E+00 AU NO OC -0.773

Filename: \ti\TIPDF009.DAT
Time Run: 13:05:14
ID PASS FP 1.000 vs. R
NP 1874 IR NONE
AR 3.300E+00 LS NO

Pstat: VStat[] Ver 2
SI 1.000E-03
FL NONE
EW 0.000E+00

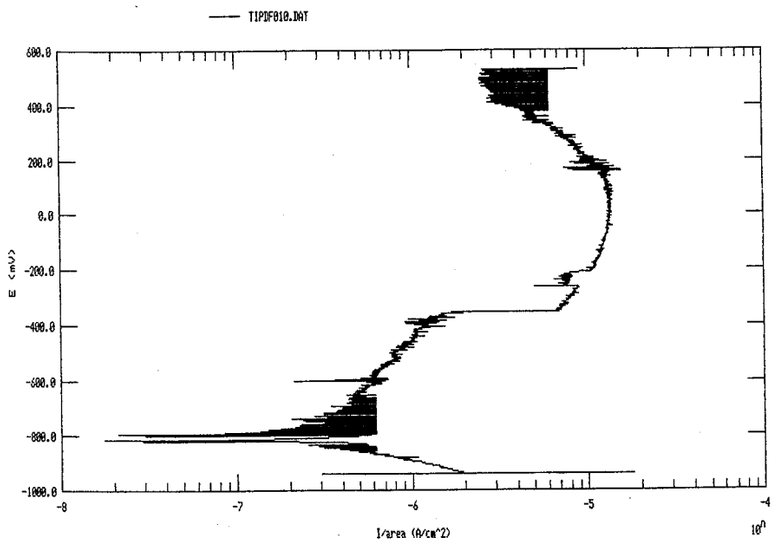


3/2/00

95°C, Ti 7, 0.1 M Cl, 0.05 M F
same as 77

F^-

Model 352/252 Corrosion Analysis Software, v. 2.30
PD POTENTIODYNAMIC File Status: NORMAL Date Run: 03-03-00
CP PASS vs. R CT PASS IP -0.100 vs. OC
SR 1.670E-04 ST 5.988E+00 CR AUTO
RT HIGH STABILITY REF 0.00000 User WRK SOLID
DEN 0.000E+00 AU NO OC -0.840
Filename: \ti\TIPDF010.DAT
Time Run: 09:53:01
ID PASS FP 1.000 vs. R
NP 1473 IR NONE
AR 3.300E+00 LS NO
Pstat: VStat[] Ver 2
SI 1.000E-03
FL NONE
EW 0.000E+00

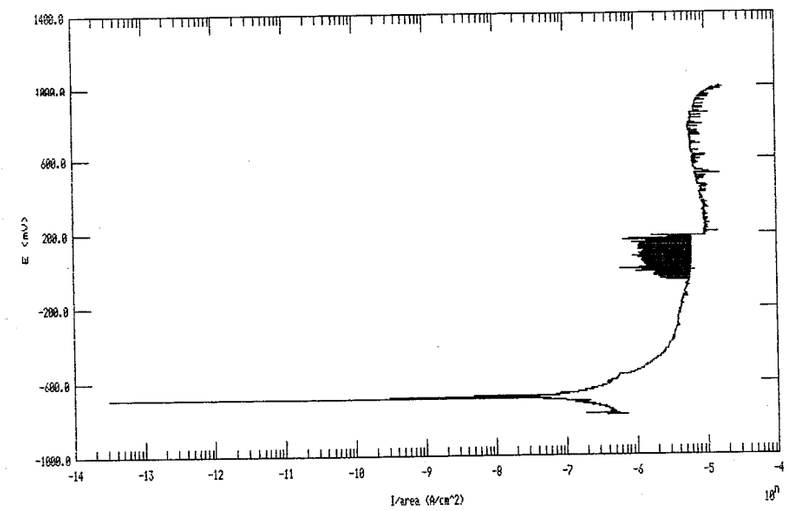


3/3/00

Ti 7, 95C, 1 M Cl, 0.005 F
same as 77

F^-

Model 352/252 Corrosion Analysis Software, v. 2.30
PD POTENTIODYNAMIC File Status: NORMAL Date Run: 03-04-00
CP PASS vs. R CT PASS IP -0.100 vs. OC
SR 1.570E-04 ST 5.988E+00 CR AUTO
RT HIGH STABILITY REF 0.00000 User WRK SOLID
DEN 0.000E+00 AU NO OC -0.678
Filename: c:\ti\tipdf011.dat
Time Run: 12:04:26
ID PASS FP 1.000 vs. R
NP 1779 IR NONE
AR 3.300E+00 LS NO
Pstat: VStat[] Ver 2
SI 1.000E-03
FL NONE
EW 0.000E+00



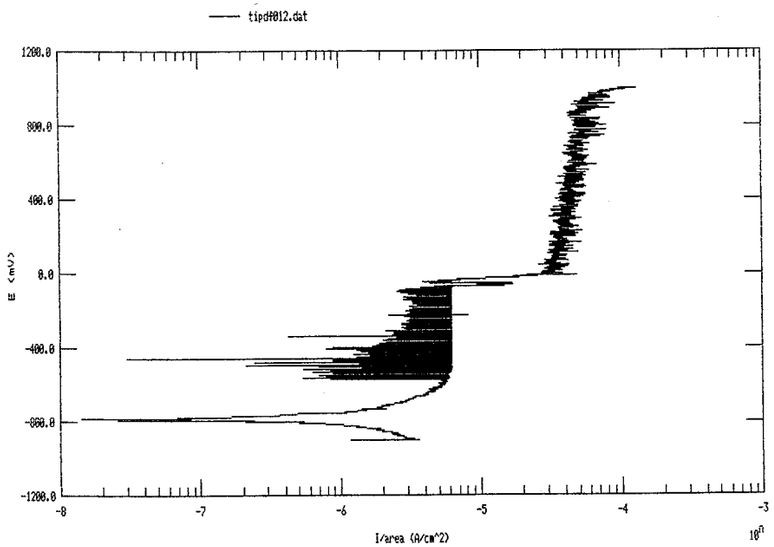
1/0.005

3/3/00

Ti7, 95 C, 1 M Cl, 0.1 M F
same as 77

F⁻

Model 352/252 Corrosion Analysis Software, v. 2.30
PD POTENTIODYNAMIC File Status: NORMAL Date Run: 03-05-00 Filename: c:\ti\tipdf012.dat Pstat: VStat[] Ver 2
CP PASS vs. R CT PASS IP -0.100 vs. OC Time Run: 10:55:46 FP 1.000 vs. R SI 1.000E-03
SR 1.676E-04 ST 5.988E+00 CR AUTO ID PASS HP 1000 IR NONE FL NONE
RT HIGH STABILITY REF 0.00000 User WRK SOLID AR 3.300E+00 LS NO EW 0.000E+00
DEN 0.000E+00 AU NO OC -0.001

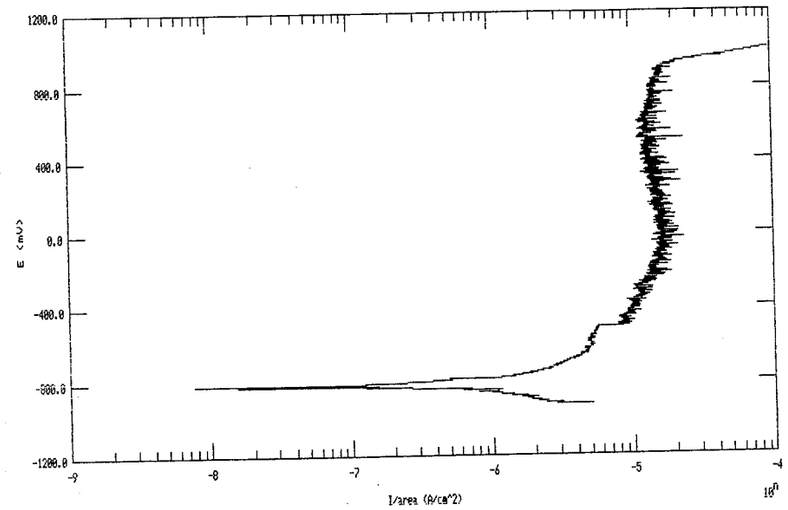


3/6/00

Repeat of pg 82 - pstat error

F⁻

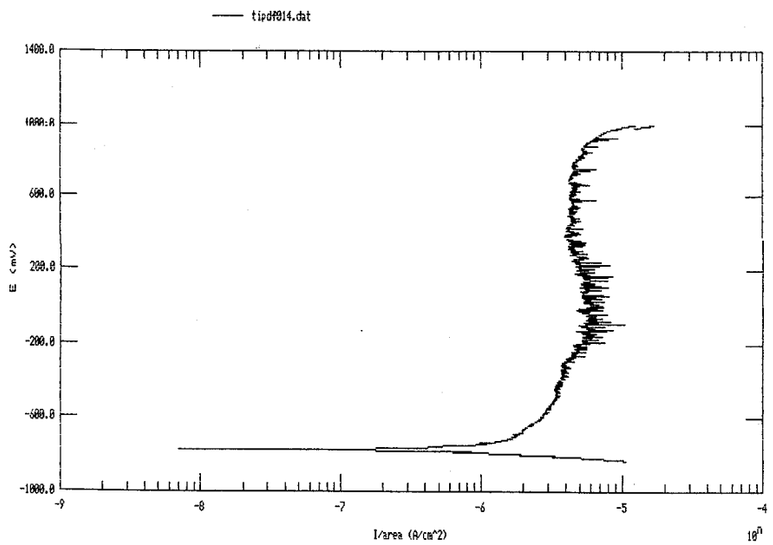
Model 352/252 Corrosion Analysis Software, v. 2.30
PD POTENTIODYNAMIC File Status: NORMAL Date Run: 03-06-00 Filename: c:\ti\tipdf013.dat Pstat: VStat[] Ver 2
CP PASS vs. R CT PASS IP -0.100 vs. OC Time Run: 10:16:27
SR 1.676E-04 ST 5.988E+00 CR AUTO ID PASS FP 1.000 vs. R SI 1.000E-03
RT HIGH STABILITY REF 0.00000 User WRK SOLID HP 1921 IR NONE FL NONE
DEN 0.000E+00 AU NO OC -0.020 AR 3.300E+00 LS NO EW 0.000E+00



3/6/00

F- TiGr7 95C, 1M Cl, 0.01F
Same as 77

Model 352/252 Corrosion Analysis Software, v. 2.30 Filename: c:\ti\tipdf014.dat Pstat: VStat[] Ver 2
PD POTENTIODYNAMIC File Status: NORMAL Date Run: 03-07-00 Time Run: 14:23:04
CP PASS vs. R CT PASS IP -0.100 vs. OC ID PASS FP 1.000 vs. R SI 1.000E-03
SR 1.670E-04 ST 5.988E+00 CR AUTO NP 1832 IR NONE FL NONE
RT HIGH STABILITY REF 0.00000 User WRK SOLID AR 3.300E+00 LS NO EW 0.000E+00
DEN 0.000E+00 AU NO OC -0.731

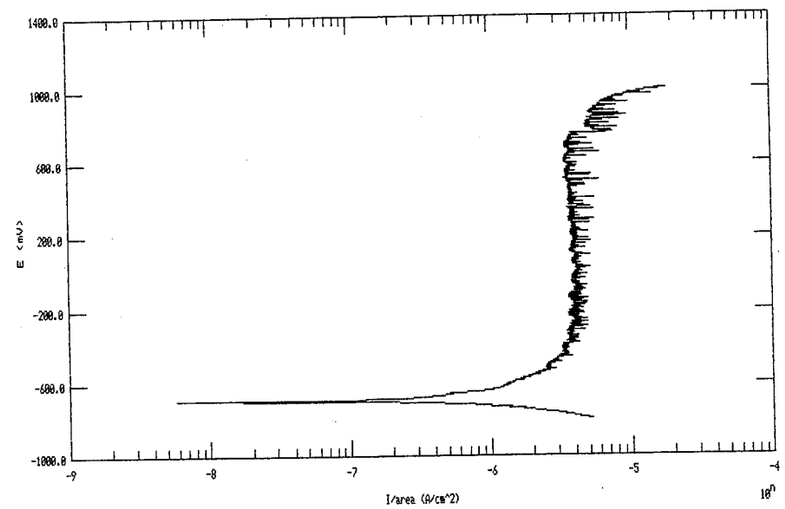


3/7/80

repeat of p 84

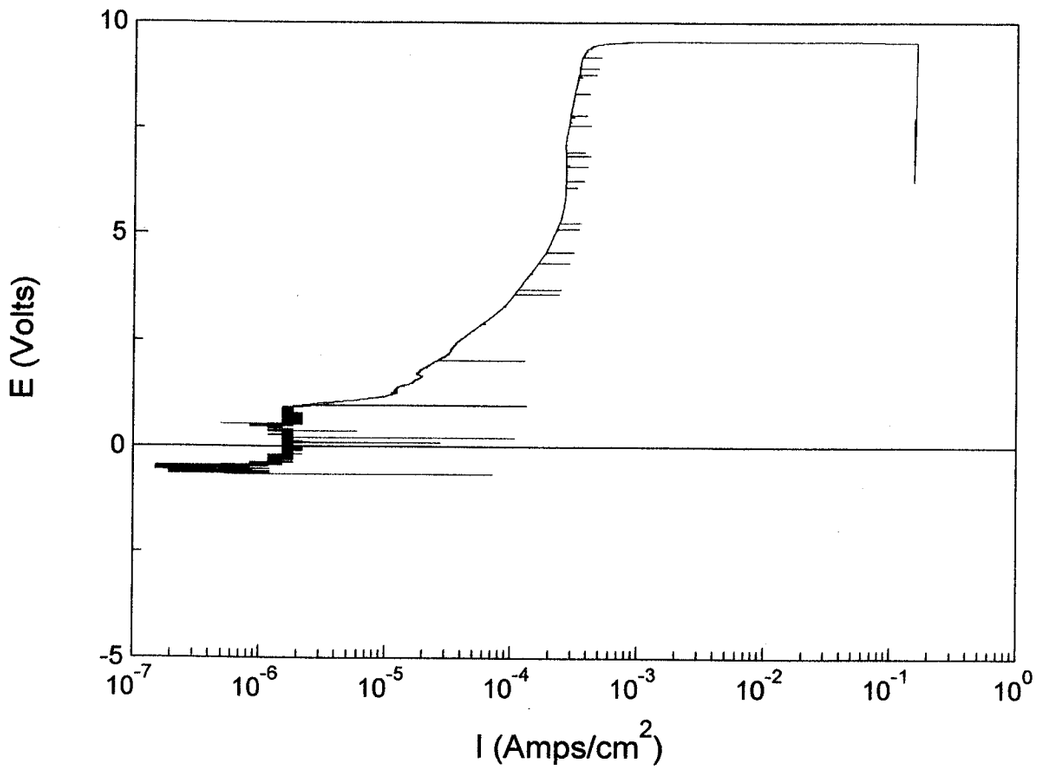
F-

Model 352/252 Corrosion Analysis Software, v. 2.30 Filename: c:\ti\tipdf015.dat Pstat: VStat[] Ver 2
PD POTENTIODYNAMIC File Status: NORMAL Date Run: 03-08-00 Time Run: 10:32:32
CP PASS vs. R CT PASS IP -0.100 vs. OC ID PASS FP 1.000 vs. R SI 1.000E-03
SR 1.670E-04 ST 5.988E+00 CR AUTO NP 1796 IR NONE FL NONE
RT HIGH STABILITY REF 0.00000 User WRK SOLID AR 3.300E+00 LS NO EW 0.000E+00
DEN 0.000E+00 AU NO OC -0.695



3/8/80

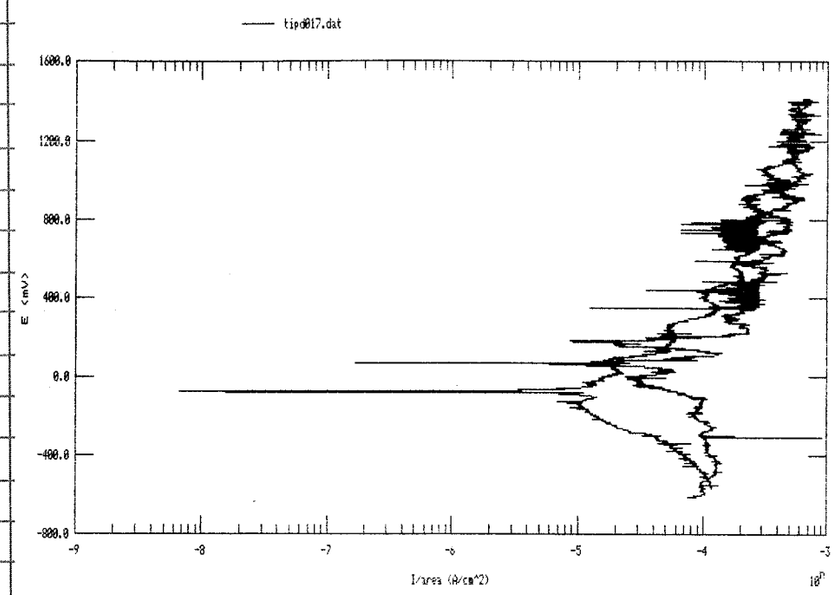
TIPD012.DAT
T=95°C
Stock Solution
10M → LiCl → 424g / lt Fisher 972239
pH= 6.550
Specimen is crevice welded Ti grade 7 polished to 600 grit + ultrasonicall, cleaned in methanol
Init wt= 20.72470g
Final wt= 17.3898g 4-7-00
Final pH= 3.736 4-7-00
Observations
Test went to approx 10v and current went very high. Specimen suffered extreme attack.



4-6-00

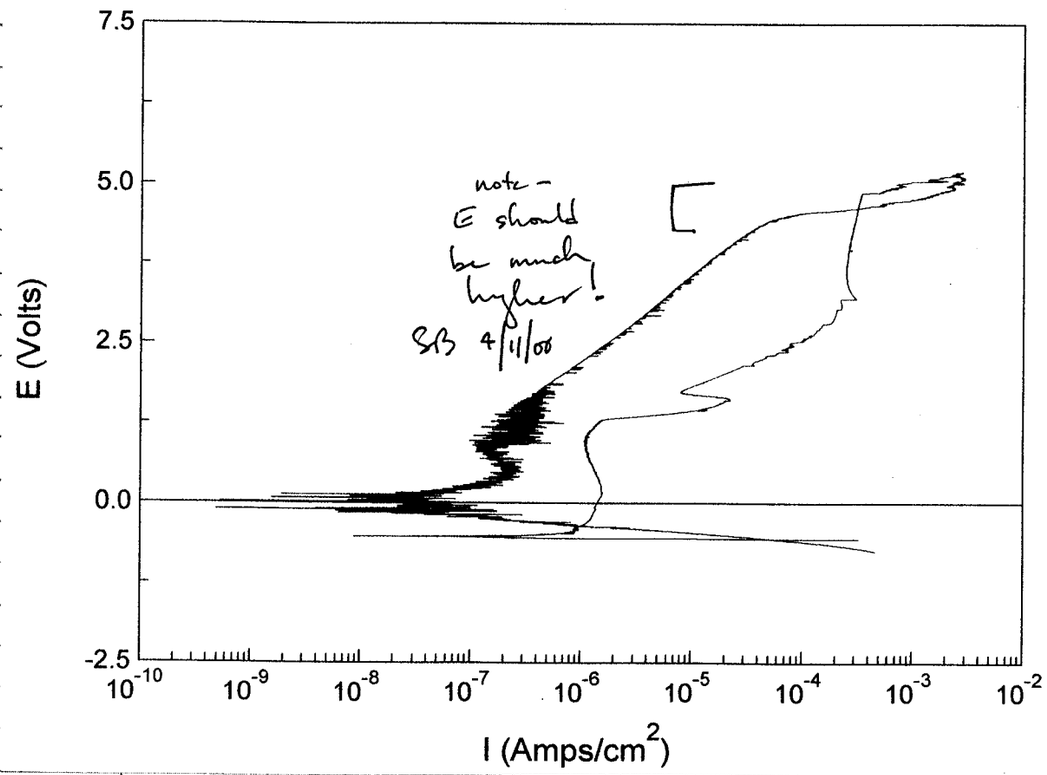
TiPD017.DAT
T= 95°C
Stock Solution
10M → LiCl → 424g/Lt Fisher 972239
pH= 6.550
Specimen is Ti CPP polished to 600grit + ultrasonicall, cleaned in methanol
Init wt= 6.38137g
Final wt= 6.38323g 4-7-00
Final pH= 6.390 4-7-00
Observations
No visible pitting, slight discoloration
4-7-00

Model 352/252 Corrosion Analysis Software, v. 2.30 Filename: c:\ti\tipd017.dat Pstat: VStat[] Ver 2
CP CYCLIC POLARIZATION File Status: NORMAL Date Run: 03-13-00 Time Run: 09:53:02
CP PASS vs. R CT PASS IP -0.050 vs. OC ID PASS VI 0.000 vs. R FP 0.000 vs. OC
SI 1.000E-03 SR 1.667E-04 ST 6.000E+00 CR AUTO NP 3999 IR NONE
FL I 5.3Hz RT HIGH STABILITY REF 0.00000 User WPK SOLID AR 7.200E+00 LS YES
IT 3.600E-02 ITA 7.200E+00 EW 0.000E+00 DEN 1.000E+00 AU NO OC -0.562
Comment: ti-gr7 10M LiCl, 95C, cpp



4-6-00

TIPD013.DAT
T=95°C
Stock Solution
.1 M → NaCl → 11.6884g / 2Lt Fisher #
PH= 5.938
Specimen is crevice welded TI g7 polished to 600 grit + ultrasonically cleaned in methanol
Init wt = 20.85336g
Final wt = 20.84997g 4-11-00
Final PH = 6.231 4-11-00
Observations
Pitting noted along weld transition to be small to medium in quantity, also one small spot of attack on one edge 4-11-00



4-7-00

TIPD018.DAT
T=95°C
Stock Solution
.1M → NaCl → 11.6889 g/2Lt Fisher #
PH= 5.942 CPP 4-7-00
Specimen is ~~crevice welded~~ TI g7 polished to 600 grit + ultrasonically cleaned in methanol
Init wt = 6.39986g
Final wt = 6.39999g 4-11-00
Final PH = 6.314 4-11-00
Observations
Discoloration below vapor line, no pitting noticed by eye 4-10-00

4-7-00

TIPD014.DAT Solatron

T=95°C

Stock Solution

.5 M → NaCl → 58.44g/2Lt

PH = 5.938

Specimen is TI7 welded crevice without former polished to 600 grit

Init wt = 20.83803g

Final wt = 20.83340g

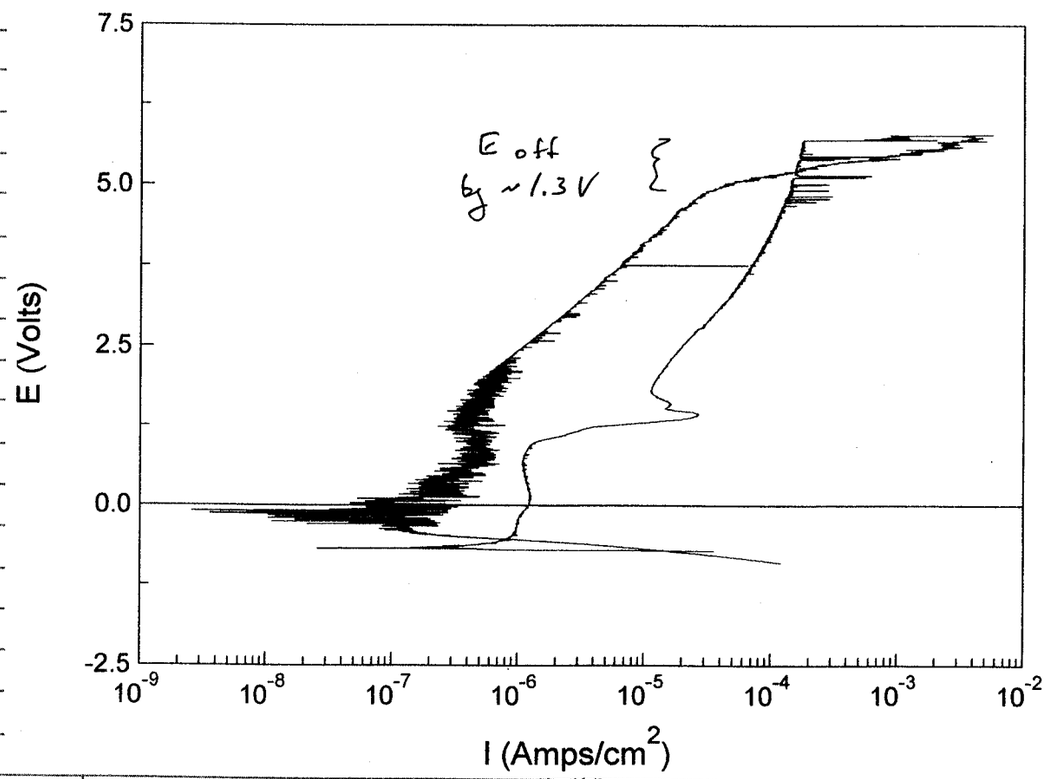
Final PH = 6.930

4-12-00

Observations

Pitting Attack at thru hole in location of weld.

4-12-00



4-11-00

TI PD 019.DAT Versostat

T = 95°C

.5 M → NaCl

PH = 5.942

Specimen is CPP TI7 polished to 600 grit & ultrasonically cleaned in methanol

Init wt = 6.39595g

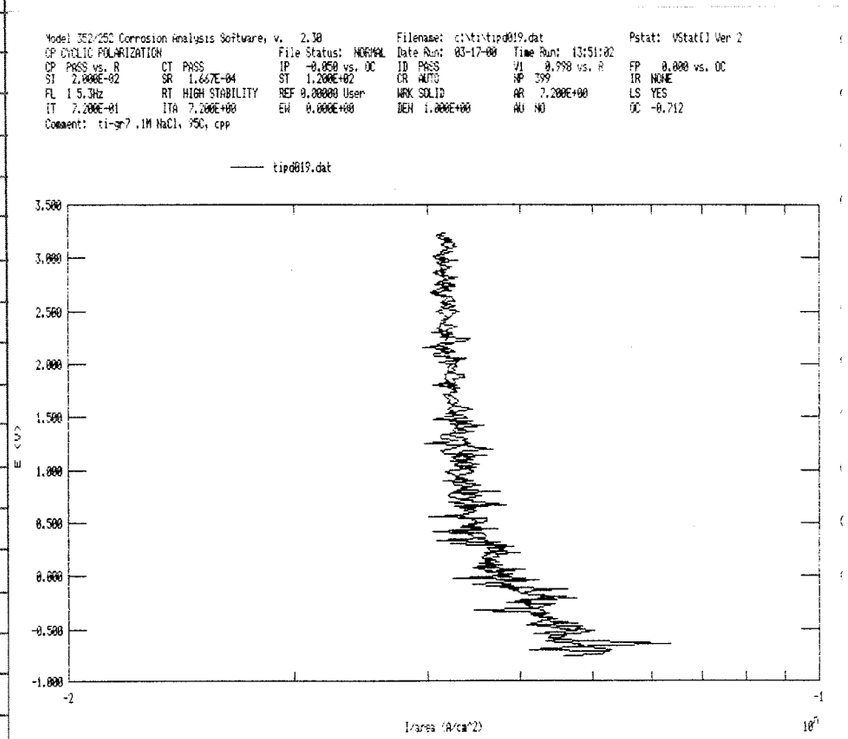
Final wt = 6.39590g 4-12-00

Final PH = 6.240 4-12-00

Observations

Discoloration below vapor line, no pitting to the eye

4-12-00



4-11-00

TIPD021.DAT Versestat

T=95°C

Stock Solution

1M → NaCl → ~~58.44~~ g 116.88g /2Lt

.005M → NaF → .4199 g /2Lt

pH= 7.640

Specimen is TI grade 7 welded polished to 600 grit
ultrasonically cleaned in methanol w/ former

Initwt= 20.84781

Final wt= 20.84703 g

Final pH= 7.690 ↖7.690

4-13-00

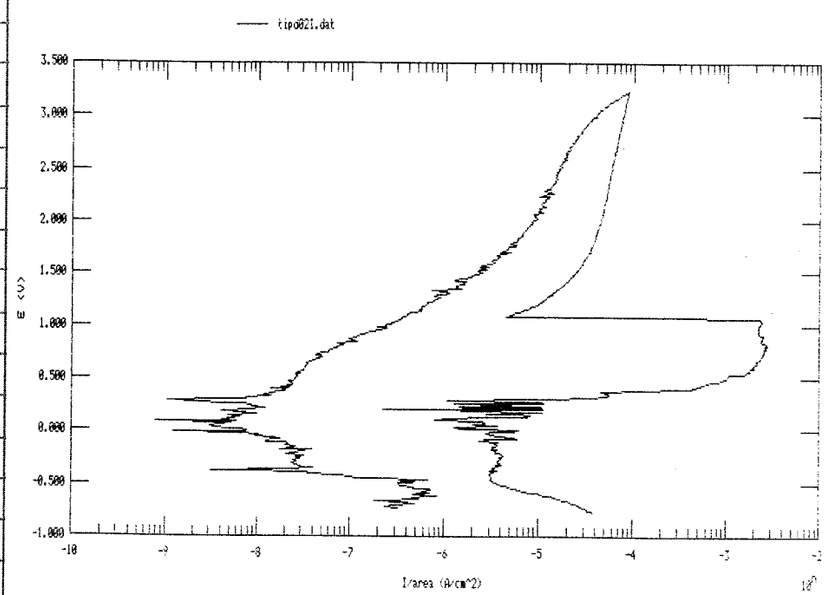
Observations

Overall sample discoloration, heavy staining at crevice test area

Model 352/252 Corrosion Analysis Software, v. 2.30 Filename: c:\ti\tipd021.dat Pstat: YStat[] Ver 2
CP CYCLIC POLARIZATION File Status: NORMAL Date Run: 03-18-00 Time Run: 12:46:51

CP	PASS vs. R	CT	PASS	IP	-0.850 vs. OC	ID	PASS	VI	1.247 vs. R	FP	0.000 vs. OC
SI	1.000E-02	SR	1.667E-04	ST	6.000E+01	CR	AUTO	NP	796	IR	NONE
FL	5.3Hz	RT	HIGH STABILITY	REF	0.00000 User	WRK	SOLID	AR	1.000E+01	LS	YES
IT	9.000E-02	ITA	1.000E+01	EW	0.000E+00	DEN	1.000E+00	AU	NO	OC	-0.723

Comment: ti-gr7 1M NaCl, .005 NaF, 95C, crevice welded w/former



4-12-00

TIPD015.DAT Solution

T=95°C

Stock Solution

1M → NaCl → 116.88 g/2Lt

pH= 6.130

Specimen is welded TI g7 polished to 600 grit
ultrasonically cleaned in methanol

Initwt= 20.73609

Final wt= 20.69958

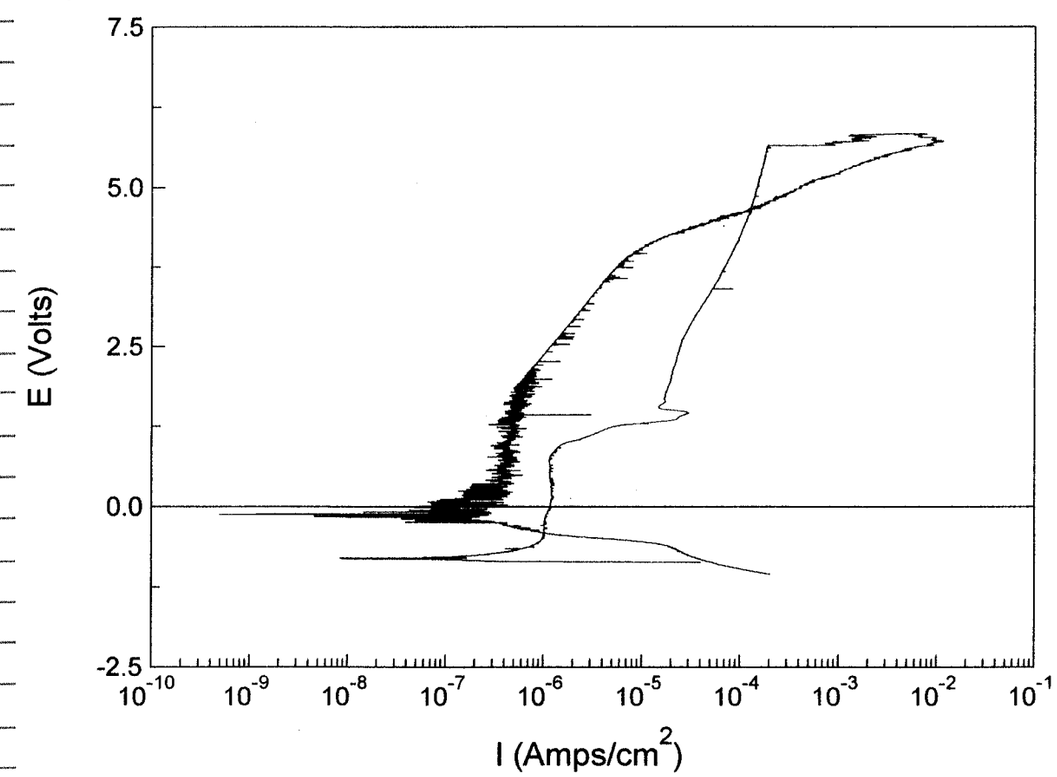
Final pH= 7.120

4-13-00

Observations

Sample discoloration pitting attack at holder SB 8/16/2000
around weld location, attack at one ~~edge~~ edge
around weld location

4-13-00



4-12-00

TIPD022.DAT Versastat

T=95°C

Stock Solution

1M → NaCl → 116.88g/2Lt

.01 → NaF → .8398g/2Lt

pH= 7.136

Specimen is Ti g7 welded polished to 600 grit & ultrasonically cleaned in methanol w/former

Init wt= 20.82357g

Final wt= 20.82358g

Final pH= 8.039

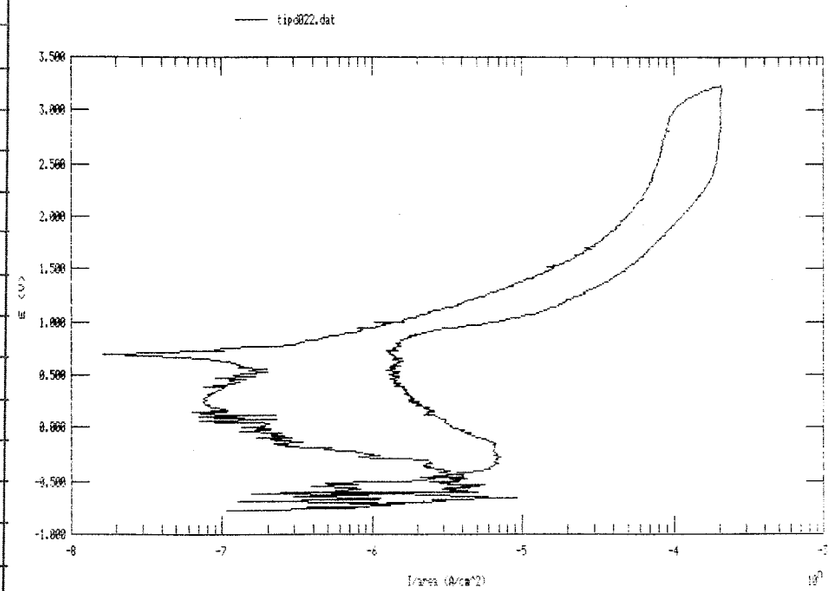
4-14-00

Observations

Staining at and around crevice but otherwise No signs of pitting.

4-14-00

Model 352/252 Corrosion Analysis Software, v. 2.30 Filename: c:\ti\tipd022.dat Pstat: VStat[] Ver 2
CP CYCLIC POLARIZATION File Status: NORMAL Date Run: 03-19-00 Time Run: 11:05:53
CP PASS.05-R SR PASS ID -0.050 vs. OC CR SCSS VA .253 vs. R EP 0.000 vs. OC
ST 1.000E-02 ST 2.667E-04 ST 5.000E+01 OR NOTD AP 75% IR NONE
FL I 5.3Hz RT HIGH STABILITY REF 0.00000 User WRK SOLID WR 1.000E+01 LS YES
IT 9.000E-02 ITA 1.500E+01 EW 0.000E+00 DEN 1.000E+00 AU NO OC -0.717
Comment: ti-gr7 1M NaCl, .01 NaF, 95C, crevice welded w/former



4-13-00

TIPD016.DAT Sdertron

T=95°C

Stock Solution SB 8/16/2000

5M → ~~NaCl~~ LiCl → 423.900g/2Lt 972239

pH= ~~7.31~~ 7.43 SB 8/16/2000

Specimen is Ti g7 welded polished to 600 grit & ultrasonically cleaned in methanol

Init wt= 20.85007g

Final wt= 20.78268g

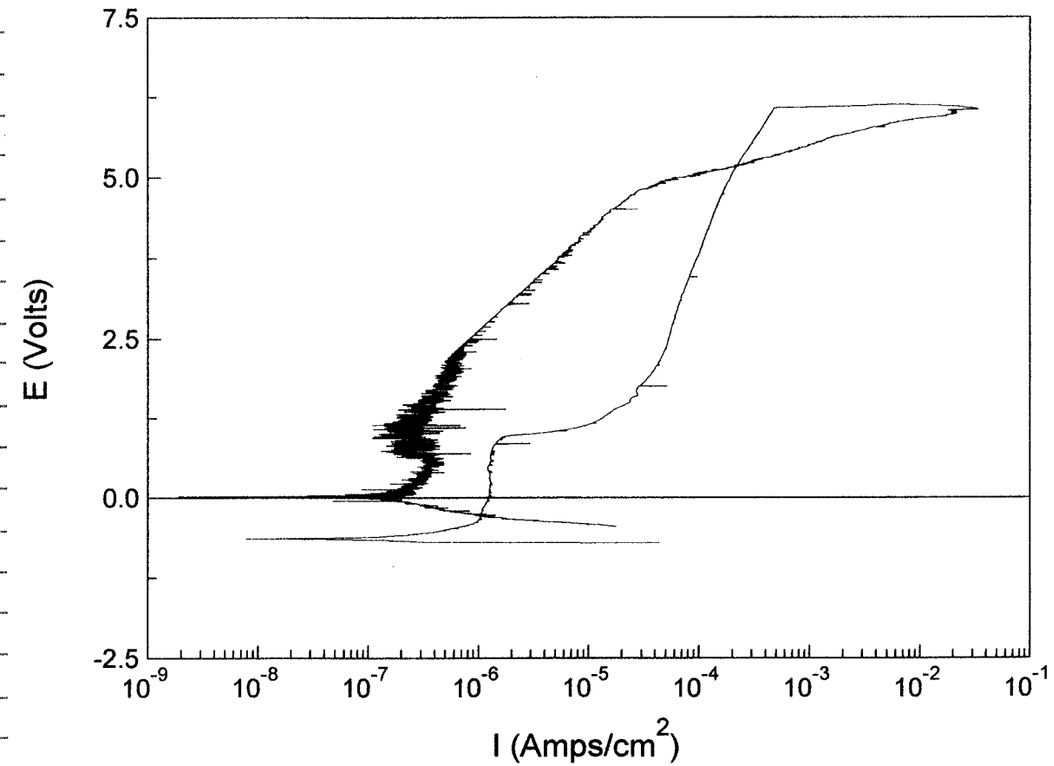
Final pH= 5.953

4-14-00

Observations

Specimen is discolored overall, pitting & general attack noted to be more aggressive than previous test @ 1M. From thru hole across weld line to side edge.

4-14-00



4-13-00

TIPD023.DAT Vessestat

T=95°C

Stock Solution

1M NaCl → 116.88g /2Lt Fisher# 975121

.05M NaF → 4.199g /2Lt Fisher# 896405

pH= 7.449

Specimen Ti gr7 welded crevice polished to 600 grit + ultrasonically cleaned in methanol w/former

Init wt = 20.77757g

Final wt: 20.76476g

Final pH 8.450

4-18-00

Observations

Specimen is heavily stained or discolored. Some possible pitting at edges of crevice foot area.

4-18-00

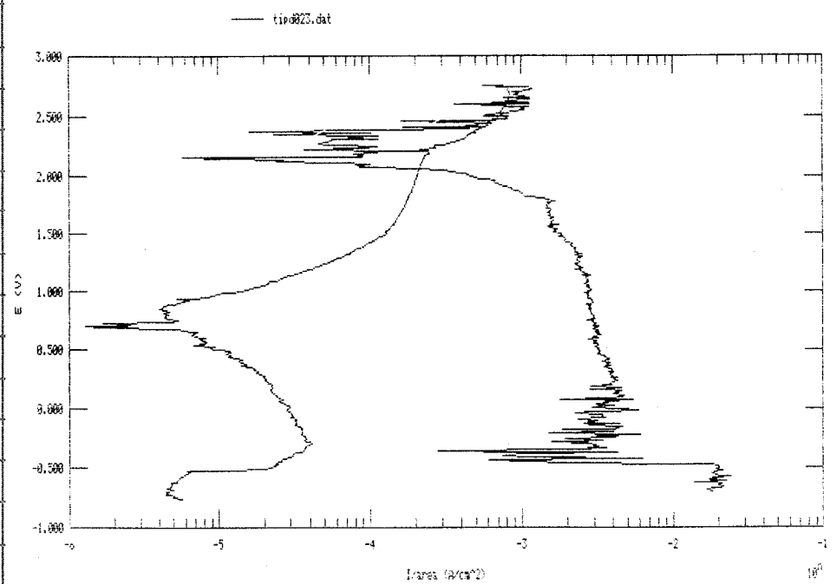
Model 352/252 Corrosion Analysis Software, v. 2.30 Filename: c:\ti\tipd023.dat Pstat: VStat11 Ver 2

CP CYCLIC POLARIZATION File Status: NORMAL Date Run: 03-21-00 Time Run: 08:50:16

CP	PASS vs. R	CT	PASS	IP	-0.050 vs. OC	ID	PASS	V1	1.254 vs. R
SI	1.000E-02	SR	1.667E-04	ST	6.000E+01	CR	AUTO	NP	595
FL	5.3Hz	RT	HIGH STABILITY	REF	0.00000 User	WRK	SOLID	AR	1.300E+01
IT	9.000E-02	ITA	1.000E+01	EN	0.000E+00	DEN	1.000E+00	AU	NO

FP 0.200 vs. OC
IR NONE
LS YES
OC -0.706

Comment: ti-gr7 1M NaCl, .05 NaF, 95C, crevice welded w/former



4-17-00

TIPD020.DAT Solatron

T=95°C

Stock Solution

1M NaCl → 116.88g/2Lt Fisher# 975121

pH= 6.379

Specimen Ti gr7 epp polished to 600 grit + ultrasonically cleaned in methanol

Init wt = 6.40704g

Final wt: 6.38094g

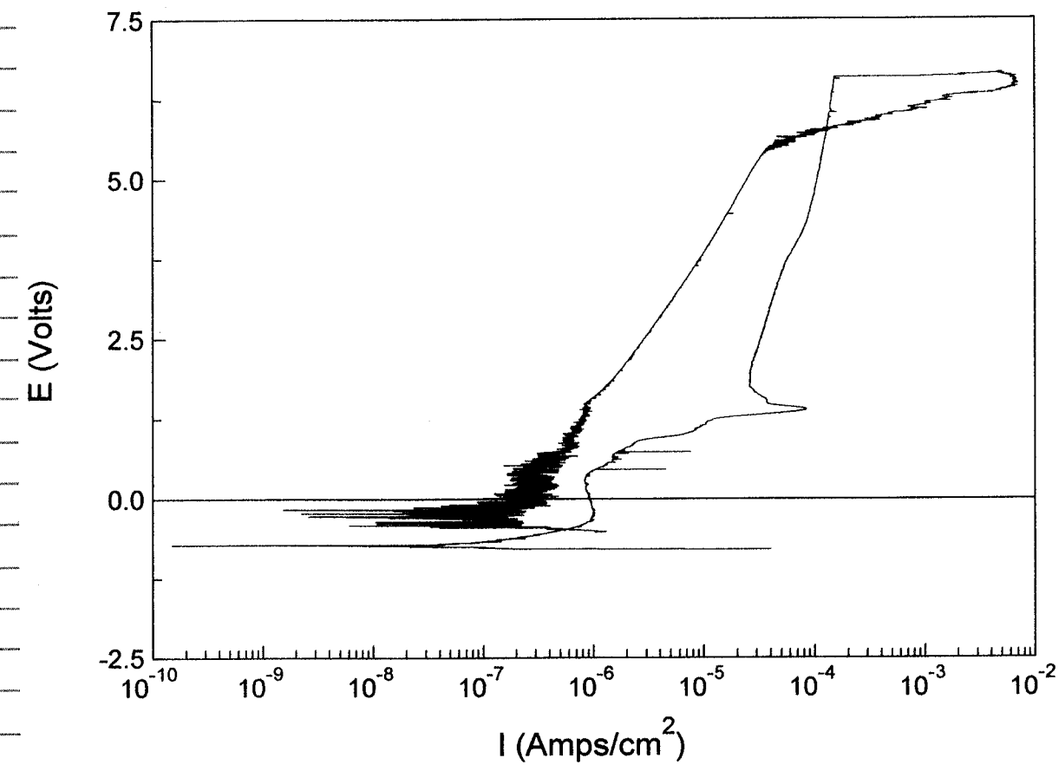
Final pH = 7.610

4-18-00

Observations

Attack noted at the vapor line of specimen only partial of circumference.

4-18-00



4-17-00

TIPD024.DAT Vesastat

T=95°C

Stock Solution

1M → NaCl → 116.88g /2Lt Fisher # 975121

.1M → NaF → 8.398g /2Lt Fisher # 896405

pH: 8.850

Specimen Ti gr7 welded polished to 600grit & ultrasonically cleaned in methanol w/former

Init wt = 20.83673g

Final wt = 20.60990g

Final pH = 7.715

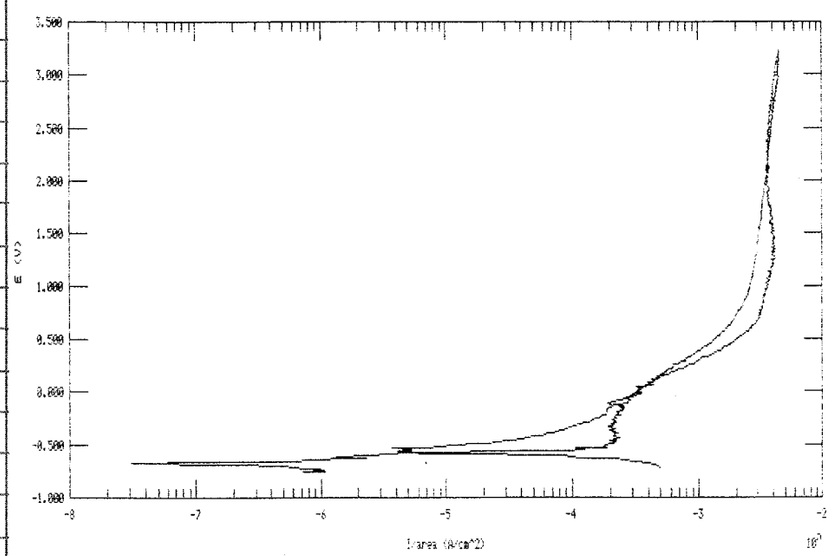
4-19-00

Observations

Heavy attack of specimen, except under crevice foot which appears to have protected from attack.

4-19-00

Model 352/252 Corrosion Analysis Software, v. 2.30 Filename: c:\ti\tipd024.dat Pstat: VStat[] Ver 2
CP CYCLIC POLARIZATION File Status: NORMAL Date Run: 03-22-00 Time Run: 09:32:01
CP PASS vs. R CT PASS IP -0.050 vs. OC ID PASS V1 1.255 vs. R FP 0.000 vs. OC
SI 1.000E-02 SR 1.367E-04 ST 2.000E+01 CR AUTO AP 2% IR NONE
FL 5.3Hz RT HIGH STABILITY REF 0.00000 User WRK SOLID AR 1.500E+01 LS YES
IT 9.000E-02 ITA 1.800E+01 EW 0.000E+00 DEN 1.000E+00 AU NO OC -0.715
Comment: ti-gr7 1M NaCl, .1 NaF, 95C, crevice welded w/former



4-18-00

TIPD027.DAT Soletron

T=95°C

Stock Solution HCl 4-18-00

5M → ~~NaF~~ → LiCl → 423.900g /2Lt Fisher 972239

pH = 7.311

Specimen is CPP Ti gr7 polished to 600grit & ultrasonically cleaned in methanol

Init wt = 6.36504

Final wt = 5.36662g

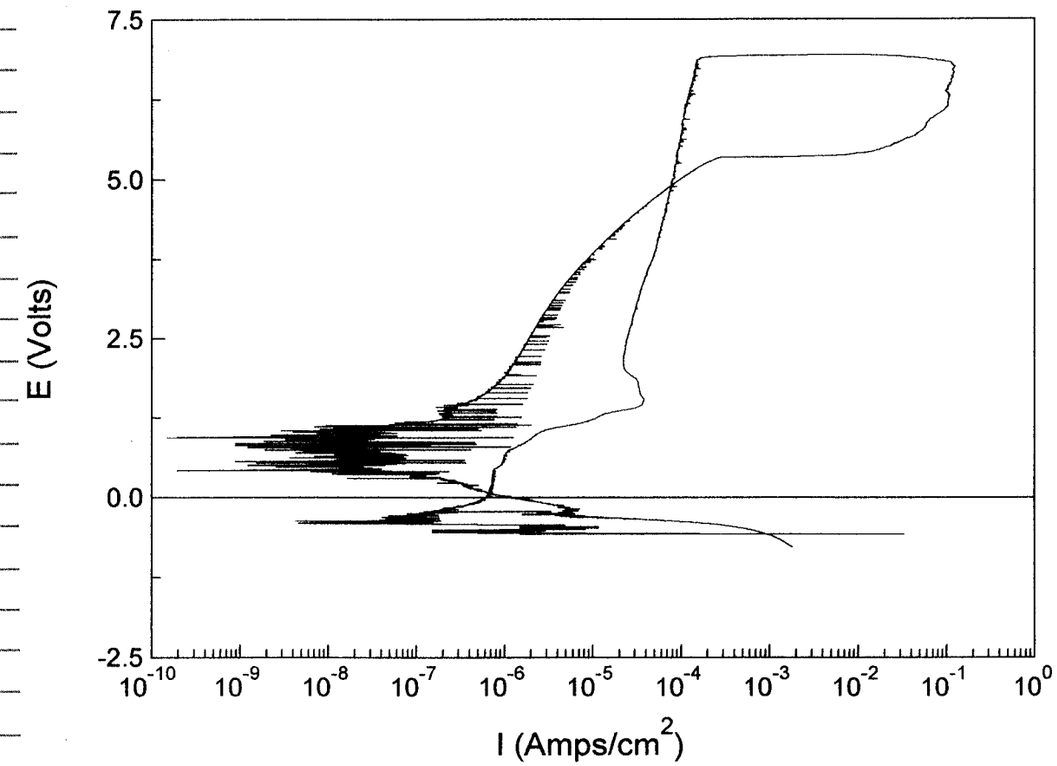
Final pH = 2.732

4-20-00

Observations

Heavy attack below vapor line, surface white & crusty.

4-20-00



4-18-00

TIPD025.DAT Versastat

T=95°C

Stock Solution

1M → NaCl → 116.88g/2Lt Fisher # 975121

.5M → NaF → 41.99g/2Lt Fisher # 991559

pH= 9.816

Specimen Ti gr7 welded polished to 600 grit + ultrasonically cleaned in methanol w/former

Init wt= 20.82172g

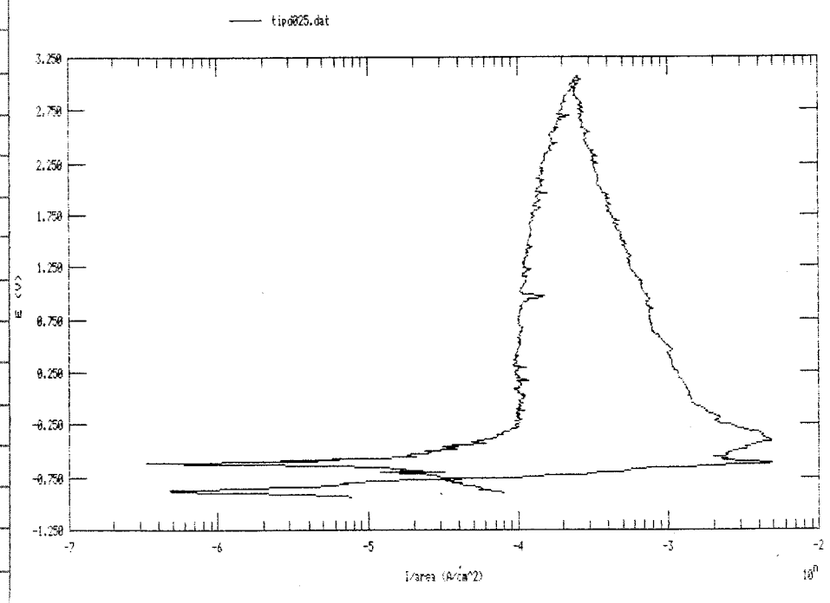
Final wt= 20.81697g } 4-20-00

Final pH= 8.730

Observations

General Attack over all of specimen except under crevice foot + above vapor line. 4-20-00

Model 352/252 Corrosion Analysis Software, v. 2.30 Filename: c:\ti\tipd025.dat Pstat: VStat[] Ver 2
CP CYCLIC POLARIZATION File Status: NORMAL Date Run: 03-23-00 Time Run: 08:45:52
CP PASS vs. R CT PASS IP -0.850 vs. OC ID PASS V1 1.250 vs. R FP 0.000 vs. OC
SI 1.000E-02 SR 1.667E-04 ST 6.000E+01 CR AUTO NP 796 IR NONE
FL 1 5.3Hz RT HIGH STABILITY REF 0.00000 User WRK SOLID AR 1.000E+01 LS YES
IT 9.000E-02 ITA 1.000E+01 EN 0.000E+00 DEN 1.000E+00 AU NO OC -0.890
Comment: ti-gr7 1M NaCl, .5 NaF, 95C, crevice welded w/former



4-19-00

TIPD026.DAT Versastat

T=95°C

Stock Solution

1M → NaCl → 116.88g/2Lt

1M → NaF → 83.98g/2Lt

pH= 8.940

Specimen Ti gr7 welded polished to 600 grit + ultrasonically cleaned in methanol w/former

Init wt= 20.82048g

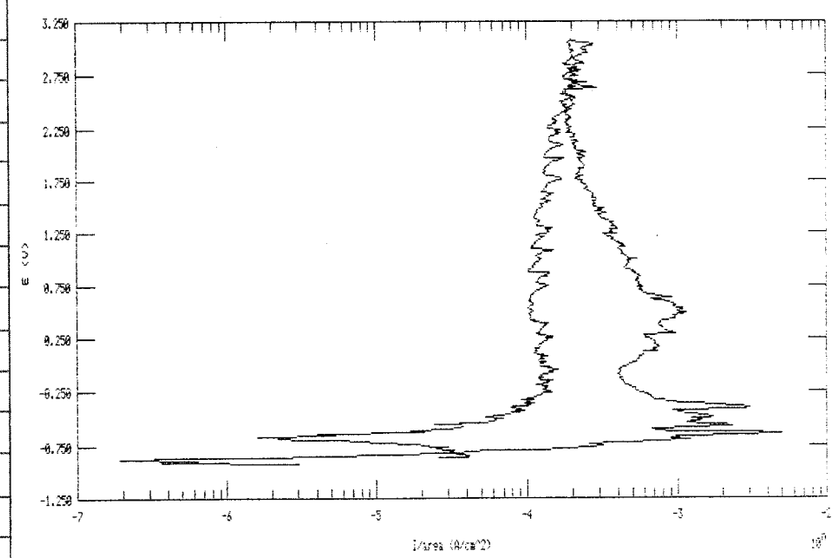
Final wt= 20.82812g } 4-21-00

Final pH= 8.815

Observations

General attack over all specimen less above vapor line + under crevice foot. Some deposits left on specimen not removed by ultrasonic cleaning which caused weight to be greater. 4-21-00

Model 352/252 Corrosion Analysis Software, v. 2.30 Filename: c:\ti\tipd026.dat Pstat: VStat[] Ver 2
CP CYCLIC POLARIZATION File Status: NORMAL Date Run: 03-24-00 Time Run: 09:39:15
CP PASS vs. R CT PASS IP -0.850 vs. OC ID PASS V1 1.248 vs. R FP 0.000 vs. OC
SI 1.000E-02 SR 1.667E-04 ST 6.000E+01 CR AUTO NP 796 IR NONE
FL 1 5.3Hz RT HIGH STABILITY REF 0.00000 User WRK SOLID AR 1.000E+01 LS YES
IT 9.000E-02 ITA 1.000E+01 EN 0.000E+00 DEN 1.000E+00 AU NO OC -0.892
Comment: ti-gr7 1M NaCl, 1 NaF, 95C, crevice welded w/former



4-20-00

TIPD028.DAT OCP 1wk in Airpurge

T=95°C

.1M → NaCl → 11.688 g/2Lt

.1M → NaF → 8.398 g/2Lt

pH=7.478

Specimen is Ti g7 CPP polished to 600 grit & ultrasonically cleaned in methanol.

Init wt=6.39060g

Final wt=6.39095g

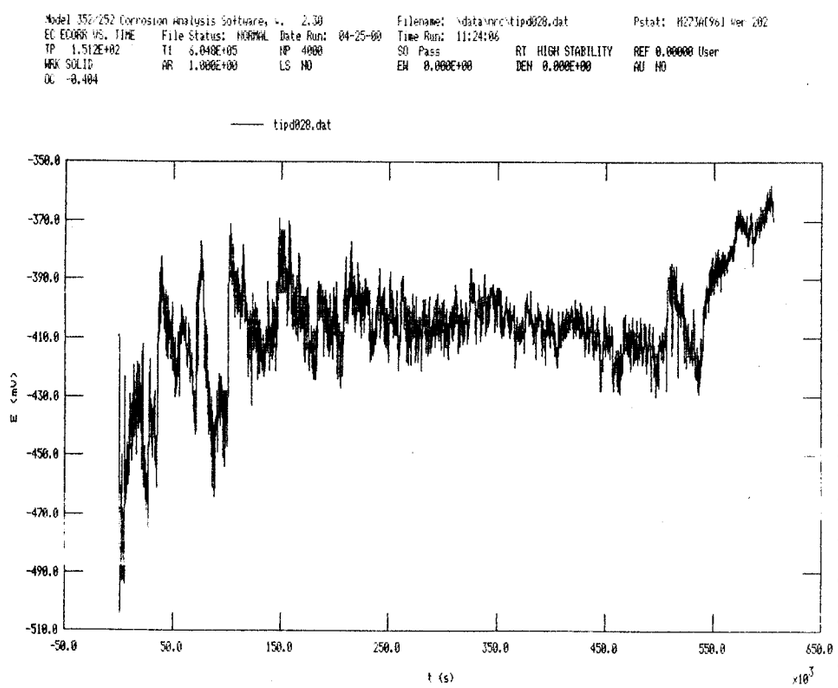
Final pH=8.773

5-2-00

Observations

No pitting observed, discoloration overall, staining and deposits noted at vapor line. Possible slight attack at vapor-liquid transition.

5-2-00



4-25-00

TIPD029.DAT Re Run of TIPD012 on Solution

T=95°C

10 M → LiCl → 827.80g /2Lt

pH=5.401

Specimen is Ti g7 welded polished to 600 grit and ultrasonically cleaned in methanol

Init wt=20.80951g

Final wt=19.55866g

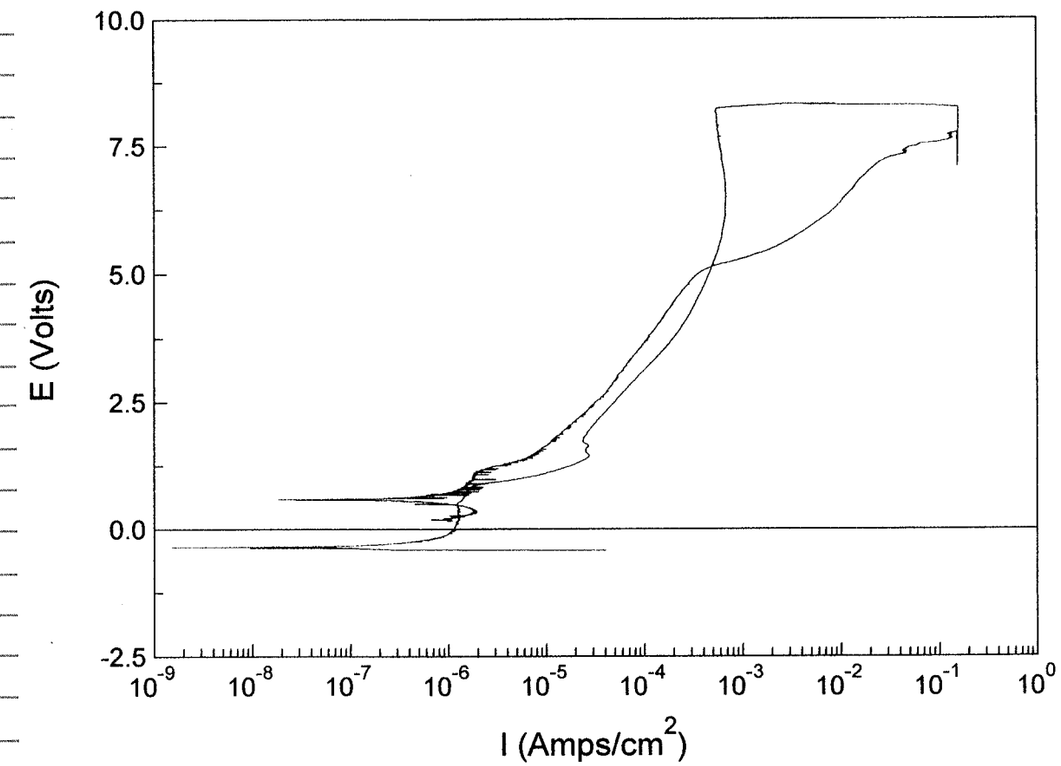
Final pH=1.893

4-27-00

Observations

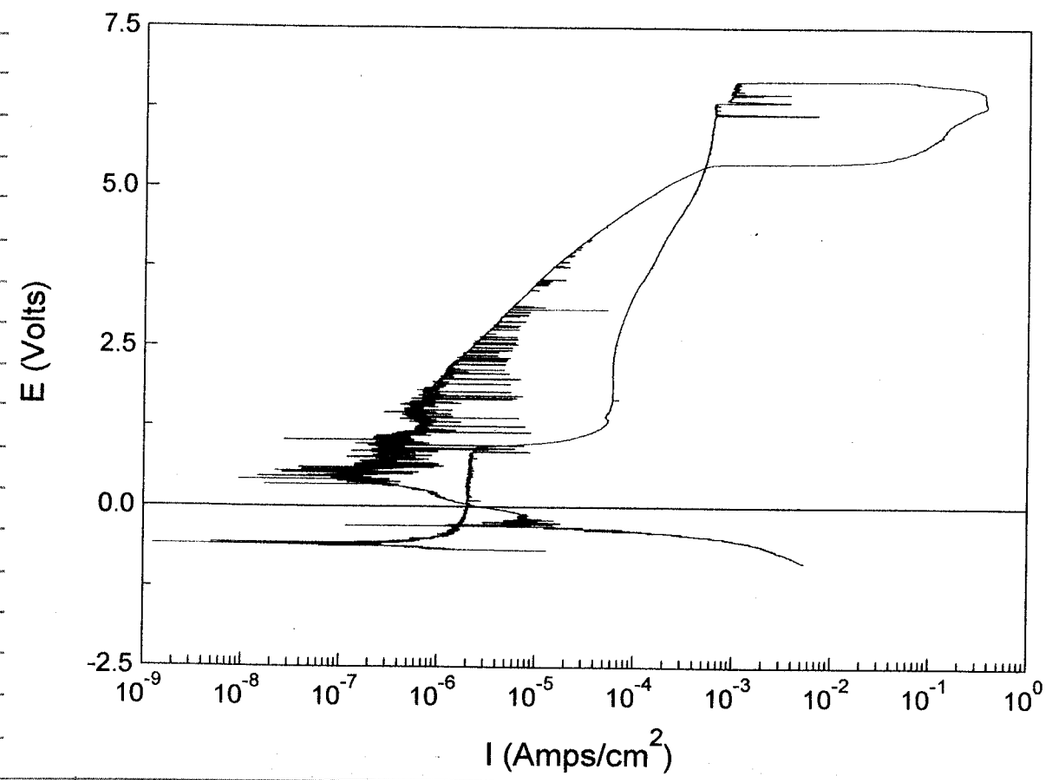
General attack & pitting heaviest at weld area around thru hole, also attack noted at edges and corners.

4-27-00



4-26-00

TIPD030.DAT
T=95°C
5M → LiCl → 423.40 g/2Lt
pH= ~~6.39280~~ 7.014 5-4-00
Specimen is Ti gr CPP polished to 600 grit + ultrasonically cleaned in methanol
Init wt= 6.39294g
Final wt= 5.54220g
Final pH= 2.910 5-5-00
Observations
Heavy Attack below vapor line. Surface white + crusty.
5-5-00



5-4-00

CONAM KAWIN
194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P. O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P. O. # 50138
DESCR 01-25-00 PO# X94367X
REG# 505956
REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 03 JOB NO:

ASTM A265 GR 7 WELD WIRE TI-GR 7 HEAT# BN4591
weld wire

CHEMICAL ANALYSIS

C	.027	Ti	REMAINDER	Fe	.03
H	17.6PPM	N	.0011	O	.046
Pd	.13				

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ASTM E1447 ; ASTM E 1409 ;

QA INSPECTOR

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

PAGE 3 OF 16

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

SB 5/15/00

CONAM KAWIN
194 Internationale Blvd., Glendale Heights, IL 60139
Telephone + 1 630-681-0008
Facsimile + 1 630-871-5520

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P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138

DESCR 01-25-00 PO# X94367X
REG# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 01

JOB NO:

ASTM B265 GR 7 WROUGHT TI-GR 7 HEAT# R5835

base metal

CHEMICAL ANALYSIS

C	.023	Ti	REMAINDER	Fe	.15
H	58PPM	N	.020	O	.20
Pd	.14				

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ASTM E1447 ; ASTM E 1409 ;

QA INSPECTOR

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5/15/00

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SOUTHWEST RESEARCH INST. 7010
6220 CULEBRA RD
P.O. DRAWER 28510
SAN ANTONIO TX 78284
SEAN BROSSIA

P.O. # 50138

DESCR 01-25-00 PO# X94367X
REG# 505956

REPORT DATE: 02/15/2000

LAB NO: 0128-005 / 02

JOB NO:

ASTM B265 GR 7 WELDED TI-GR 7 HEAT# R5835 & BN4591

weldment

CHEMICAL ANALYSIS

C	.026	Ti	REMAINDER	Fe	.08
H	32PPM	N	.0049	O	.10
Pd	.14				

TEST METHODS: ASTM E 663 ; ASTM E 1019 ; ASTM E1447 ; ASTM E 1409 ;

QA INSPECTOR

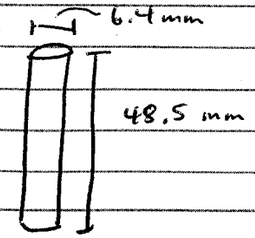
ALL CHEMICAL TEST RESULTS ARE REPORTED IN WEIGHT PERCENT UNLESS OTHERWISE NOTED.

THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL,
WITHOUT THE WRITTEN APPROVAL OF CONAM KAWIN, INC.

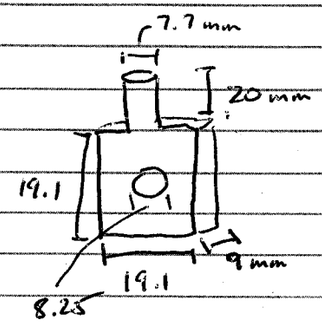
5/15/00

Inspection of New Ti-2 Specimens PO X86114S

CPP specimens -



Crevice specimens:



Metal Samples
Corrosion Monitoring Systems

Metal Samples Corrosion Monitoring Systems
a division of Alabama Specialty Products, Inc.
152 Metal Samples Rd. P.O. Box 8
Munford, AL 36268
Phone: (256) 358-4202 Fax: (256) 358-4515
e-mail: benl@alspi.com Internet: www.alspi.com

Fax Transmission from Benjamin Lackey

Recipient	Sean Brossia
Company	Southwest Research Institute
Fax Number	1-210-522-5184
Subject	MTR's for your order# X86114S
Date	05/15/2000
Number of Pages (including cover)	5

Dear Sean,

Following are copies of the Metal Samples MTR sheet and the original manufacturer MTR's for the materials used on the above mentioned order.

Ti Gr2 – Metal Samples Lot# N843 – CPP Electrodes
Ti Gr2 – Metal Samples Lot# H801 – Crevice Repassivation Specimens
Zr4 – Metal Samples Lot# D830 – CPP Electrodes

Thank you for your order. If you have any questions, or need anything else, please let us know.

Best regards,
Benjamin Lackey

SB 6/1/00

MATERIAL TEST REPORT

DATE : 05/15/00
PAGE : 1
ORDER: 43363

Metal'Samples Company
P.O. Box 8
152 Metal Samples Road
Munford, AL 36268
Ph. (256)358-4202 Fx. (256)358-4515

Customer: 01482 SOUTHWEST RESEARCH INSTITUTE
Your PO#: X86114S

Lot No. N843 Mill: Our Order Line No. 1
Description: TIGR2 .375"RD X 639.75"(50R/L
Chemical Properties:
C:0.011 Fe:0.080 H:0.0015 N:0.006
O:0.150 Ti:BALANCE
Physical Properties:
Tensile-PSI:79,710 Elong-%:26.56
Yield-PSI:63,560 R/A-%:47.39
Condition:ANLD

Lot No. H801 Mill: TICO TITANIUM, INC. Our Order Line No. 2
Description: TIGR.2 .375"X25"X48"
Chemical Properties:
C:0.032 Fe:0.080 H:0.004 N:0.002
O:0.110 Ti:BALANCE
Physical Properties:
Tensile-PSI:66,900 Elong-%:25.6
Yield-PSI:44,600 Condition:ANLD

Lot No. D830 Mill: TELEDYNE WAH Our Order Line No. 3
Description: ZR4 .265 X 4.2 X 93
Chemical Properties:

Al:45 PPM	B:<0.250	C:110 PPM	Co:<10 PPM
Cr:0.110	Cu:<10 PPM	Fe:0.210	H:<5 PPM
Hf:70 PPM	Mg:<10 PPM	Mn:<25 PPM	Mo:<10 PPM
N:<24 PPM	Nb:<0.250	Ni:<35 PPM	Si:73 PPM
Sn:1.500	Ti:<25 PPM	U:<50 PPM	W:<50 PPM
Zr:BAL			

Physical Properties:
Not Available

We certify that the Material Test Report is correct to the best of our knowledge and that the material supplied meets your required P.O. specifications.

THANK YOU, Quality Control Dept. Larry Braden (KD)

SB 6/1/00

05/15/2000 10:41 2563584515 A L S P I PAGE 03

TEST REPORT

TITANIUM INDUSTRIES, INC.

181 E. Halsey Road, Parsippany, NJ 07054 • 973-428-1900 • Fax 973-428-7250
801 Sheard Dr., Wood Dale IL 60191 • 708-860-2606 • Fax 708-860-2877
51 Sunbeam Rd., Suite 12, Jacksonville, FL 32257 • 904-730-2007 • Fax 904-730-0350
18030 S. Carmenita Rd., Cerritos, CA 90703 • 310-802-2888 • Fax 310-404-8072
1 North Hwy. 360, Suite 200, Grand Prairie, TX 75050 • 214-606-1121 • Fax 214-660-2179
427D Hayden Station Rd., Windsor, CT 06095 • 860-683-1820 • Fax 860-683-8861

DATE	OUR ORDER NO.	CUSTOMER ORDER NO.
06/09/98	JAX 1818	395214

CUSTOMER NAME: METAL SAMPLES CO.

CPP Specimens

MATERIAL DESCRIPTION	NO. PCS.	LINEAR FEET/WEIGHT	HEAT NO.
.375" DIA.	4	PCS.	BN5224

SPECIFICATION

ASME SB-348 GRADE 2

CHEMICAL ANALYSIS

N	C	H	Fe	Oz	Al	V	Sn	Pd	Mo	Zr	Ni
0.0080	0.0110	0.0015	0.0800	0.1500							

RESIDUALS EACH	RESIDUALS TOTAL	Ti	Cr	Ta	Cb	Y	O PLUS Fe	Mn	Si	Mg
		BAL.								

MECHANICAL PROPERTIES

TENSILE	L	79.880	L	79.540
STRENGTH KSI	T		T	
YIELD STRENGTH	L	58.480	L	68.640
KSI (0.2%) OFFSET	T		T	
ELONGATION	L	27.080	L	26.040
(INCHES)	T		T	
REDUCTION	L	46.610	L	46.160
IN AREA	T		T	

HARDNESS MAT'L. I.D. NO. N843 P.O. NO. 395214

SPEC. _____ INITIAL MBJ

GRAIN SIZE FIGR2 KT.

BEND TEST		OTHER DATA
STATIC NOTCH STRESS RUPTURE		
ULTRASONIC TEST		ALSO VALID TO:
FLARE TEST		ASTM B348-95 GR-2,
IMPACT TEST		ASTM F67-95 GR-2
FLATTENING TEST		
HYDROSTATIC TEST		ANNEALED
EDDY CURRENT TEST		
PNEUMATIC TEST		
REVERSE FLATTENING TEST		
DYE PENETRANT		
RADIOGRAPHIC (X-RAY) TEST		
MICROSTRUCTURE PERFORMED		
MICROSTRUCTURE COMPLIANCE		
MACROSTRUCTURE PERFORMED		
MACROSTRUCTURE COMPLIANCE		

INSPECT MATERIAL BEFORE PROCESSING

Condition of Sale: Defective material will be replaced or credit will be allowed for the price thereof upon its return, but the seller shall not be liable for any claims for labor or consequential damages.

DATE 06/09/98

THIS IS TO CERTIFY THAT THE ABOVE TEST RESULTS ARE CORRECT AS CONTAINED IN THE RECORDS OF THE COMPANY.

SIGNED Bill Colon
Quality Assurance

QA131 10/05 R.O.

N843

SB 6/1/00

05/15/2000 10:41 2563584515 A L S P I PAGE 04

TICO TITANIUM, INC.

24581 Crestview Court • Farmington Hills, Michigan 48335
(800) 521-4392 • (313) 478-4700 • FAX (313) 478-0223
321 South Buncombe Rd. • Greer, South Carolina 29650
(803) 879-4277 • FAX (803) 879-3961

TO: MESAA
METAL SAMPLES COMPANY, INC.
P.O. BOX 8
MUNFORD, AL 36268

DATE: 1/30/92

CUSTOMER PO: 15632

CERTIFICATION OF TESTS

S.O. No: 023538

HEAT NO. 11044
SPECIFICATION: ASTM B-265-79 GRADE 2

DESCRIPTION: PLATE 3/8" X 25" X 48" - 1PC 72#

154.32 (2)

CREVICE SPECIMENS

CHEMISTRY

IRON	.08		
OXYGEN	.11		
NITROGEN	.002		
CARBON	.032		
HYDROGEN	.0019	FINAL PRODUCT	.0040

RESIDUAL ELEMENTS (EACH) LESS THAN .10
RESIDUAL ELEMENTS (TOTAL) LESS THAN .40
TITANIUM REMAINDER

HSN (1094) CRES-4665375

TENSILE DATA	LONGITUDINAL TEST 1	LONGITUDINAL TEST 2	TRANSVERSE TEST 1	TRANSVERSE TEST 2
TENSILE PSI	66900	75000	70500	75300
YIELD 0.2% OFFSET	44600	55800	58600	61900
ELONG %	25.6	30.3	31.0	34.0

PRODUCT ANNEALED 1400 F FOR 1/2 HOUR, A.C.

MATERIAL FREE FROM MERCURY CONTAMINATION.

BONNIE BREY\CERTIFICATION CLERK

Signature Bonnie Brey

H801

SB 6/1/00

QW-482 SUGGESTED FORMAT FOR WELDING PROCEDURE SPECIFICATION (WPS)

(See QW-200.1, Section IX, ASME Boiler and Pressure Vessel Code)

Company Name: METAL SAMPLES COMPANY By: BJL

Welding Procedure Specification No. 154668 Date 03/02/99 Supporting PQR No.(s)

Revision No. 1 Date 04/24/00

Welding Process(es): GTAW Type(s): MACHINE (Automatic, Manual, Machine, or Semi-Auto.)

JOINTS (QW-402)

Joint Design: DOUBLE VEE GROOVE

Backing (Yes) (No)

Backing Material (Type) (Refer to both backing and retainers.)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

Details

Sketches, Production Drawings, Weld Symbols or Written Description should show the general arrangement of the parts to be welded. Where applicable, the root spacing and the details of weld groove may be specified.

(At the option of the Mfgr., sketches may be attached to illustrate joint design, weld layers and bead sequence, e.g. for notch toughness procedures, for multiple process procedures, etc.)

***BASE METALS (QW-403)**

P-No. Group No. to P-No. Group No.

OR

Specification type and grade: TITANIUM GRADE 7 1/2" PLATE

to Specification type and grade: TITANIUM GRADE 7 1/2" PLATE

OR

Chem. Analysis and Mech. Prop.

to Chem. Analysis and Mech. Prop.

Thickness Range:

Base Metal: Groove Fillet

Pipe Dia. Range: Groove Fillet

Other

***FILLER METALS (QW-404)**

Spec. No. (SFA)

AWS No. (Class)

F-No. TITANIUM GRADE 7

A-No.

Size of Filler Metals 1/16" ϕ

Weld Metal Thickness Range:

Groove

Fillet

Electrode-Flux (Class)

Flux Trade Name

Consumable Insert

Other

*Each base metal-filler metal combination should be recorded individually.

(12/91) This form (E00006) may be obtained from the Order Dept., ASME, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300. REPRINT 8/93

SBL 6/2/00

QW-482 (Back) WPS No. 154668 Rev. 1

POSITIONS (QW-405)

Position(s) of Groove 1-G

Welding Progression: Up Down

Position(s) of Fillet

PREHEAT (QW-406)

Preheat Temp. Min.

Interpass Temp. Max.

Preheat Maintenance

(Continuous or special heating where applicable should be recorded)

POSTWELD HEAT TREATMENT (QW-407)

Temperature Range

Time Range

GAS (QW-408)

	Gas(es)	Percent Composition (Mixture)	Flow Rate
Shielding	ARGON	99.9%	35 CFH
Trailing			
Backing	ARGON	99.9%	35 CFH

ELECTRICAL CHARACTERISTICS (QW-409)

Current AC or DC DC Polarity STRAIGHT

Amps (Range) 130-135 Volts (Range) 14-16

(Amps and volts range should be recorded for each electrode size, position, and thickness, etc. This information may be listed in a tabular form similar to that shown below.)

Tungsten Electrode Size and Type (Pure Tungsten, 2% Thoriated, etc.)

Mode of Metal Transfer for GMAW (Spray arc, short circuiting arc, etc.)

Electrode Wire feed speed range

TECHNIQUE (QW-410)

String or Weave Bead STRING

Orifice or Gas Cup Size

Initial and Interpass Cleaning (Brushing, Grinding, etc.) ACETONE

Method of Back Gouging

Oscillation

Contact Tube to Work Distance

Multiple or Single Pass (per side) MULTIPLE → 8-10 PASSES PER SIDE.

Multiple or Single Electrodes

Travel Speed (Range) 6-8 IPM

Peening

Other

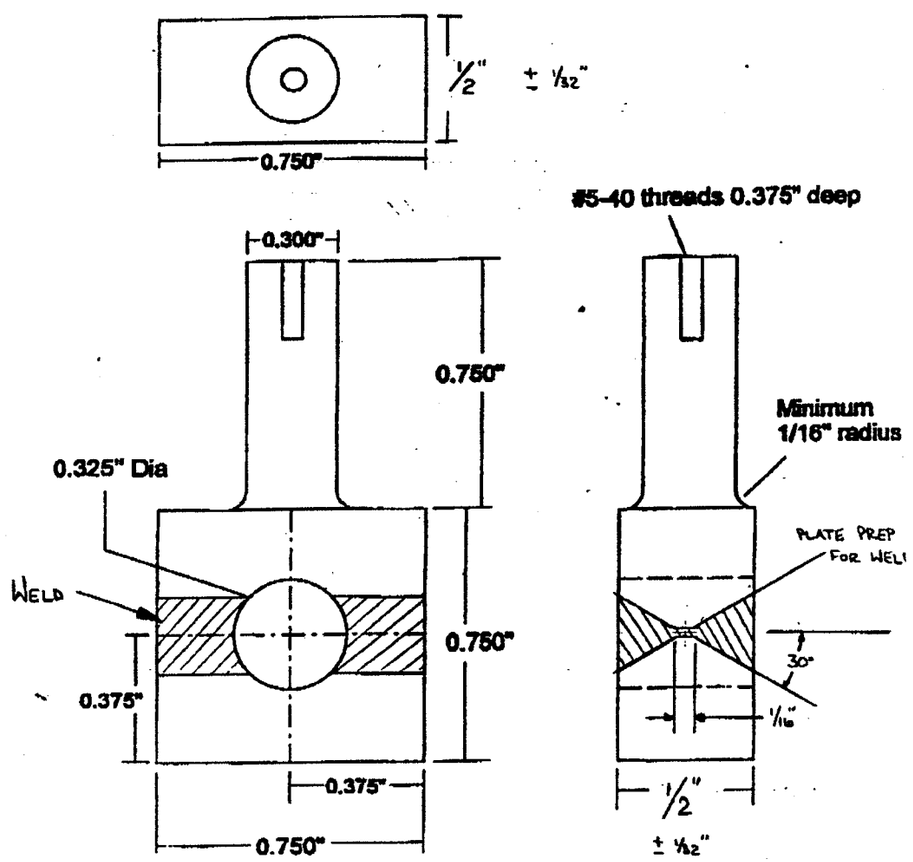
Weld Layer(s)	Process	Filler Metal Class	Filler Metal Dia.	Current Type Polar.	Current Amp. Range	Volt Range	Travel Speed Range	Other (e.g., Remarks, Comments, Hot Wire Addition, Technique, Torch Angle, Etc.)

SBL 6/2/00

SwRI - CNWRA
Bldg. 57
Ext. 6090

WELDED

CREVICE REPASSIVATION SPECIMEN
All Dimensions +/- 0.003", UNLESS NOTED



ALL FEATURES ARE ASSUMED TO BE ON CENTERLINE, PER CUSTOMER. D. DUNN / BJL 18 MAR 97

P/N CU014820109 1-26-99 Southwest Research

SB 6/2/00

Sean Brossia

From: PorterRLP@aol.com
Sent: Tuesday, April 25, 2000 7:05 AM
To: sbrossia@swri.edu
Subject: Titanium Welding

Sean,

Thanks for your inquiry. Note that I my direct e-mail is porterrlp@aol.com. I am going to send you a copy of an RMI welding brochure, unfortunately the brocure is out of print and all that is available is a photocopy. Please review the brochure and call me 330-544-1145 or e-mail me with any questions that you might have. Also please note that some of the alloys in the brochure are outdated and not currently used, however the basic procedures are the same.
As for grades 2, 7, 11, 16, 17, 26 and 27 guidelines for welding CP titanium will apply. Note that grades 16, 17, 26 and 27 are probably likely to be welded with ER Ti-7 weld wire as it is commercially available. While ER Ti-27 weld wire can be used for grades 26 and 27, it is likely that for the time being that ER Ti-7 will utilized. We have examined the corrosion resistance of weldments of Ti-Ru alloys autogenously welded and also those welded with Ti-Pd weld wire (ER Ti-7) . If you wish to obtain some material for welding such as Ti-Grade 26 (TiRu-26, Ti-0.1Ru) or Ti-Grade 27 (TiRu-27, Ti-0.1Ru) I will be happy to supply it. Also if you are interested in welding a material for which weld wire is not available we can make some strips that will serve the purpose quite nicely.

Look forward to hearing from you soon.

Rick Porter
Corrosion Engineer
RMI Titanium Company
1000 Warren Avenue
Niles, Ohio 44446
PH 330.544.1145
FAX 330.544.1002

1

SB 6/2/00

Sean Brossia

From: Grauman, Jim [Jim.Grauman@TIMET.com]
Sent: Tuesday, April 25, 2000 12:21 PM
To: sbrossia@swri.edu
Subject: RE: TIMET WWW Technical Support Request

Dr. Brossia:

Some guidelines can be found in our Design Handbook, located in the 'Products' section of our web site. This manual can be downloaded or viewed on-line. The only specification I am aware of is an ANSI/AWS specification (D10.6) titled 'Rec. Practices for GTAW of Ti Pipe & Tubing'. There may be others-you could check with someone at the Edison Welding Institute of the International Titanium Association (www.titanium.org) <http://www.titanium.org)> .

Regards,

Jim Grauman

James S. Grauman
Manager-Corrosion & Analytical Technology
TIMET-Henderson Technical Laboratory
PO Box 2128 Henderson, NV 89009
702.566.4414 Voice
702.564.9038 FAX
Jim.Grauman@TIMET.com
http://www.timet.com

-----Original Message-----
From: sbrossia@swri.edu [SMTP:sbrossia@swri.edu]
Sent: None
To: technical.htl@timet.com
Subject: TIMET WWW Technical Support Request

Below is the result of your feedback form. It was submitted by (sbrossia@swri.edu) on Monday, April 24, 2000 at 10:06:33

---

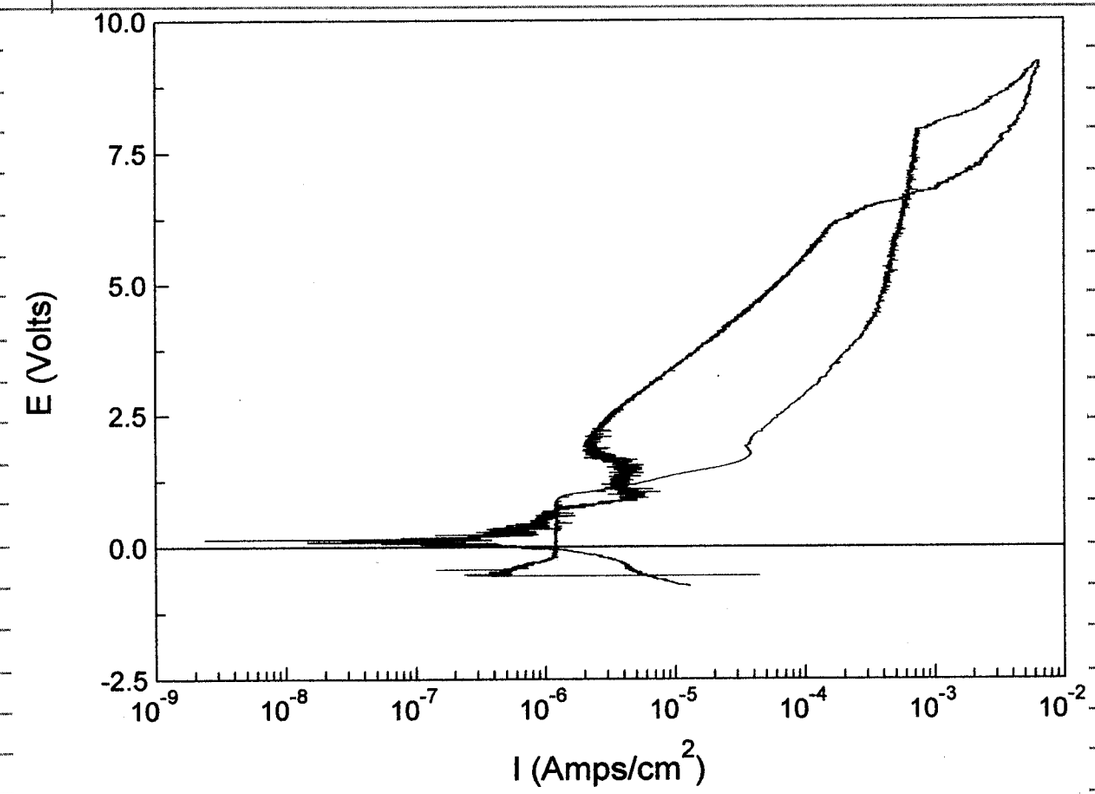
email: sbrossia@swri.edu

title_: Dr.
firstname: Sean
lastname: Brossia
company_name: Southwest Research Institute
address1: 6220 Culebra Rd
address2:
city: San Antonio
state/province: Texas
zip/postal: 78238
country: United States
other_country:
phone: 210-522-5797
fax: 210-522-5184
email: sbrossia@swri.edu
job_description: Technical/R&D
other_job_description:
industry: *Other
other_industry: contract research and development
Message: I am looking for specifications, standards, recomended practices for welding Ti. Specifically for grades 2, 7, and 16.

1

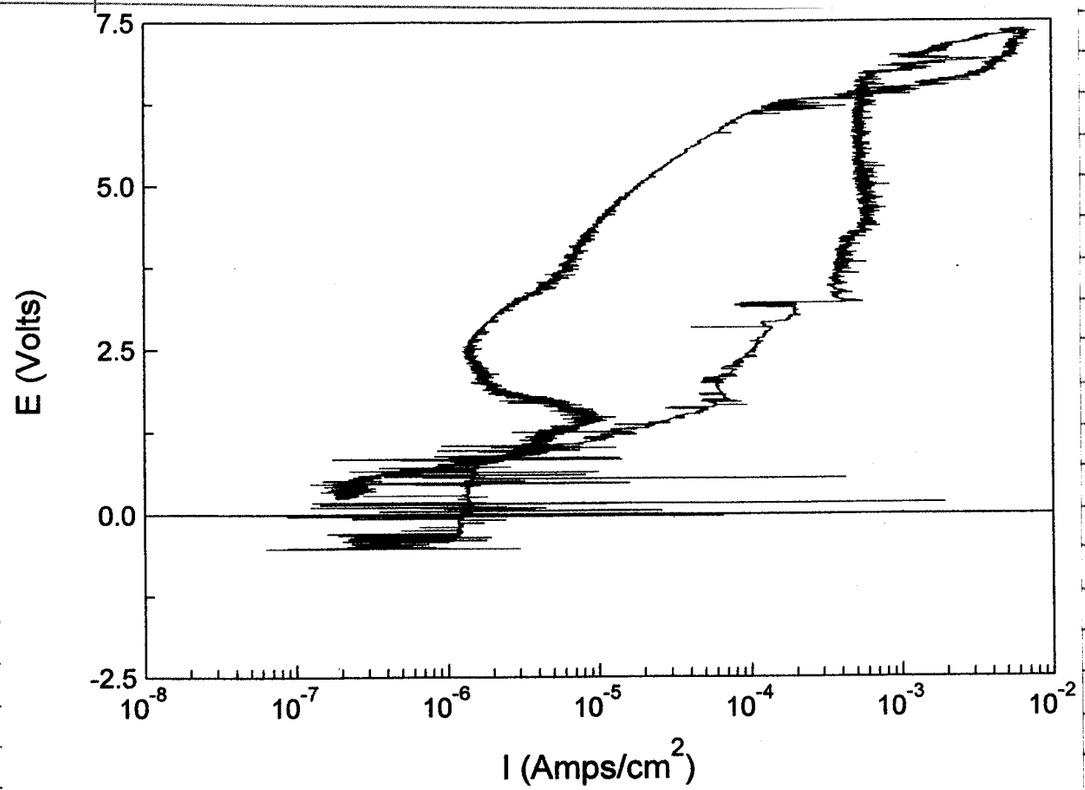
SB 6/2/00

TIPDG2-001.DAT
T=95°C
.01 M → NaCl → 1.1688g/2Lt Fisher # 000274
Init pH = 5.349
Specimen Ti G2 crevice specimen polished to 600grit + ultrasonically cleaned in methanol
Init wt = 15.9340g
Final wt = 15.83693g } 6-16-00
Final pH = 6.802
Observations
General corrosion on edges + corners of crevice, two feet had corrosion but appeared to have migrated from outside to in 6-16-00



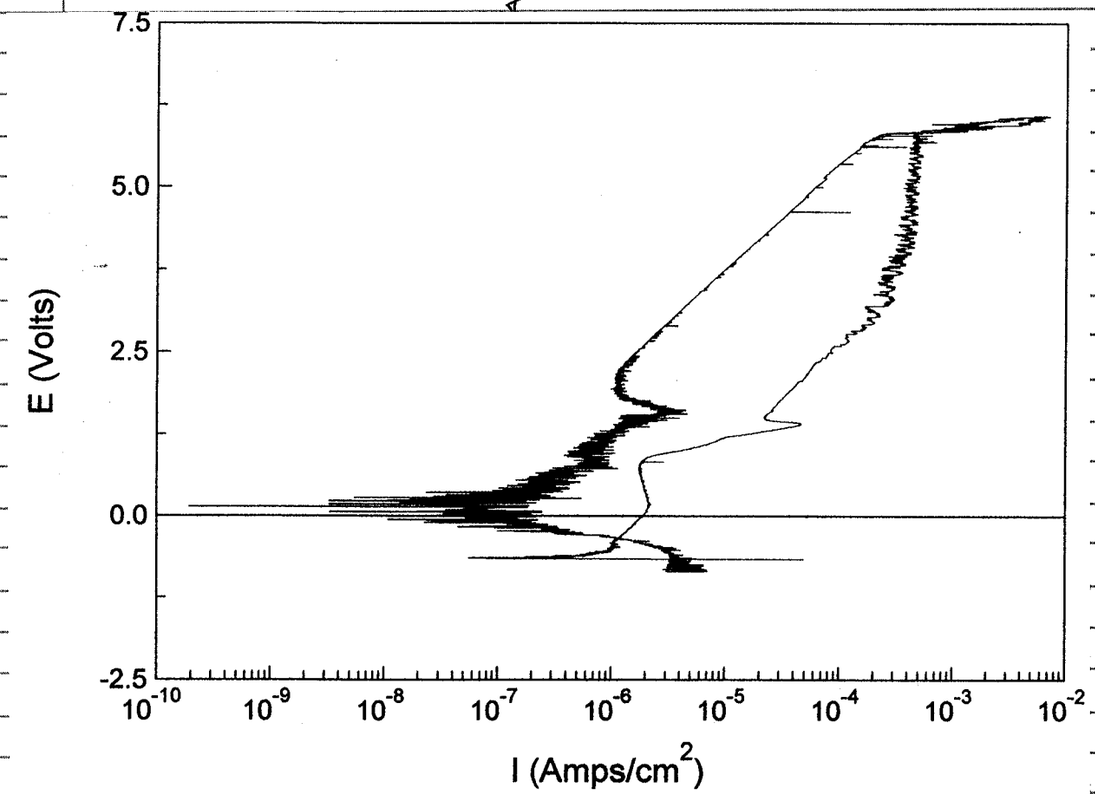
6-15-00

TIPD62-002.DAT
T=95°C
.1 M → NaCl → 11.6880g/2Lt Fisher # 000274
Init pH = 5.930
Specimen Ti 62 crevice polished to 600 grit + ultrasonically cleaned in methanol
Init wt = 15.89263g
Final wt = 15.84512g } 6-22-00
Final pH = 6.659
Observations
General corrosion @ edges + corners 6-22-00



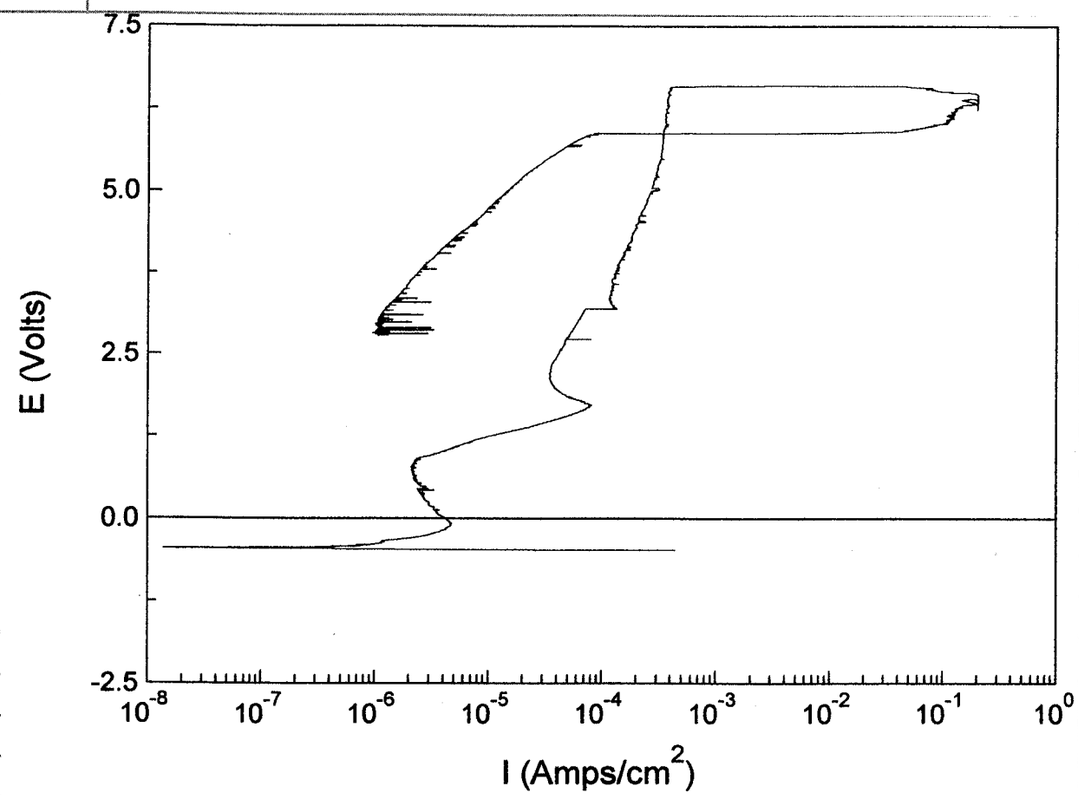
6-21-00

TIPD62-003.DAT
T=95°C
1 M → NaCl → 116.880g/2Lt Fisher #000274
Init pH = 6.208
Specimen Ti 62 crevice polished to 600 grit + ultrasonically cleaned in methanol
Init wt = 15.92873
Final wt = 15.91786 } 6-23-00
Final pH = 7.644
Observations
Minor general corrosion @ edges + corners, None under feet. 6-23-00



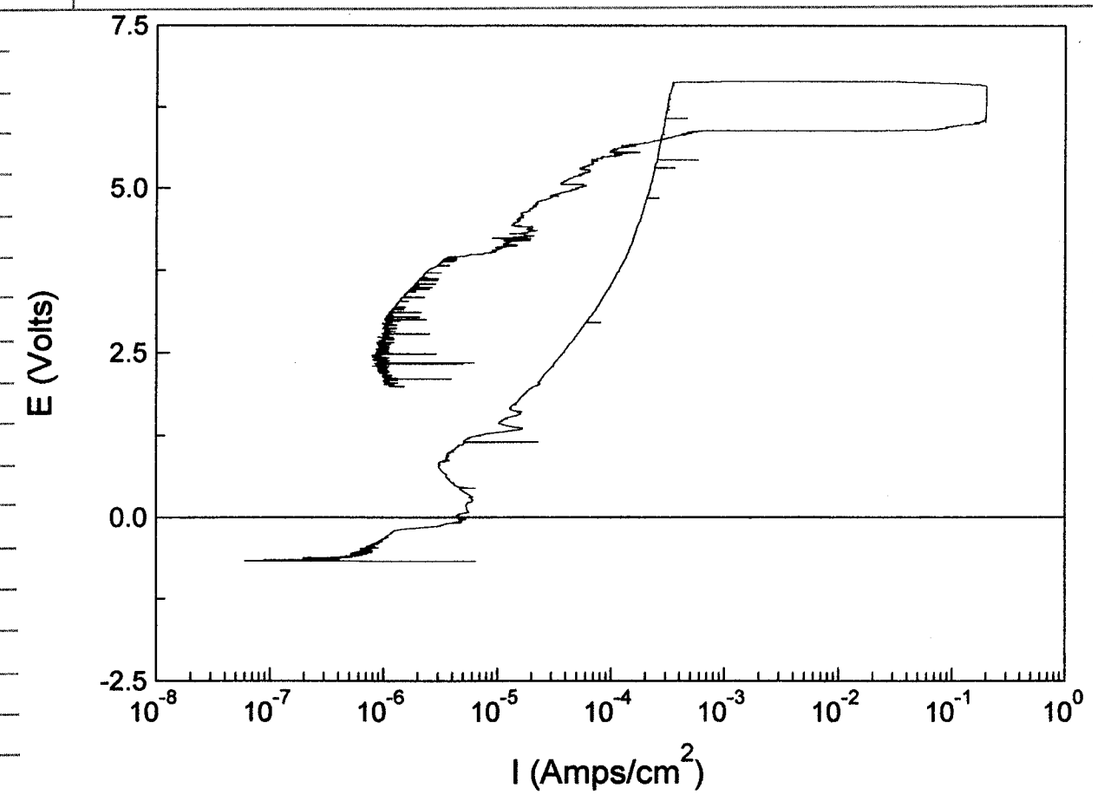
6-22-00

TIPD62-004.DAT
T=95°C
5M → NaCl → 584.400g/2Lt Fisher # 000274
Init pH: 7.450
Specimen T162 polished to 600 grit + ultrasonically cleaned in methanol
Init wt: 15.86149
Final wt: 14.96003 } 6-27-00
Final pH: 3.514
Observations
Heavy corrosion @ edges + corners, none under crevice
6-27-00



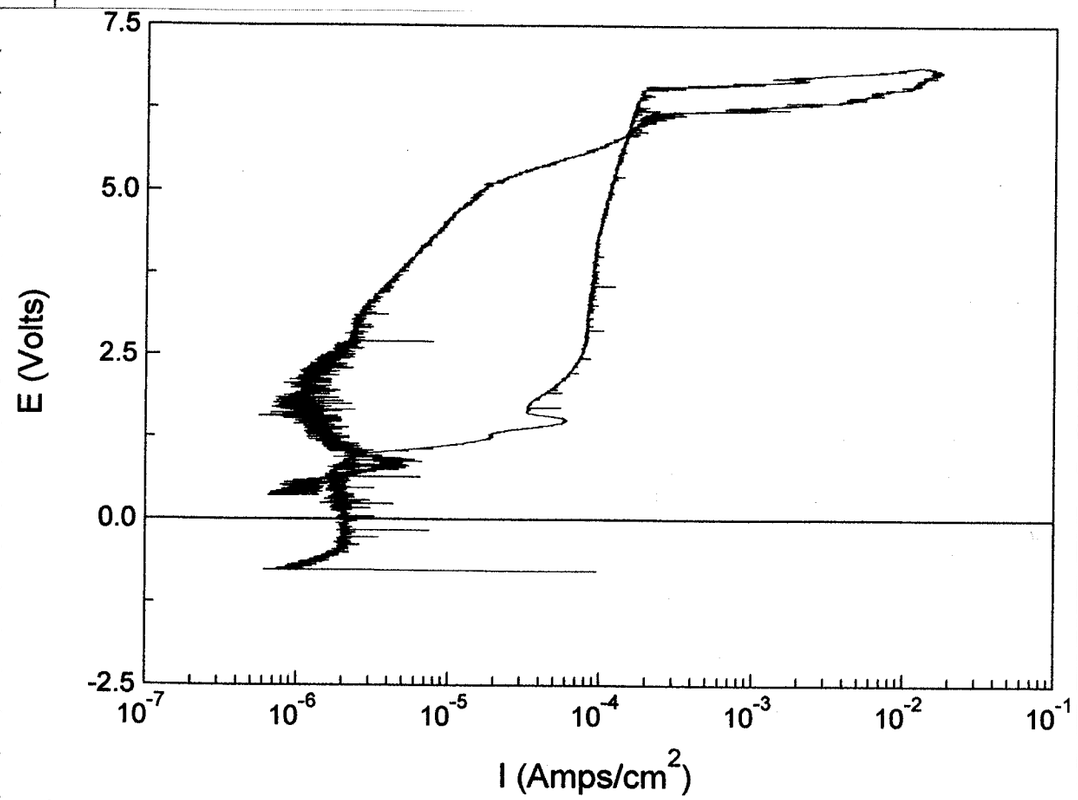
6-26-00

TIPD62-005.DAT
T=95°C
5M → NaCl → 584.400g/2Lt Fisher # 000274
Init pH: 7.250
specimen T162 polished to 600 grit + ultrasonically cleaned in methanol. Crevices reversed
Init wt: 15.94431g
Final wt: 14.61072g } 6-28-00
Final pH: 3.298
Observations
Heavy corrosion @ edges + corners, none under foot
6-28-00



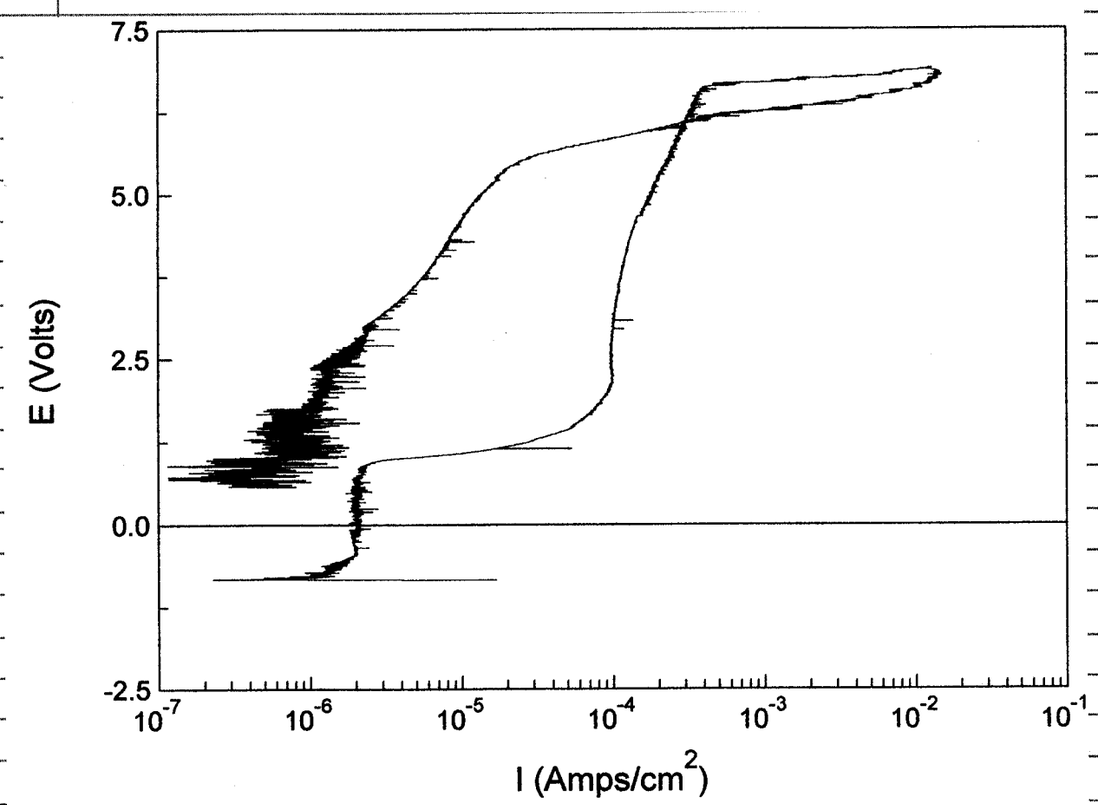
6-27-00

TIPDG2-006.DAT
T=95°C
.1 M → NaCl → 11.6880g/2L Fisher # 000 274
.001 M → NaF → 0.0840g/2Lt 991559
Specimen TI G2 pitting specimen polished to 600 grit
+ ultrasonically cleaned in methanol
Init wt: 6.40553g
Final wt: 6.36846g } 6-29-00
Final pH: 7.180
Init pH: 5.973
Observations
Some pitting/corrosion streaks and staining
6-29-00



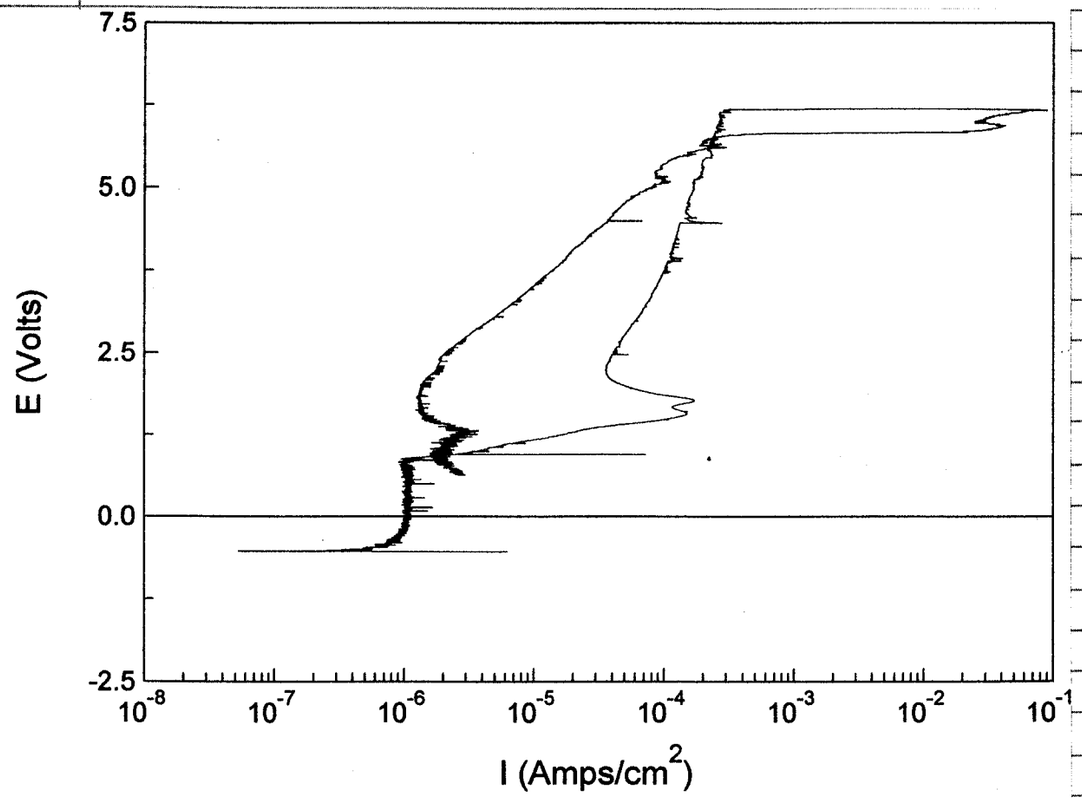
6-28-00

TIPDG2-007.DAT
T=95°C
.1 M NaCl → 11.6880g/2Lt Fisher # 000 274
.01 M NaF → 0.8398g/2Lt # 991559
Specimen is pitting specimen TI G2 polished to 600grit
+ ultrasonically cleaned in methanol
Init pH: 6.591
Init wt: 6.38488g/2Lt
Final wt: 6.35433g/2Lt } 6-30-00
Final pH: 7.087
Observations
Some pitting/corrosion streaks + staining 6-30-00



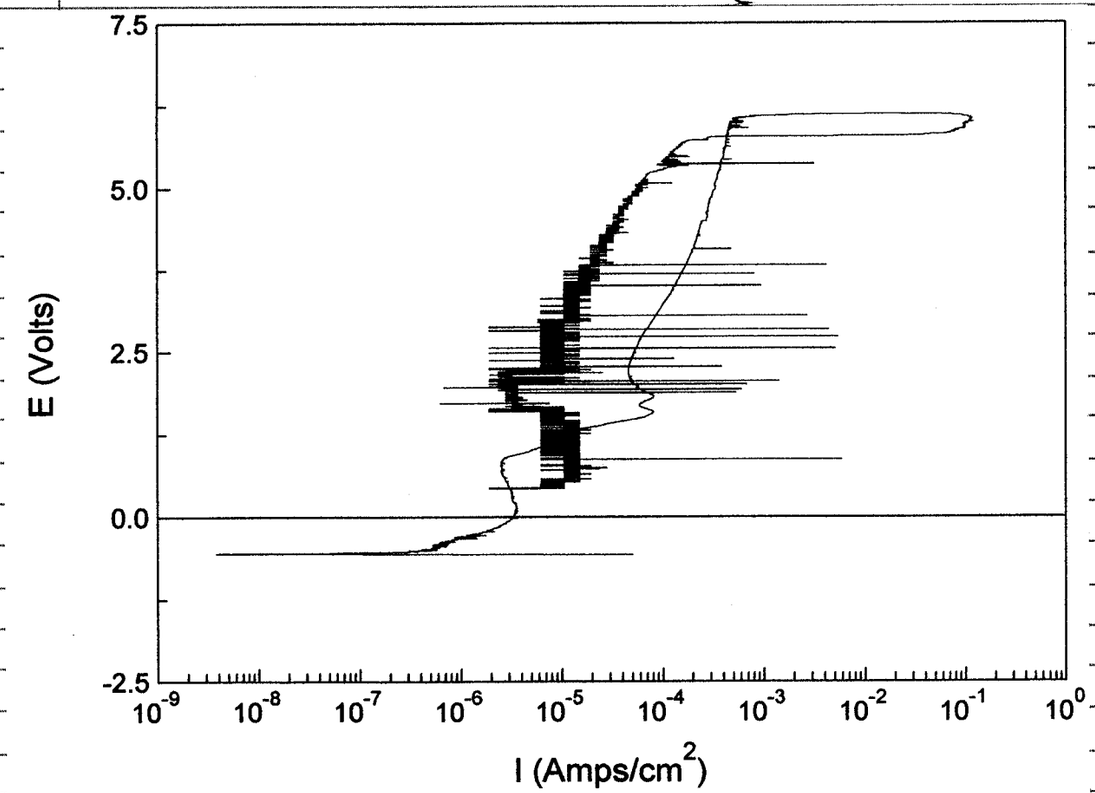
6-29-00

TIPDG2-008.DAT
T=95°C
5M → NaCl → 584.400g/2Lt Fisher # 000274
Specimen is TI G2 crevice specimen polished to 600 grit
+ ultrasonically cleaned in methanol Solid sq teflon blocks 1.9x1.9cm
Init pH = 6.900
Init wt = 15.97895g
Final pH = 4.71
Final wt = 15.83877g } [signature] 7-7-00
Observations
No pitting under crevice, general corrosion at
edges + corners [signature] 7-7-00



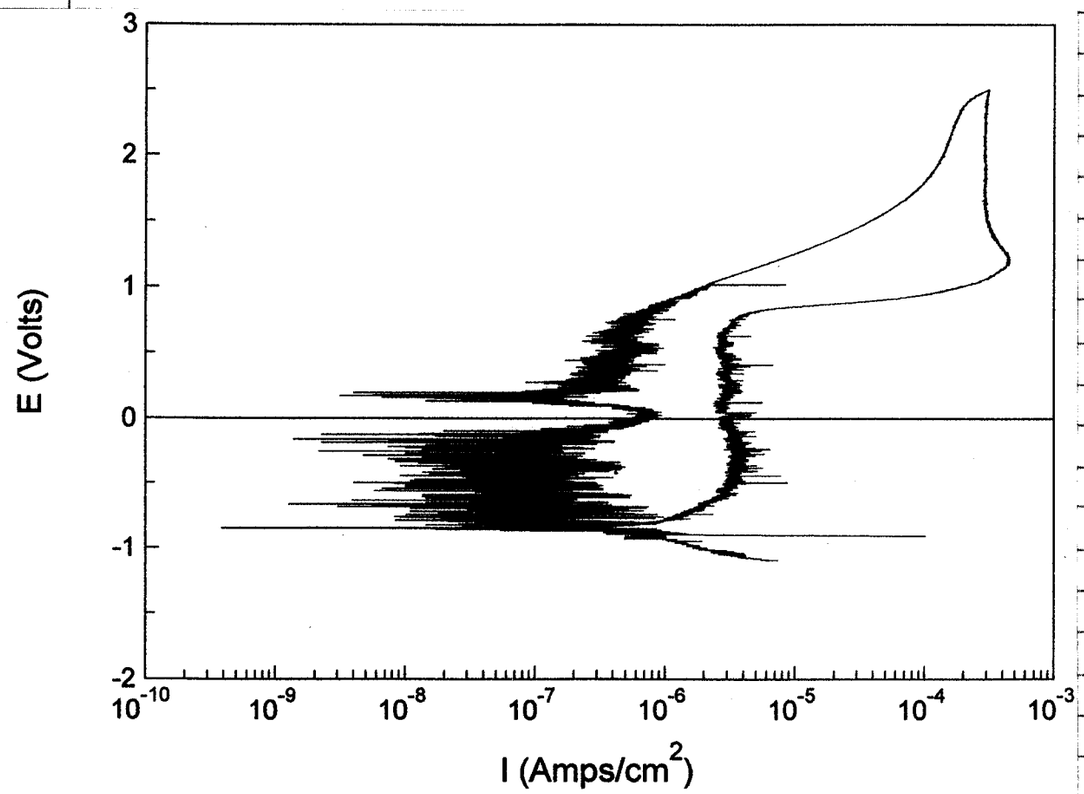
7-6-00

TIPDG2-009.DAT
T=95°C
5M NaCl → 584.400g/2Lt
Specimen is TIG2 polished to 600 grit + ultrasonically cleaned
in methanol. Crevice is another TIG2 polished to 600
Init pH = 6.95
Init wt = 16.05231g
Init wt crevice = 16.05545g
Final pH = 4.02
Final wt = 15.74082
Final wt crevice = 16.05469 } [signature] 7-11-00
Observations
No pitting under crevice, general corrosion @
edges + corners. Crevice former had no
pitting or corrosion on it. [signature] 7-11-00



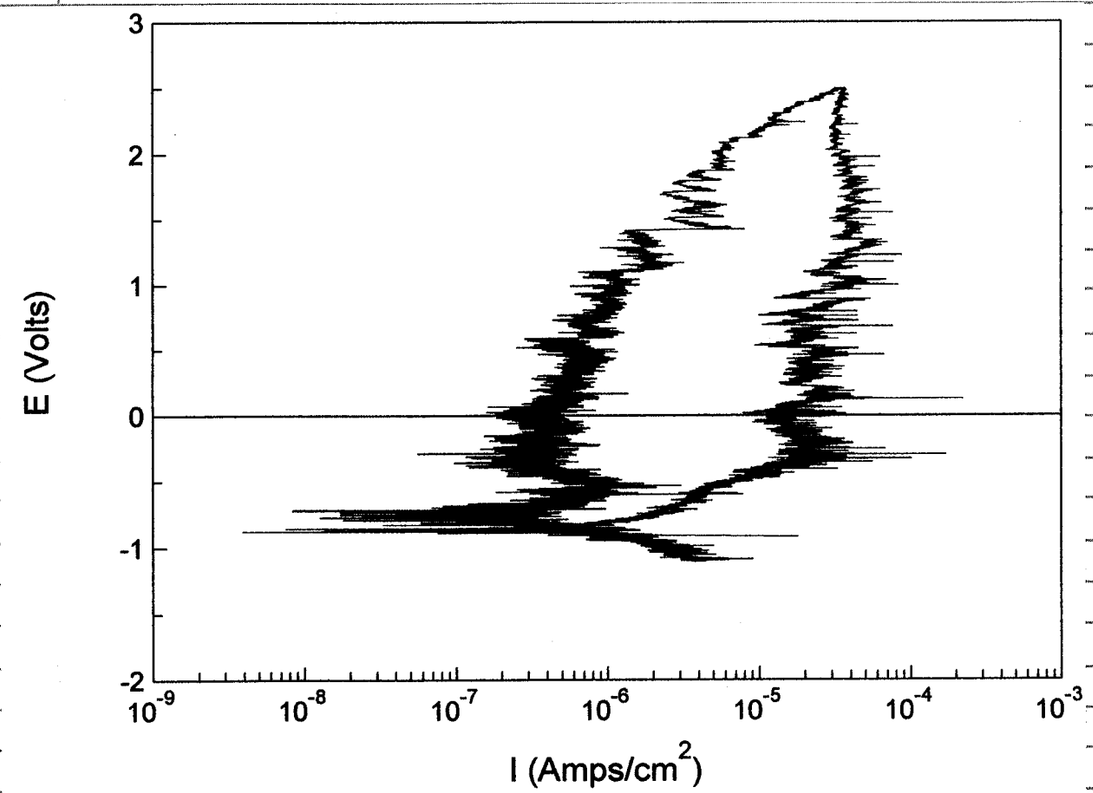
[signature] 7-10-00

TIPD62-010.DAT
T=95°C
.1 M NaCl → 11.6880g/2Lt Fisher # 000274
.05M NaF → 4.1990 g/2Lt # 991559
Specimen is T162 pitting polished to 600 grit
+ ultrasonically cleaned in methanol
Init pH: 6.990
Init wt: 6.39044g
Final pH: 8.690
Final wt: 6.38985g
7-12-00
Observations
No pitting, some discoloration above vapor line
7-12-00



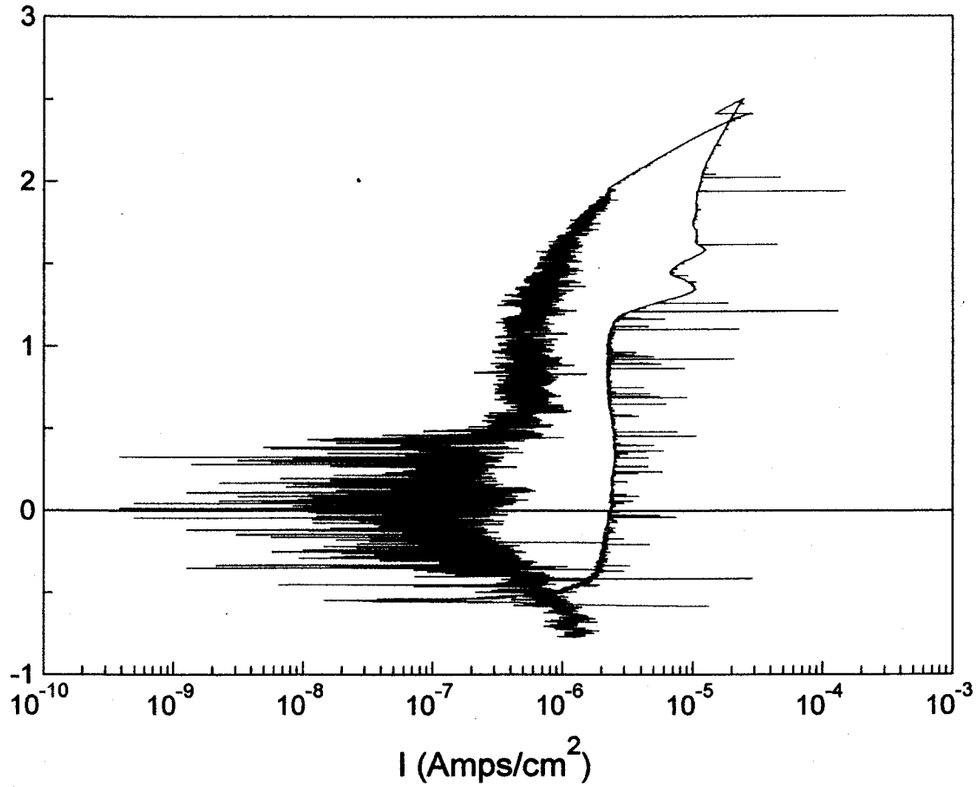
7-11-00

TIPD62-011.DAT
T=95°C
.1 M NaCl → 11.6880g/2Lt Fisher # 000274
.1 M NaF → 8.398 g/2Lt # 991559
Specimen is T162 pitting polished to 600 grit
+ ultrasonically cleaned in methanol.
Init pH = 6.860
Init wt = 6.34581
Final pH: 8.620
Final wt: 6.34577
7-14-00
Observations
No pitting, some discoloration above vapor line
7-14-00



7-13-00

TIPD62-012.DAT
T=95°C
5M NaCl → 584.400g /2Lt Fisher # 000274
Specimen is T162 crevice polished to 600 grit + ultrasonically cleaned in methanol, reversed crevice loosely tightened by hand
Init pH: 6.840
Init wt: 16.01398g
Final pH: 6.870
Final wt: 16.01372g
} 7-19-00
Observations
No pitting or corrosion, some staining 7-19-00



7-18-00

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

SCIENTIFIC NOTEBOOK REVIEW CHECKLIST RECORD

Scientific Notebook No.: 320

Accomplished

- [yes ✓] 1. Initial entries per QAP-001
- [yes ✓] 2. Dating of entries
- [NO ✗] 3. Corrections (crossed out, one line through w/initials/date)
- [yes ✓] 4. White out not used
- [yes ✓] 5. Page number visible on original notebook
- [yes ✓] 6. In process entries per QAP-001
- [N/A ✓] 7. Figure numbers present
- [yes ✓] 8. Text visible
- [N/A ✓] 9. Electronic Scientific Notebook changes initialed and dated
- [yes ✓] 10. Permanent ink or type only
- [yes ✓] 11. Signing of entries (not required on each page)
- [N/A ✓] 12. Statement at the end of electronic Scientific Notebook print outs—"No original text removed"
- [N/A ✓] 13. Electronic media in the scientific notebook properly labeled

Discrepancies have been identified. Yes X No ____

Checker: [signature] Date: 8/16/00

The discrepancies identified in this Scientific Notebook Review Checklist have been addressed by:

SB — Signature — 8/16/2000 — Date

CNWRA Form QAP-01 (8/2000)

SB 8/16/2000

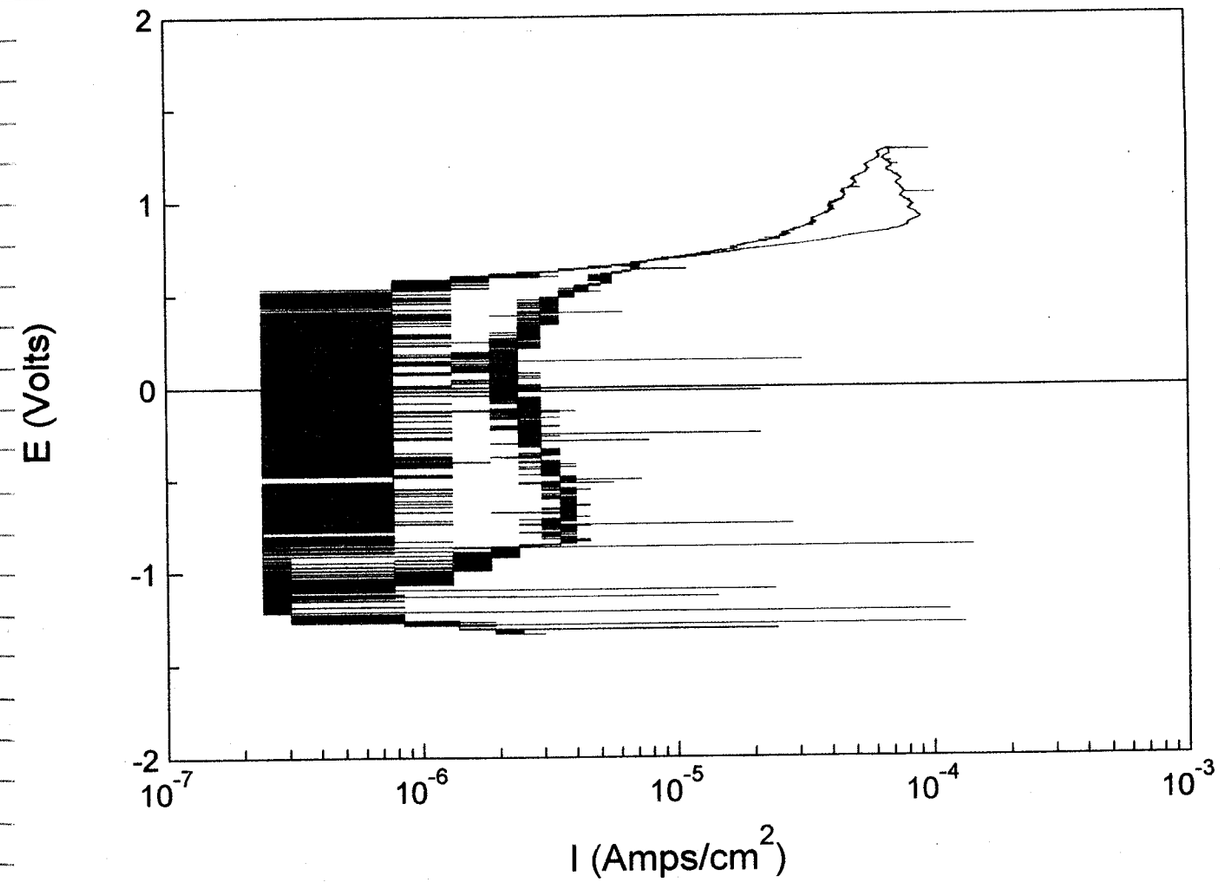
Copy of pages 77 - 129 sent to QA

9/5/2000

TiPdK001.dat
1.77 M KCl
2.05 M NaCl
0.072 M NaF
95°C
wt_i = 6.26938
wt_f = 6.26987
pH_i = 8.463
pH_f = 8.357

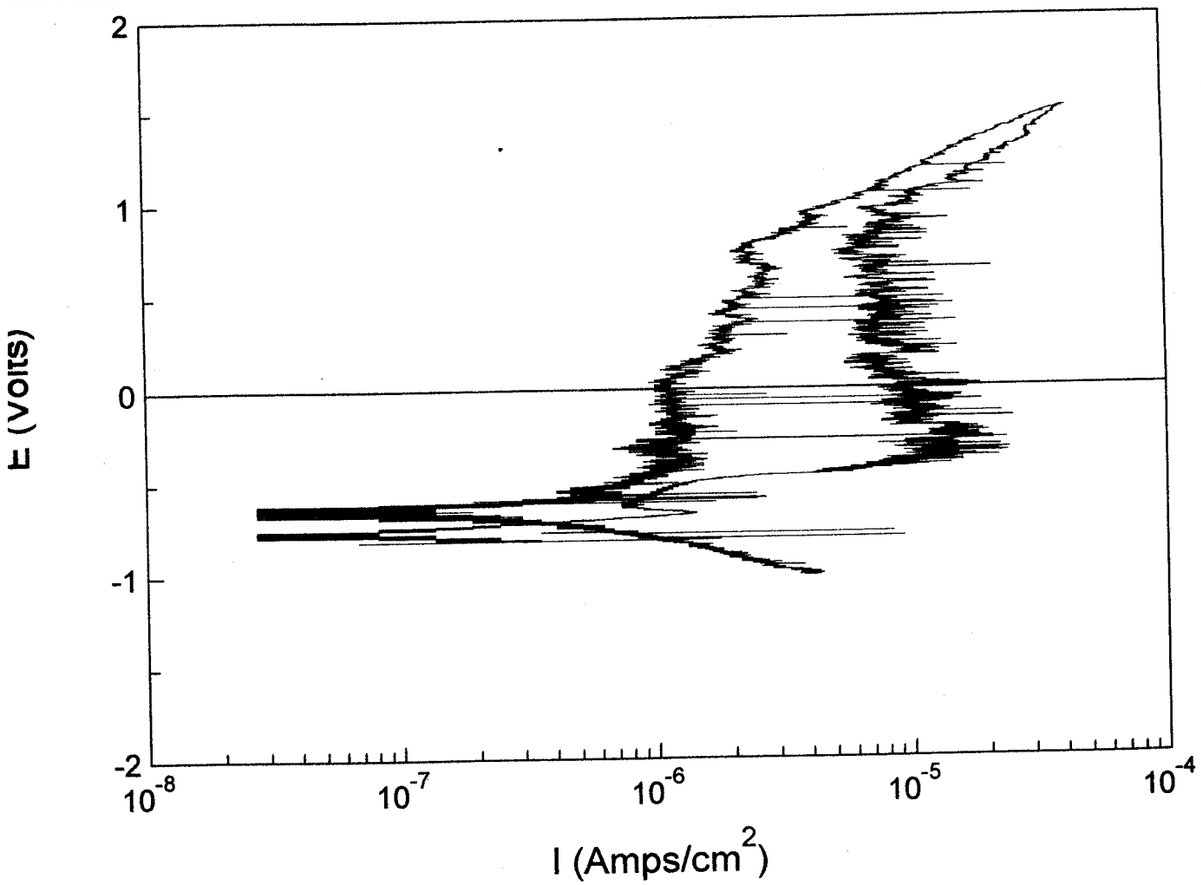
DOE Basic Satd waters tests w/ Ti-Pd (Grade 7)

→ pg 131 — 134 all 95°C, deaerated w/ N_2



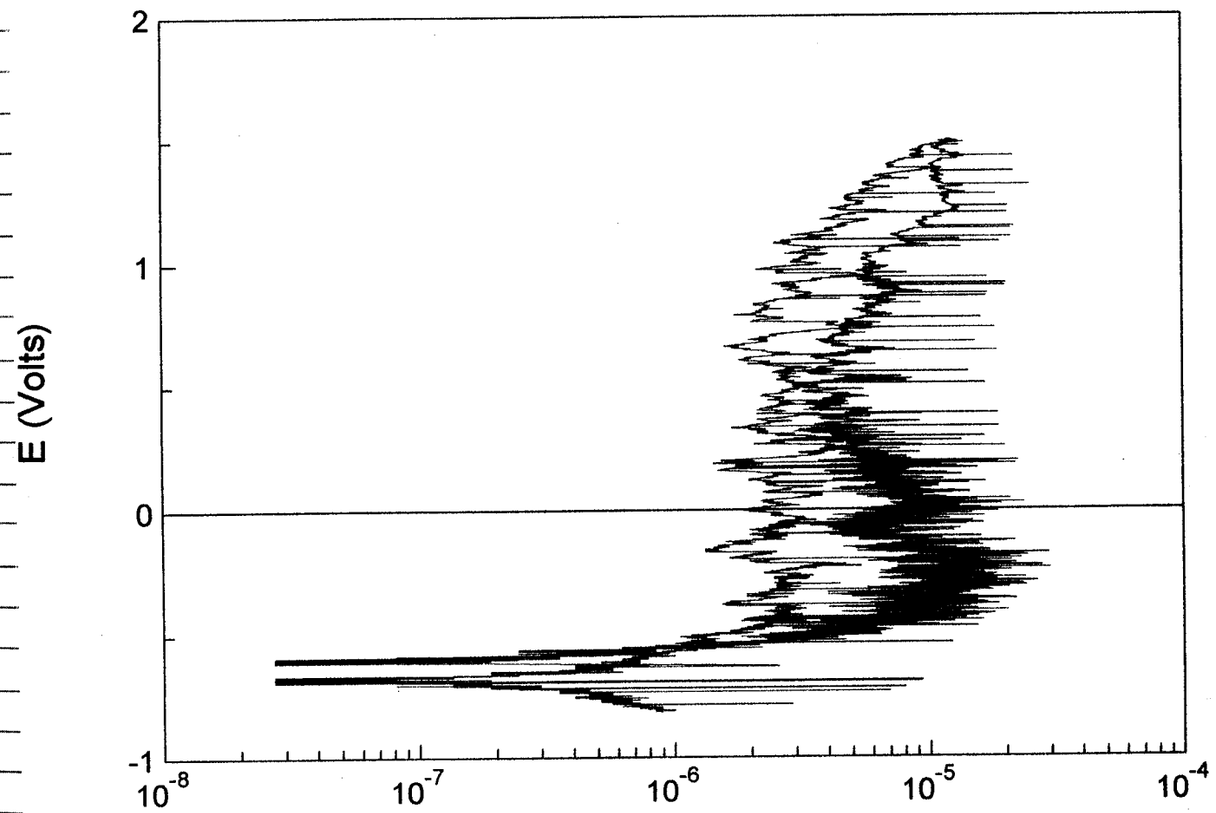
8/17/00

TiPdK002.dat
1.77 M KCl
2.05 M NaCl
0.072 M NaF
0.03 M NaOH
wt_i = 6.32874
wt_f = 6.32848
pH_i = 12.283
pH_f = 12.336



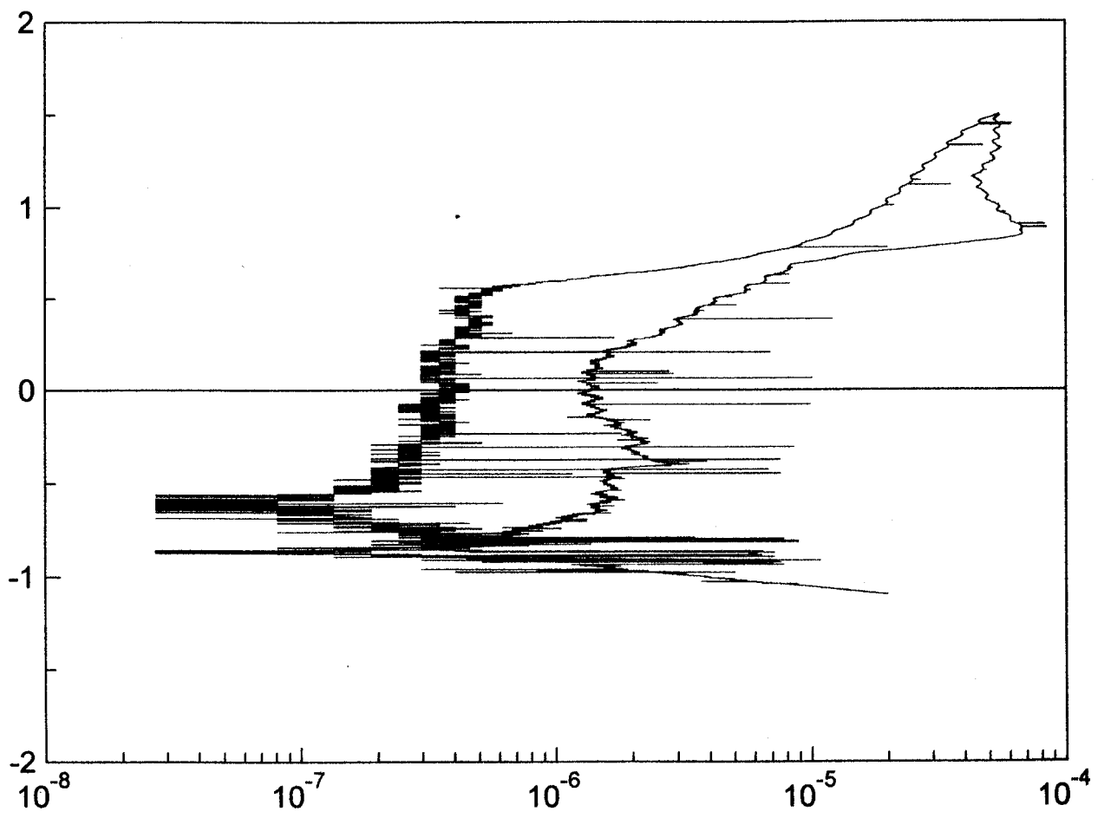
SB 8/22/2000

TiPdK003
1.77 M KCl
2.05 M NaCl
0.072 M NaF
2.3 M $NaNO_3$
~~0.15 M Na~~ SB 8/30/2000
wt_i = 6.25407
wt_f = 6.25436
pH_i = 8.525
pH_f = 8.742



SB 8/30/00

Ti:PdK004.dat
1.77 M KCl
2.05 M NaCl
0.072 M NaF
2.3 M $NaNO_3$
0.03 M NaOH
wt_i 6.31533
wt_f 6.31509
pH_i 12.359
pH_f 12.039

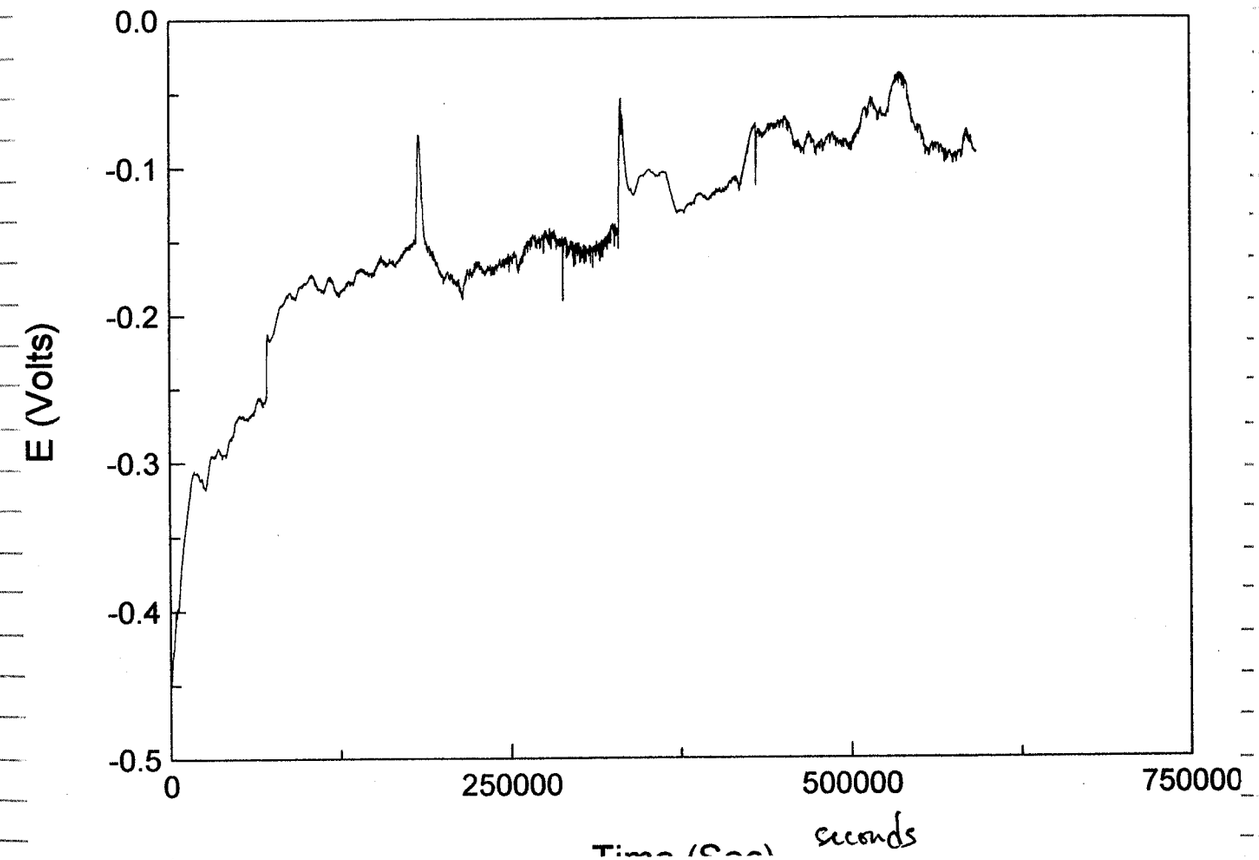


2.

8/30/2000

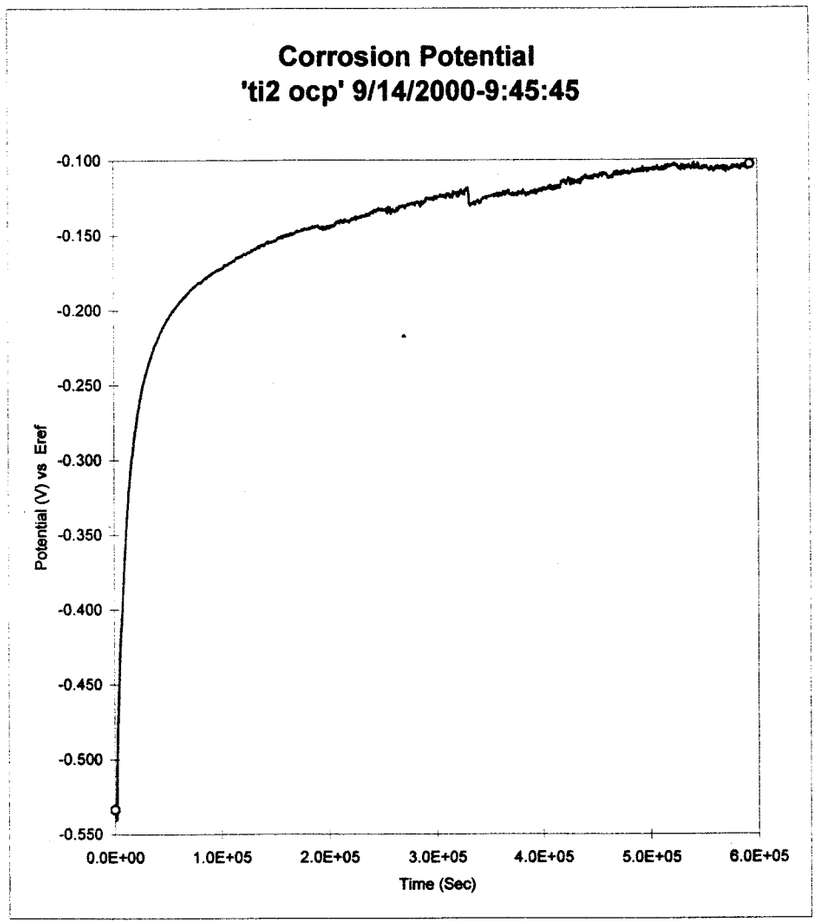
Simulated Crevice Solution Tests pgs 135 – 144
– all tests:
5M LiCl
0.1M HCl
95°C
pH_i ~ -0.55 for all (bulk batch solution for all tests)

Ti7 OCP



9/21/00

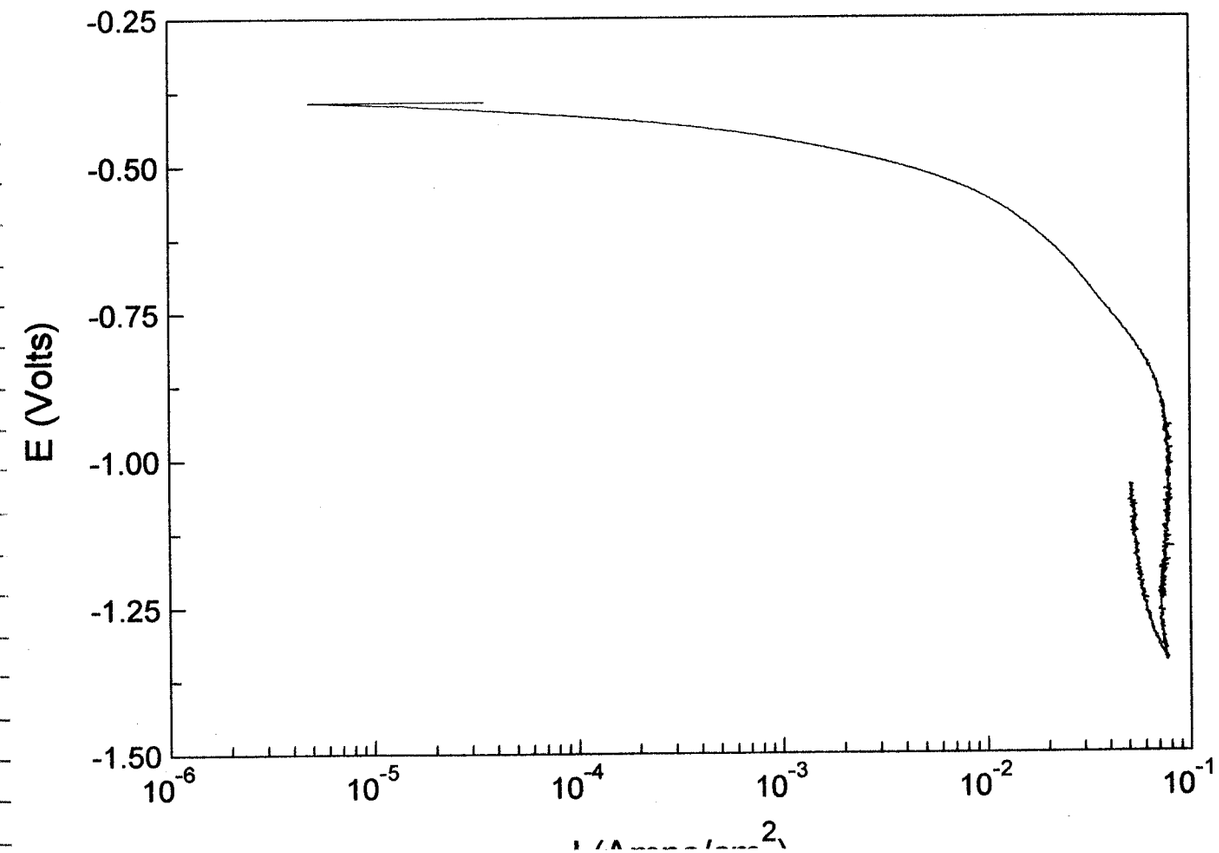
Ti 2 OCP



SB 9/21/00

solution
crevice/pol Tc

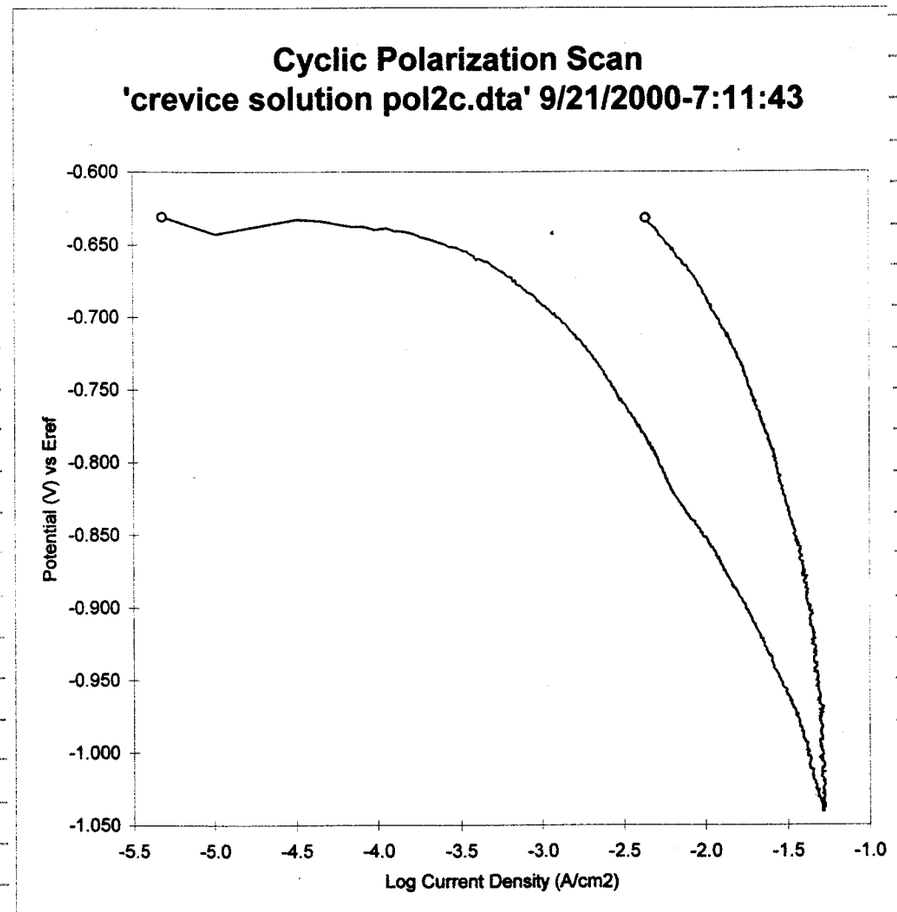
Ti Grade 7 – cathodic



SB 9/21/00

crevice solution pol 2c

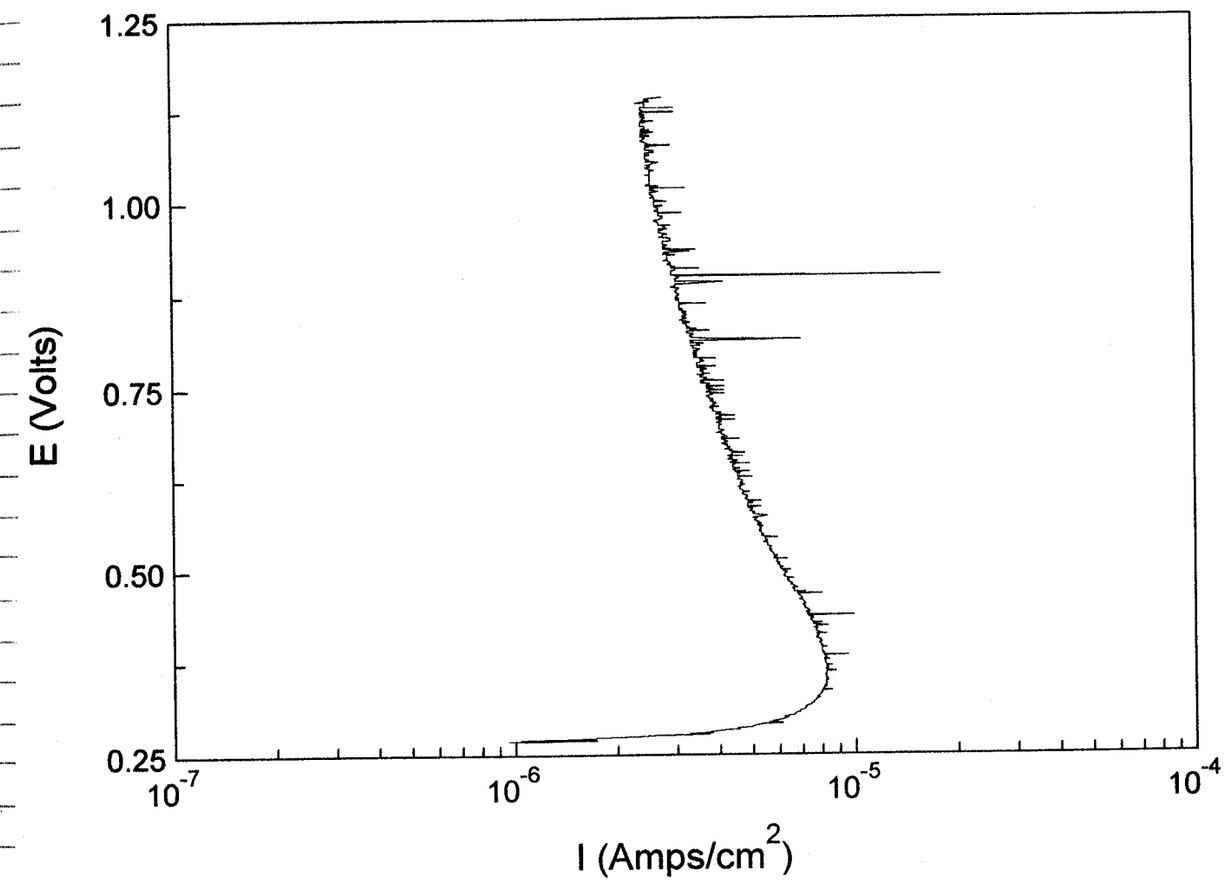
Ti Grade 2 — cathodic



SB 9/21/00

crevice solution pol 7a

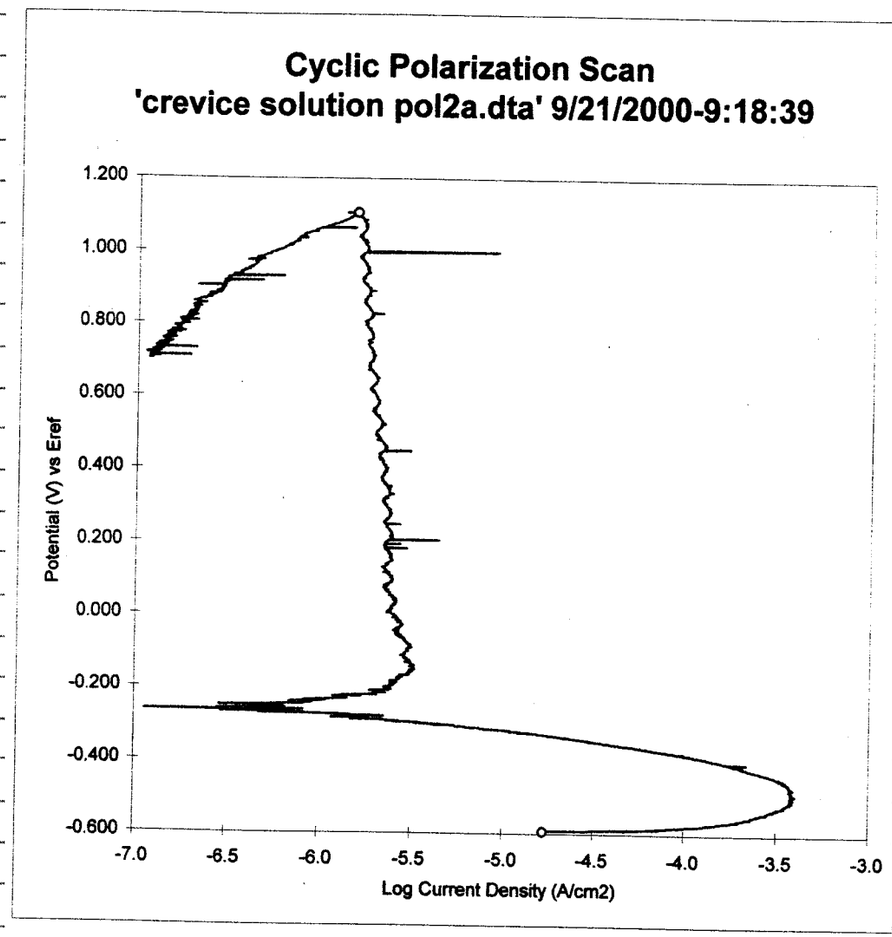
Ti Grade 7 — Anodic



SB 9/21/00

crevice solution pol 2a

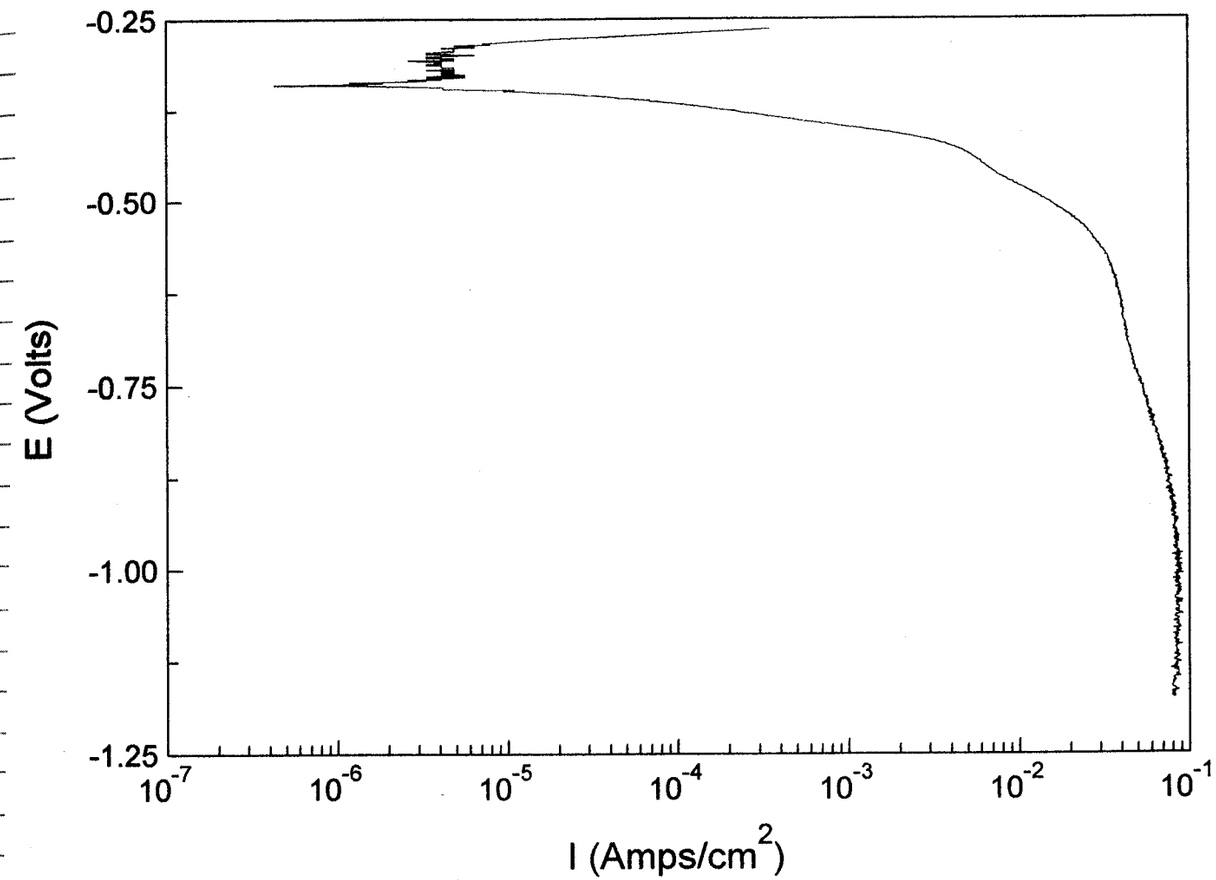
Ti Grade 2 - anodic



CSB 9/21/00

crevice solution pol 7c 3

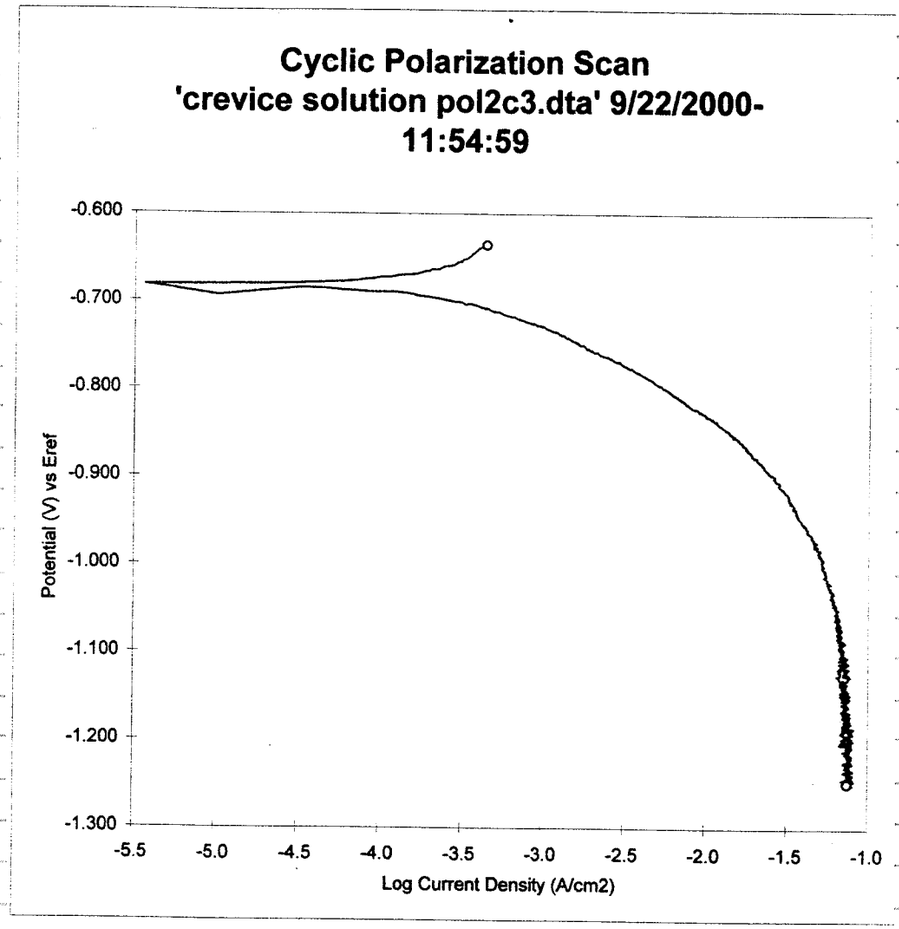
- duplicate of pg 137



CSB 9/22/00

crevice solution pol 2c 3

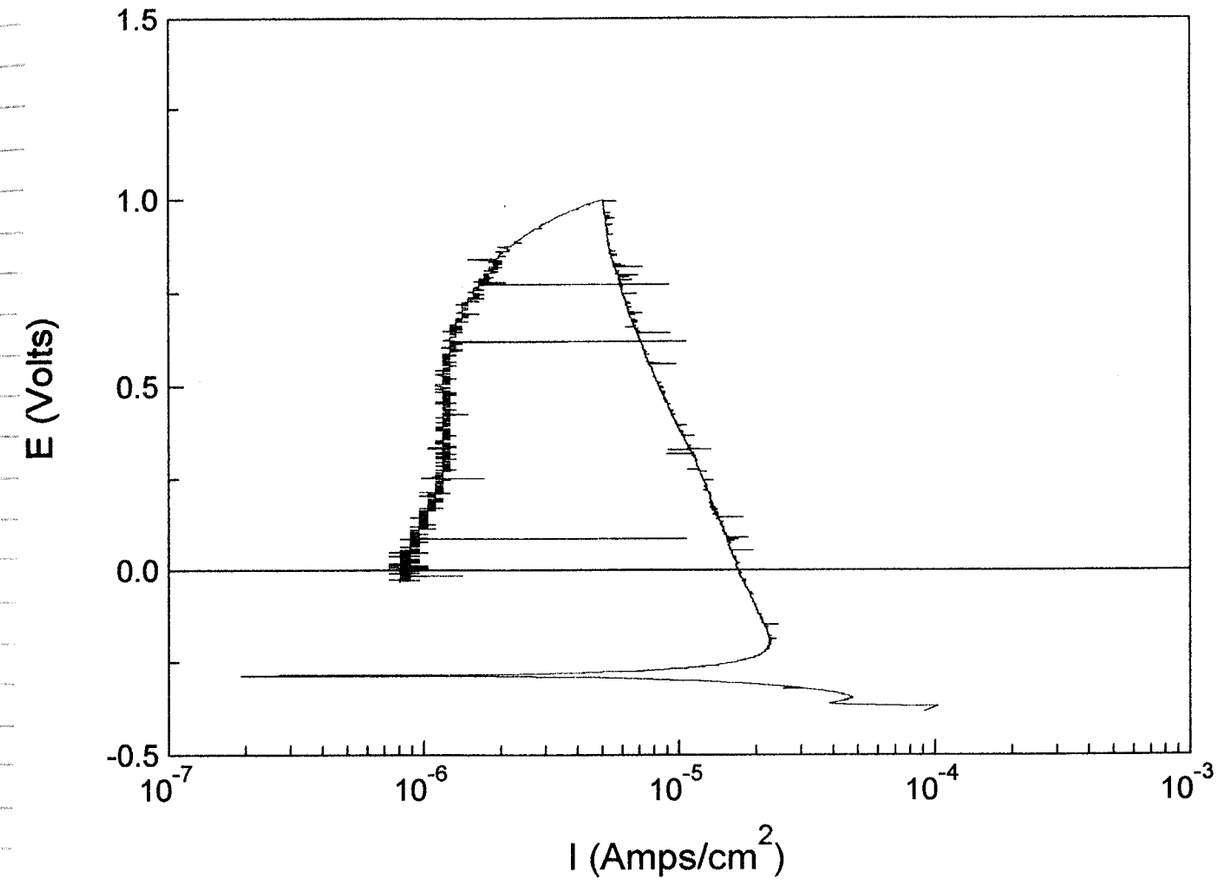
duplicate of pg 138



SB 9/22/00

crevice solution pol 7a 3

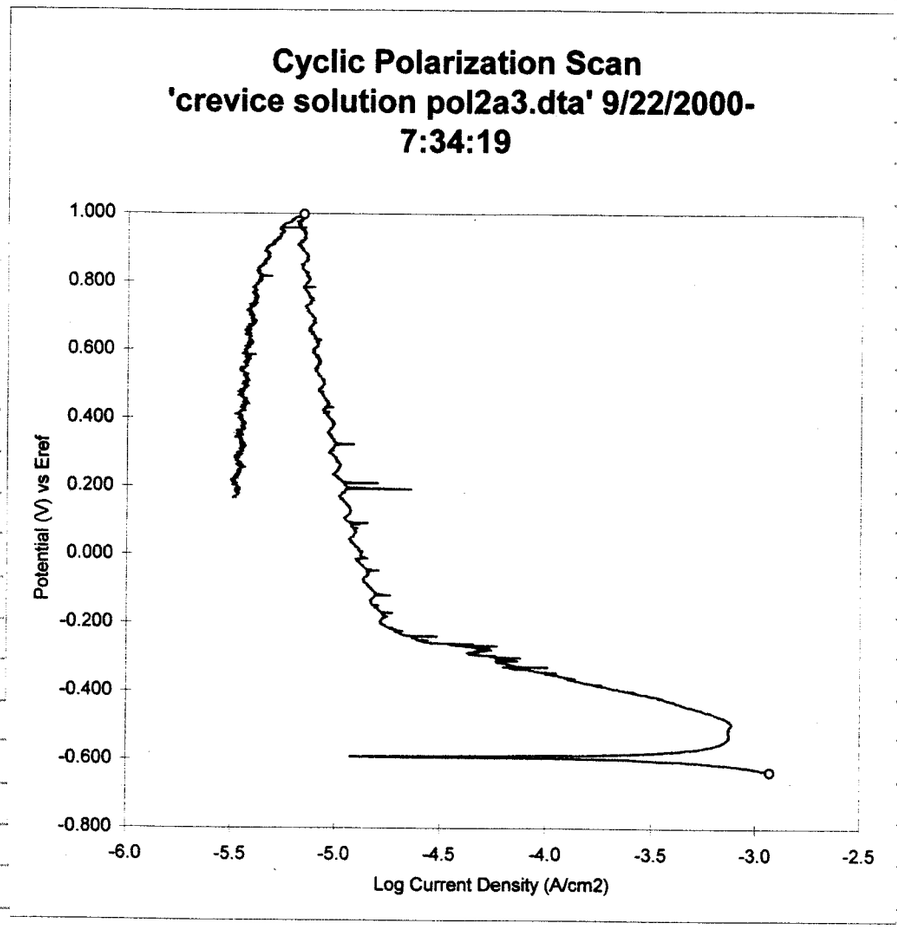
duplicate of pg 139



SB 9/22/00

crevice solution pol 2a3

duplicate of pg 140



SB 9/22/00

Long-term polarization of Ti-Grade 2 & 7 pgs 145 —

start 8/3/00 → all at E=0 V_{SCE}, 95°C, deaerated, crevice spec.

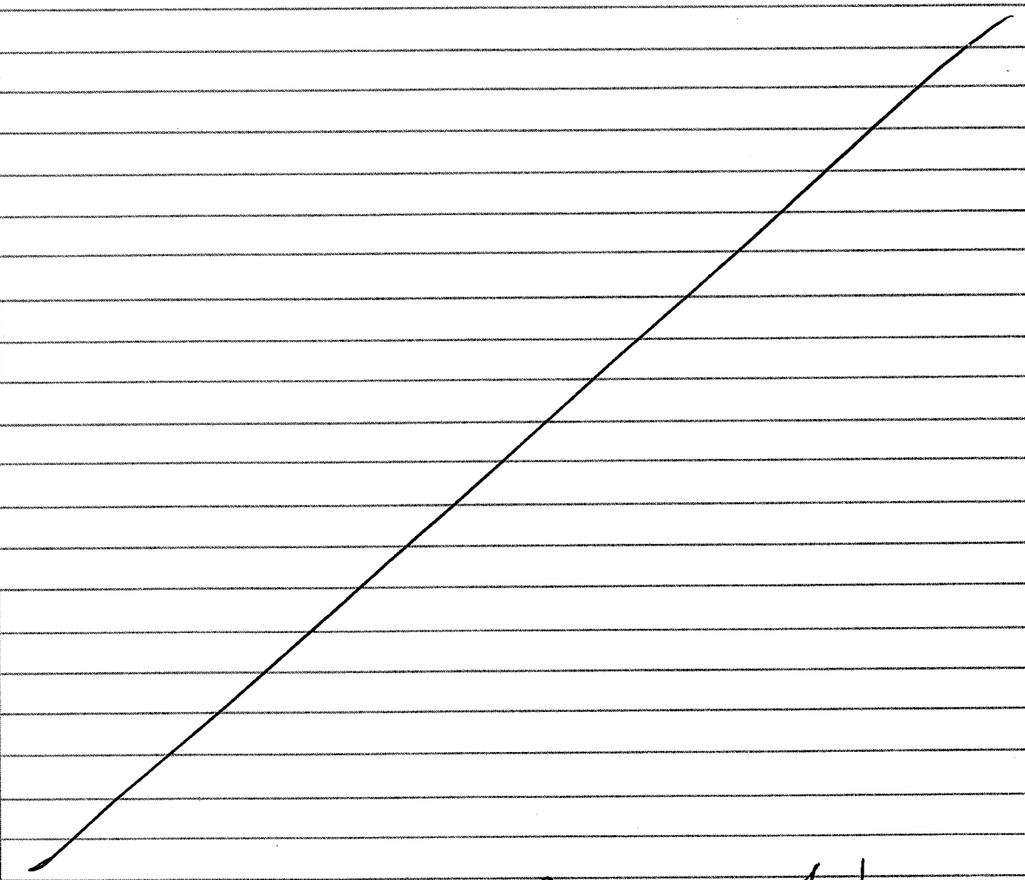
5M LiCl

Grade 2 : tig2_001 — ptfe crevice

tig2_002 — ti g2 crevice

Grade 7 : tig7_001 — ptfe crevice

tig7_002 — ti g7 crevice



SB 8/11/00

Ti Grade 2:

tig2_3 1 M NaCl, ptfe crevice

tig2_4 1 M NaCl, tig2 crevice

Ti Grade 7

tig7_01b
tig7_02b } continuation from pg 145

SB 8/11/00

New long-term Expts w/ F^-

Ti Grade 2:

tig2_03b
tig2_04b } continuation of pg 146 expts in 1M NaCl

tig2F_01 — 1M NaCl + 0.01 M NaF

~~Ti~~ SB 9/15/00 tig2F_02 — 1M NaCl + 0.1 M NaF

Ti Grade 7:

tig7_01c
tig7_02c } continuation of pg 145, 146 expts in 5M LiCl

tig7F_01 - 1M NaCl + 0.01M NaF

tig7F_02 - 1M NaCl + 0.01 M NaF

SB 9/15/00

Ti grade 7 ocp in 1 M NaCl + 0.1 M NaF 95°C
aerated soln.
12/28/00 SRB

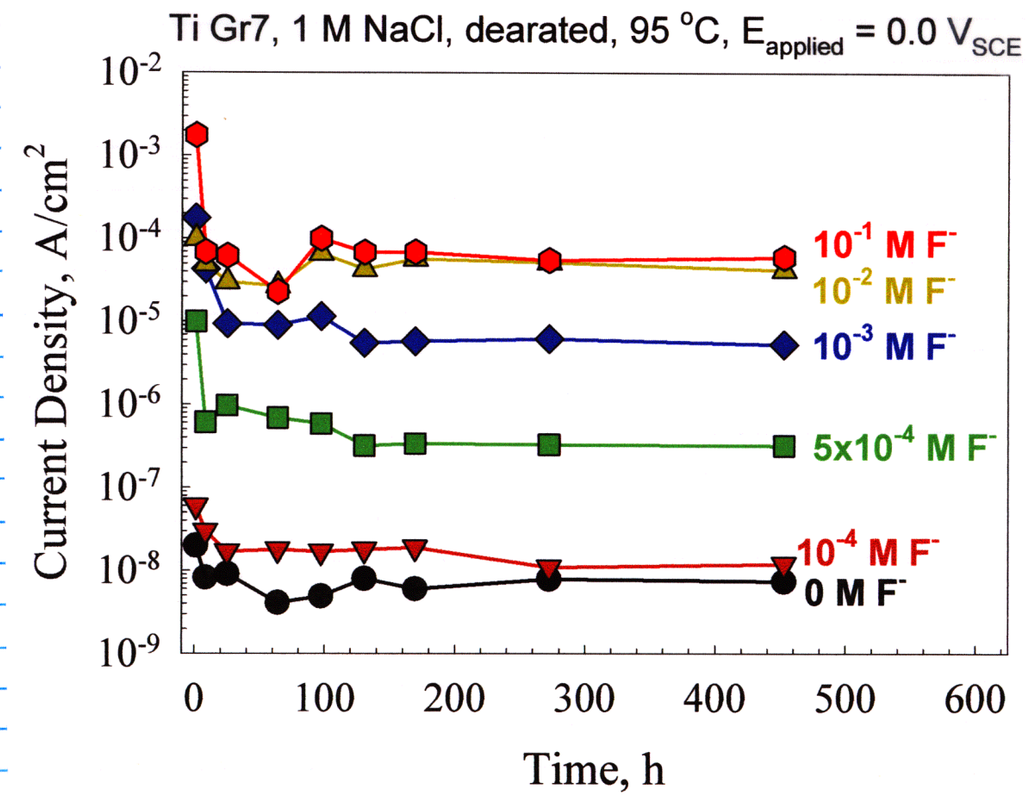
Testing still in progress SRB 3/22/01

Ti grade 7 long-term pstat hold at 0 VSCE
in 1 M NaCl + 0.0001 M NaF 95°C
12/28/00 SRB

5×10^{-4} M NaF
10^{-3} M NaF
10^{-2} M NaF
10^{-1} M NaF

Same conditions as above w/ different NaF concentrations

SRB 3/22/01



SRB 3/22/01

TIMET

Titanium Metals Corporation
100 Titanium Way, Toronto, Ohio 43964
Telephone (614) 537-5694, FAX (614) 537-5759

APPROVED CERTIFICATE

PAGE 1 OF 1

MILL ORDER
18-45811-02
HEAT
R5835

CUSTOMER
Titanium Industries
GRADE
TIMETAL'50A .15Pd

PURCHASE ORDER
27203
PRODUCT DESCRIPTION
1" PLATE

SPECIFICATIONS

ASME 265 GR 7_95; ASTM B 265 GR 7_95A

CHEMICAL ANALYSIS
(Weight Percent)

	C	Fe	N	O	Pd
R5835-AVG	0.009	0.115	0.007	0.140	0.155

	H2 (ppm)	LOCATION	METHOD
R5835-J2658-1	50	-	HOT EXT.

The Chemistry reported is the average of two results.
Balance titanium.

MECHANICAL PROPERTIES

ANNEAL 30 MIN @ 1550°F-AC
Room Temperature Tensile Results (YS @ .2% offset)

IDENTITY	TENSILE DIR	TS KSI	YS KSI	4D, % EL	RA, %
R5835-J2658-1	L	79	54	25	45
R5835-J2658-1	T	85	64	25	48

COMPLIANCE STATEMENTS

1 Material has received a .010" minimum pickle.
2 Surface free from contamination.
3 Grade Ti-PD to ASTM B 265-95 Grade 7 and ASME SB 265-92 Grade 7.

Results are from TIMET Quality Control records on file
Cert Master used: PLATE18

TIMET 85 M.R. McC
Authorized Signature

Date : 8-JAN-1998
Time : 13:14

This certification package contains the following checked items :

MANIFEST ____
CERTIFICATION ____
BILLET MAP ____
CUSTOMER WAIVER FORM ____

MAT'L. I.D. NO. P586 P.O. NO. 41573
SPEC. KS2400 INITIAL MJS
TIGR7 R.T.

ANSI-RAB American Quality Assessors
REGISTERED ISO 9002

NADCAP PRI Performance Review Institute Accredited
NDT & LAB

First in Titanium Worldwide

1/8/01 SB

AMERICAN FILLER METALS CO.

P.O. BOX 12748 • HOUSTON, TEXAS 77217-2748
PHONE: (713) 649-8785 • FAX: (713) 644-9628 • 1-800-394-4550

*** ACTUAL MATERIAL TEST REPORT ***

CUSTOMER ORDER #	DATE	OUR ORDER #
164264	09/10/98	38617

SOLD: HOLOX
SHIP: HOLOX

ITEMS

ITM	QTY	PRODUCT CODE	/ HEAT #	DESCRIPTION
1	20	A	/BN4591	ERTI-7 1/16 X 36 AWS A5.16

CHEMICAL PROPERTIES

ITM	HEAT #	C	Fe	O	N	FE	PD	TI
	BN4591	.01	.038	.0014	.007	.03	.184	BAL

CHEMICAL PROPERTIES

ITM HEAT #

PHYSICAL PROPERTIES

ITM	YIELD STRENGTH	TENSILE STRENGTH	ELONG. % IN 2"	REC. AREA	HARDNESS	CHARPY TEST	LAT. EXPAN.	SHEAR % FRAC.	TEST TEMP
1									

NOTES

MAT'L. I.D. NO. P150 P.O. NO. 40153
SPEC. ERTI-7 INITIAL MJS

This certification is provided by American Filler Metals Inc. with the understanding that if the product covered does not conform to the stated specifications, there shall be no personal liability of any kind by the undersigned. Furthermore, the obligation and liability (of such non-conformance) by American Filler Metals, Inc. will be limited to: a) furnishing the purchaser with a product conforming to the correct specifications, at no additional charge, or b) to refund the full purchase price paid for such non-conforming product. American Filler Metals, Inc. will not be liable for consequential damage.

Authorized Representative

1/8/01 SB

Copies made and sent to QA records
SB 3/22/01

B 265

TABLE 1 Chemical Requirements

Element	Composition, %									
	Grade									
	1	2	3	4	5	6	7	10	11	12
Nitrogen, max	0.03	0.03	0.05	0.05	0.05	0.05	0.03	0.05	0.03	0.03
Carbon, max	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.08
Hydrogen,[A] max	0.015	0.015†	0.015	0.015	0.015	0.020	0.015	0.020	0.015	0.015
Iron, max	0.20	0.30	0.30	0.50	0.40	0.50	0.30	0.35	0.20	0.30
Oxygen, max	0.18	0.25	0.35	0.40	0.20	0.20	0.25	0.18	0.18	0.25
Aluminum	...	...	...	...	5.5 to 6.75	4.0 to 6.0	...	...	...	...
Vanadium	...	...	...	...	3.5 to 4.5	...	...	...	...	...
Tin	...	...	...	...	...	2.0 to 3.0	...	3.75 to 5.25	...	...
Palladium	...	...	...	...	...	...	0.12 to 0.25	...	0.12 to 0.25	...
Molybdenum	...	...	...	...	...	...	...	10.0 to 13.0	...	0.2 to 0.4
Zirconium	...	...	...	...	...	...	...	4.50 to 7.50	...	...
Nickel	...	...	...	...	...	...	...	...	...	0.6 to 0.9
Residuals[B,C] (each), max	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Residuals[B,C] (total), max	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Titanium[D]	remainder	remainder	remainder	remainder	remainder	remainder	remainder	remainder	remainder	remainder

[A] Lower hydrogen may be obtained by negotiation with the manufacturer.
[B] Need not be reported.
[C] A residual is an element present in a metal or an alloy in small quantities inherent to the manufacturing process but not added intentionally.
[D] The percentage of titanium is determined by difference.
† Editorially corrected.

1/8/01 SB

Ti 7 Long-Term Potentiostatic Holds @ 0 VSCE
In Cl Solutions

Cell #1
Solution:
116.88g NaCl Lot# 010166
8.40g NaF Lot# 991559
92.80g $NaNO_3$ Lot# 9617724
261.36 Na_2SO_4 Lot# 901213
+ DI water To 2000 mls

Start wt = 6.445g
End wt = 6.420g 8-1-01 BKO
PH I = 8.604
PH F = 8.092 8-1-01 BKO
Reference: Fisher 13-620-52 SN# 0052123
Temp: 95°C Hg Thermometer SN# 110858 cal 5/3/02

Cell #2
Solution
116.89g NaCl Lot# 010166
0.842g NaF Lot# 991559
92.83g $NaNO_3$ Lot# 9617724
261.35g Na_2SO_4 Lot# 901213
+ DI water To 2000 mls

Start wt = 6.403g
End wt = 6.402g 8-1-01 BKO
PH I = 6.942
PH F = 7.780 8-1-01 BKO
Reference: Fisher 13-620-52 SN# 8260481
Temp = 95°C Hg Thermometer SN# H00-387 cal 11/15/01

Cell #3
Solution
108.73g NaCl Lot# 010166
19.324g NaF Lot# 991559
93.50g $NaNO_3$ Lot# 9617724
159.04g Na_2SO_4 Lot# 901213
+ DI water To 2000 mls

Start wt = 6.405g
End wt = 6.395g 8-1-01 BKO
PH I = 8.358
PH F = 8.290 8-1-01 BKO
Reference = Fisher 13-620-52 SN# 8238341
Temp = 95°C Hg Thermometer SN# H98-162 cal 5/1/02

All weight measurements Taken with
OHaus Precision Standard Scale SN# 2883 cal 3/2/01

All PH measurements Taken with
Fisher Accumet 950 meter SN# 3340 cal 7/20/00 - Cal 7/24/01
Probe # 13-620-296 SN# 1100208

6/12/01

Ti 7 Long-Term Potentiostatic Holds @ 0 VSCE
In Cl Solutions

Cell #4
Solution
448.83g NaCl Lot# 010166
6.047g NaF Lot# 991559
394.36g $NaNO_3$ Lot# 9617724
42.32g Na_2SO_4 Lot# 901213
+ DI water To 2000 mls

Start wt = 6.431g
End wt = 6.426g 8-1-01 BKO
PH I = 6.847
PH F = 7.905 8-1-01 BKO
Reference = Fisher 13-620-52 SN# 8205244
Temp = 95°C Hg Thermometer SN# C98-132 cal 8/8/00

Cell #5
Solution
116.88g NaCl Lot# 010166
9.413g NaF Lot# 991559
102.00g $NaNO_3$ Lot# 9617724
11.084g Na_2SO_4 Lot# 901213
+ DI water To 2000 mls

Start wt = 6.428g
End wt = 6.427g 8-1-01 BKO
PH I = 6.808
PH F = 8.572 8-1-01 BKO
Reference = Fisher 13-620-52 SN# 8238321
Temp = 95°C Hg Thermometer SN# C96-852 cal 11-1-00

Cell #6
Solution
116.89g NaCl Lot# 010166
1.581g NaF Lot# 991559
101.99g $NaNO_3$ Lot# 9617724
11.089g Na_2SO_4 Lot# 901213
+ DI water To 2000 mls

Start wt = 6.441g
End wt = 6.438g 8-1-01 BKO
PH I = 6.328
PH F = 7.791 8-1-01 BKO
Reference = Fisher 13-620-52 SN# 7282317
Temp = 95°C Hg Thermometer SN# C96-816 cal 11-1-00

All weight measurements Taken with
OHaus Precision Standard Scale SN# 2883 cal 3/2/01

All PH measurements Taken with
Fisher Accumet 950 meter SN# 3340 cal 7/20/00 - Cal 7/24/01
Probe # 13-620-296 SN# 1100208

* Test Stopped 7-31-01 *

6/12/01

Copies made & sent to QA records

[signature] 9/17/2001

Potentiostatic Test of Ti_2

objective: To measure Crevice Corrosion on Ti_2 specimen

Specimen: Ti_2 Polished To 600 Grit Finish - 2 PTFE Crevice washers Attached At 50 In-Oz Using Pro 6104 SN# 314047 cal 6/4/01
Start wt: 15.87147g Sartorious Genius SN# 12809099 cal 6/22/01
End wt: Not Taken

Solution: 1 m Cl^-
146.108g NaCl Lot# 015568
+ DI water To 2500 mls

Start pH = 6.589 Fisher Acumet 950 meter SN# 3340 cal 7/24/01
End pH = Not Taken PH Probe 13-620-296 SN# 1100208

Temperature 95°C Hg Thermometer SN# C96-833 cal 6/26/01

Potentiostat - Gamry model # PC4/750

Reference - Fisher 13-620-52 SN# 8205245

Econn -640mv Keithley 614 SN# 467374 cal 10/4/01
Ept -169mv

Solution Deaerated with 99.999% N_2

Specimen Assembled wet In Test Solution - Also 1 PTFE Crevice washer was Inverted
Specimen Examination - will Repolish for further Testing

* Test Shutdown Results Inconclusive
[signature] 12/3/01 [signature] 11/20/01

Galvanostatic Test of Ti_2

objective: To Measure Crevice Corrosion on Ti_2 Specimen

Specime: Ti_2 Polished To 600 Coat Finish
2 PTFE Crevice Washers Attached At 50 In-Oz
Using Proto 6104 SN# 314047 cal 6/4/01

Start wt 15.84510 g Sartorius Genius SN# 12809099 cal 6/26/01
End wt 13.95473 g

Solution 1m Cl^-
146.142 g NaCl Lot # 015568
+ DI water To 2500 mls

Start pH: 6.753 Fisher Accumet 950 meter SN# 3340 cal 7/24/01
End pH: 4.203 pH Probe 13-620-296 SN# 100208

Temperature: 95°C Hg Thermometer SN# C96-833 cal 6/26/01

Potentiostat: Solartron 1287

Reference: Fisher 13-620-52 SN# 8205245

Econ: -530 mv Keithley 614 SN# 467374 cal 10/4/01
Ept: +60 mv

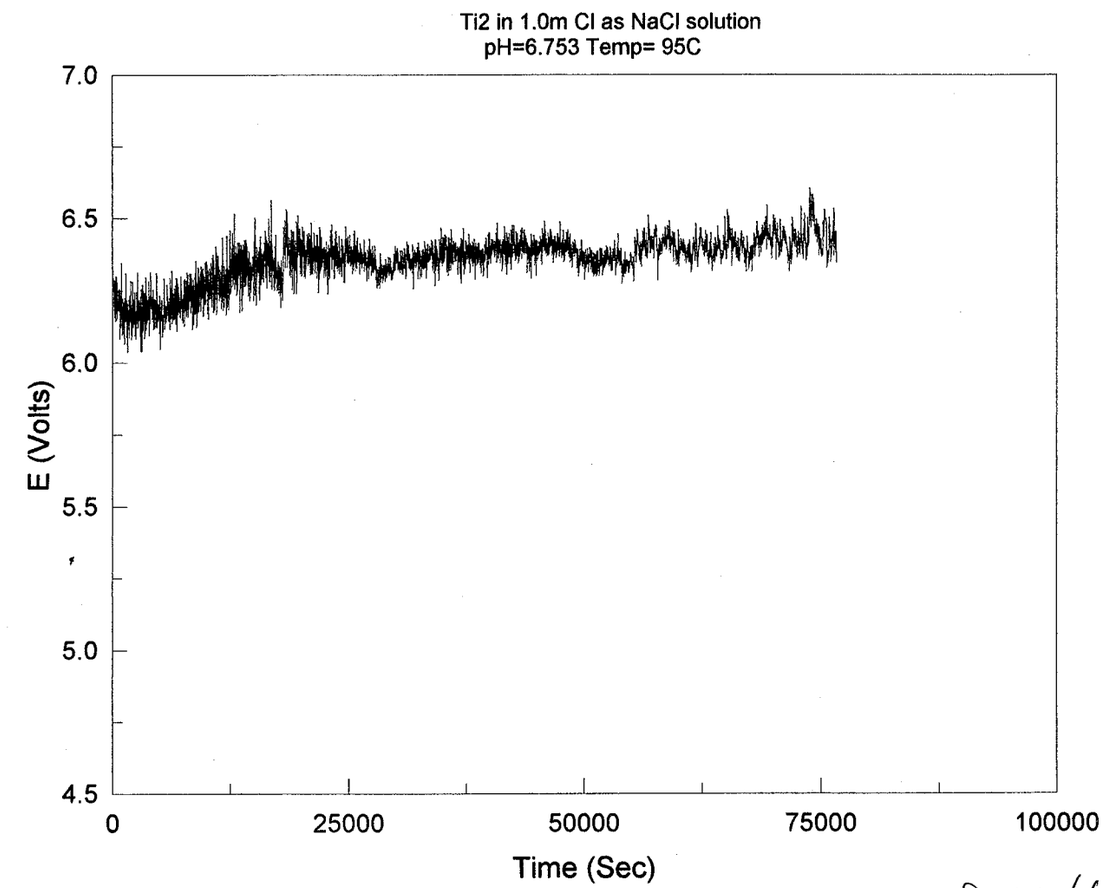
Solution Deaerated with 99.999% N_2

Specimen Assembled wet In Test Solution - with 1 PTFE Crevice washer Inverted

Specimen Examination - Crevice Corrosion Noticed on Specimen
Also All Surfaces of Specimen Are Deteriorated

12/5/01

Test Data Ti2 galvastat1.con



12/6/01

12/6/01

Galvanostatic Test of ~~Ti2~~ Ti7 12/6/01

Objective: To measure Crevice Corrosion on Ti7 Specimen

Specimen: Ti7 Polished To 600 Grit Finish
2 PTFE Crevice washers Attached At 50 In-Oz
Using Proto 6104 SN# 314047 Cal 6/4/01

Start wt = 16.72151g Sartorious Genius SN# 12809099 Cal 6/22/01
End wt = 14.83953g

Solution = 1m Cl^-
146.153g NaCl Lot# 015564
+ DI water To 2500mls

Start pH = 6.547 Fisher Accumet 950 meter SN# 3340 Cal 7/24/01
End pH = 6.055

Temperature = 95°C Hg Thermometer SN# C96-833 Cal 6/26/01

Potentiostat = Solartron 1287

Reference = Fisher 13-620-52 SN# 8205245

Econ = +156 Keithley 614 SN# 467374 Cal 10/4/01
Ept = -445

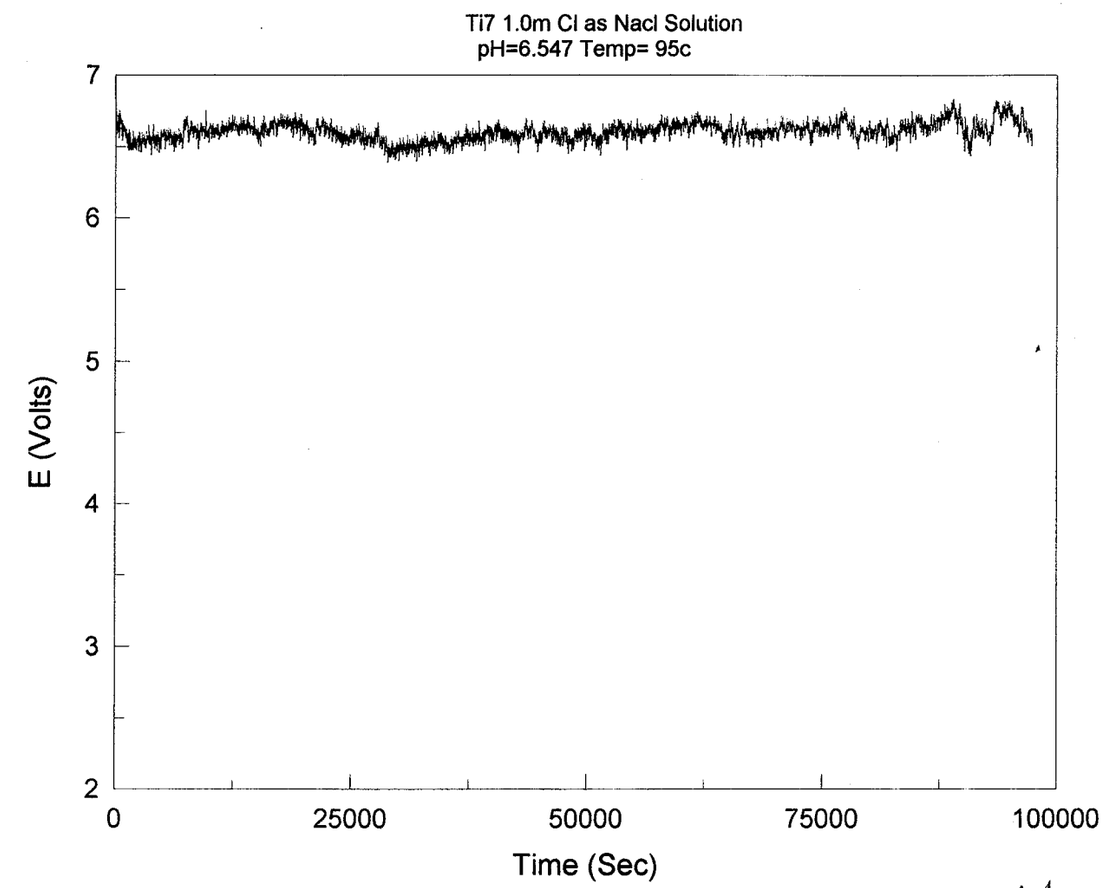
Solution Deaerated with 99.999% N_2

Specimen Assembled wet In Test Solution - with 1 PTFE Crevice washer Inverted

Specimen Examination: Crevice Corrosion Noticed on Specimen
All Surfaces of Specimen Are Deteriorated

12/6/01

Test Data Ti7 galvanostat1.Com



12/7/01

12/7/01

Copies to QA

3/12/02 SFB

9/5/02 SFB

I have reviewed this scientific notebook and find it in compliance with QAP-001. There is sufficient information regarding procedures used for conducting tests, acquiring and analyzing data so that another qualified individual could repeat the activity.

9/27/2004