

## Appendix E3

### SEM/EDS Data for Test #3, Day-30 Galvanized Steel Coupons

#### Figures

Figure E3-1.	SEM image magnified 100 times for a Test #3, Day-30 suspended galvanized steel coupon. (T3D30GalSteelSusp012).....	E3-5
Figure E3-2.	SEM image magnified 1000 times for a Test #3, Day-30 suspended galvanized steel coupon. (T3D30GalSteelSusp013).....	E3-5
Figure E3-3.	Backscattered SEM image magnified 250 times for a Test #3, Day-30 suspended galvanized steel coupon. (T3D30GalSteelSusp014).....	E3-6
Figure E3-4.	Annotated backscattered SEM image magnified 250 times for a Test #3, Day-30 suspended galvanized steel coupon. (T3D30GalSteelSusp014).....	E3-6
Figure E3-5.	EDS counting spectrum for the white spot (EDS1) shown in Figure E3-4. (T3D30SuspGal09).....	E3-7
Figure E3-6.	Annotated SEM image magnified 100 times for a Test #3, Day-30 suspended galvanized steel coupon. (T3D30GalSteelSusp012).....	E3-7
Figure E3-7.	EDS counting spectrum for an egg shaped particle (EDS2) shown in Figure E3-6 (T3D30SuspGal10).....	E3-8
Figure E3-8.	EDS counting spectrum for the smooth surface (EDS3) shown in Figure E3-6. (T3D30SuspGal12).....	E3-8
Figure E3-9.	EDS counting spectrum for a porous irregular particle (EDS4) shown in Figure E3-6. (T3D30SuspGal11).....	E3-9
Figure E3-10.	SEM image magnified 100 times for a Test #3, Day-30 submerged galvanized steel coupon. (T3D30GalSteelSubm009).....	E3-9
Figure E3-11.	SEM image magnified 1000 times for a Test #3, Day-30 submerged galvanized steel coupon. (T3D30GalSteelSubm010).....	E3-10

Figure E3-12. Backscattered SEM image magnified 100 times for a Test #3, Day-30 submerged galvanized steel coupon. (T3D30GalSteelSubm011).....E3-10

Figure E3-13. Annotated SEM image magnified 100 times for a Test #3, Day-30 submerged galvanized steel coupon. (T3D30GalSteelSubm009).....E3-11

Figure E3-14. EDS counting spectrum for the white surface (EDS5) shown in Figure E3-13. (T3D30SubmGal07).....E3-11

Figure E3-15. EDS counting spectrum for the dark surface (EDS6) shown in Figure E3-13. (T3D30SubmGal08).....E3-13

### **Tables**

Table E3-1. Chemical Compositions for T3D30SubmGal07, Figure E3-14.....E3-12

Table E3-2. Chemical Compositions for T3D30SubmGal08, Figure E3-15.....E3-14

This appendix shows the SEM/EDS results for the metal galvanized steel coupons under two categories: (1) suspended and (2) submerged. Suspended refers to coupons located above the water level of the solution during ICET tests. Suspended coupons were contacted with the solution only during the 4-hour spraying period at the initial date of the test. In addition, the surface of the suspended coupons may also be affected by the moisture in the test chamber gas space during the test. Submerged refers to the coupons that were submerged in the solution during the test.

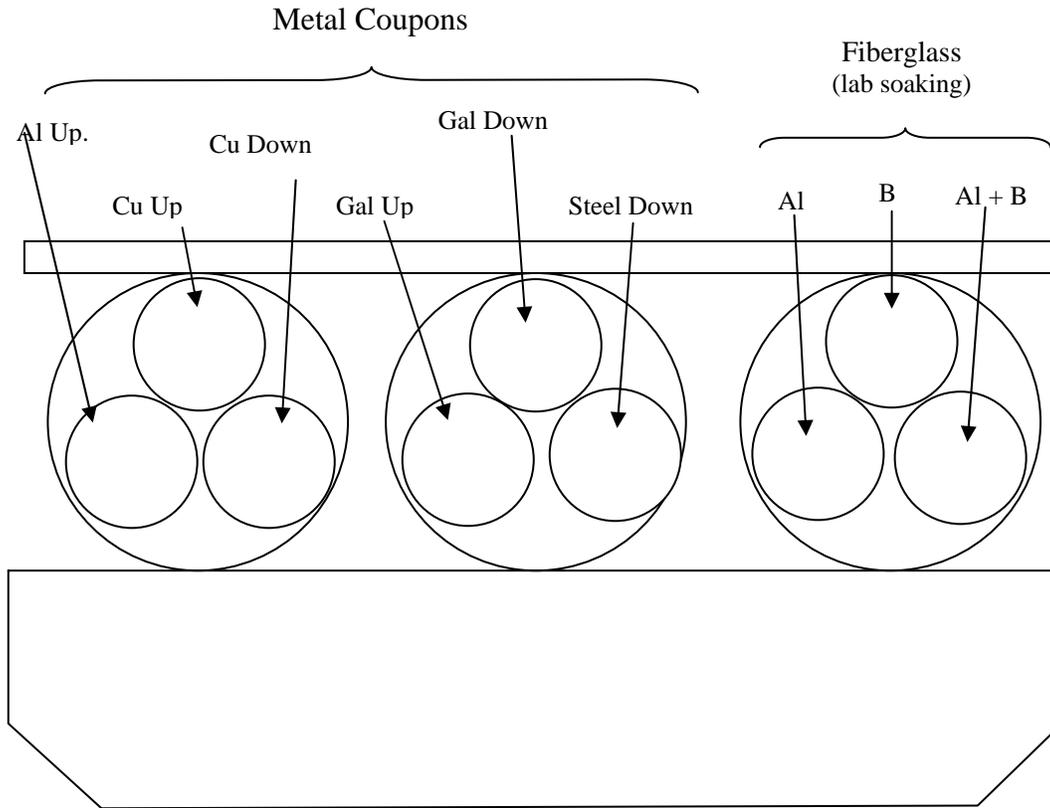
The coupon samples were collected on May 5, 2005 (the date Test #3 was shut down), and subsequently examined by SEM/EDS. The galvanized steel coupon samples were dried in air before coating with Au/Pd for SEM examination. SEM results present the surface condition of the galvanized steel coupons. In addition, EDS results provide a semi-quantitative elemental analysis of the coupon surface and the corrosion products. Available logbook entries for this laboratory session are included in this appendix as transcribed notes.

This page is intentionally blank.

## Transcribed Laboratory Log

Laboratory session from May 17, 2005.

Test #3, Day-30 Metal Coupons



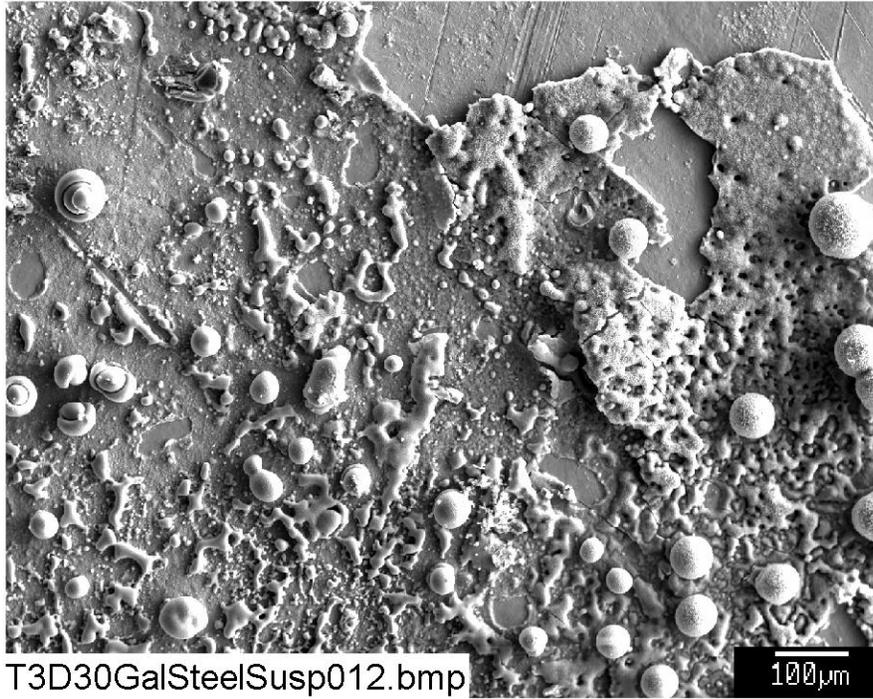
\*\*Coat with Gold

### Suspended Gal-Steel

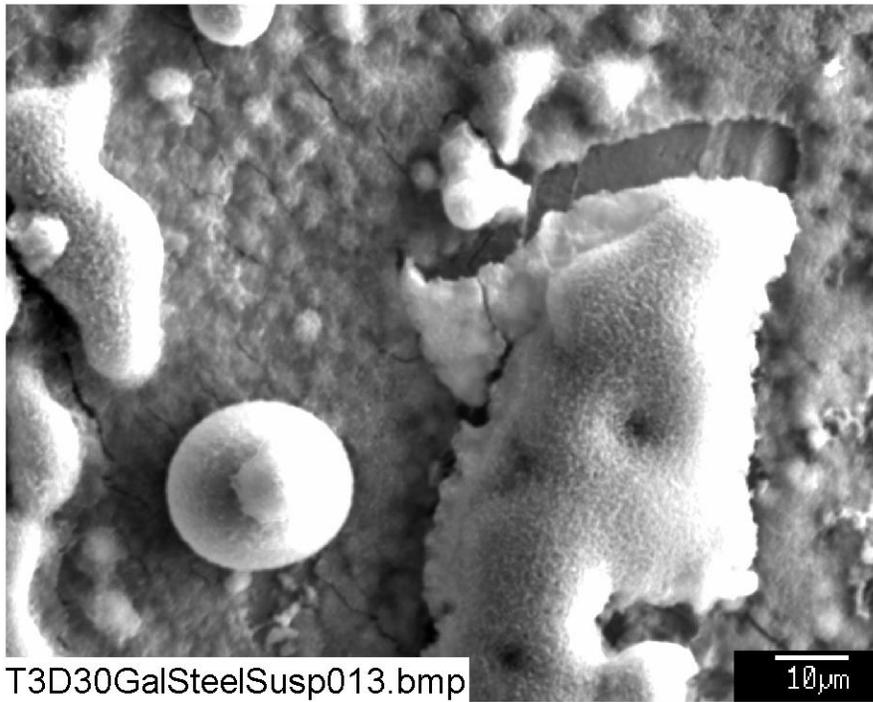
Image:	T3D30GalSteelSusp012	100 ×		Figure E3-1
	T3D30GalSteelSusp013	1000 ×		Figure E3-2
	T3D30GalSteelSusp014	250 ×	Backscattered image	Figure E3-3
	T3D30GalSteelSusp014	250 ×	Annotated backscatter SEM	Figure E3-4
EDS:	T3D30SuspGal09		White spot on 014	Figure E3-5
Image:	T3D30GalSteelSusp012	100 ×	Annotated SEM image	Figure E3-6
EDS:	T3D30SuspGal10		Egg shaped particle on 014	Figure E3-7
	T3D30SuspGal12		Smooth surface on 012	Figure E3-8
	T3D30SuspGal11		Porous irregular shape on 014	Figure E3-9

### Submerged Gal-Steel

Image:	T3D30GalSteelSubm009	100 ×		Figure E3-10
	T3D30GalSteelSubm010	1000 ×		Figure E3-11
	T3D30GalSteelSubm011	100 ×	Backscattered image	Figure E3-12
	T3D30GalSteelSubm009	100 ×	Annotated SEM image	Figure E3-13
EDS:	T3D30SubmGal07		White surface shown in 009	Figure E3-14
	T3D30SubmGal08		Dark surface shown in 009	Figure E3-15



**Figure E3-1.** SEM image magnified 100 times for a Test #3, Day-30 suspended galvanized steel coupon. (T3D30GalSteelSusp012)



**Figure E3-2.** SEM image magnified 1000 times for a Test #3, Day-30 suspended galvanized steel coupon. (T3D30GalSteelSusp013)

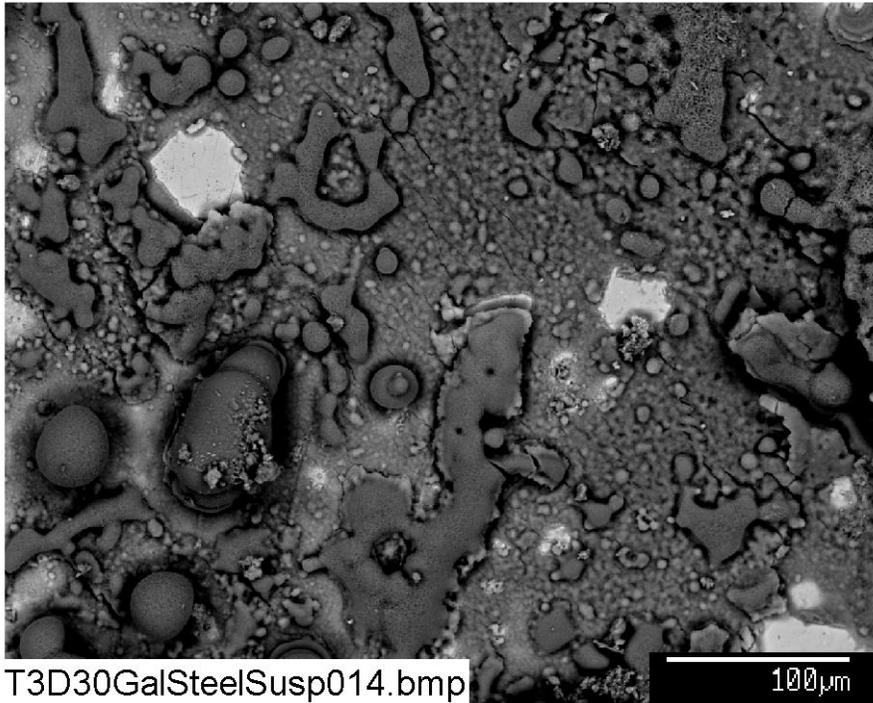


Figure E3-3. Backscattered SEM image magnified 250 times for a Test #3, Day-30 suspended galvanized steel coupon. (T3D30GalSteelSusp014)

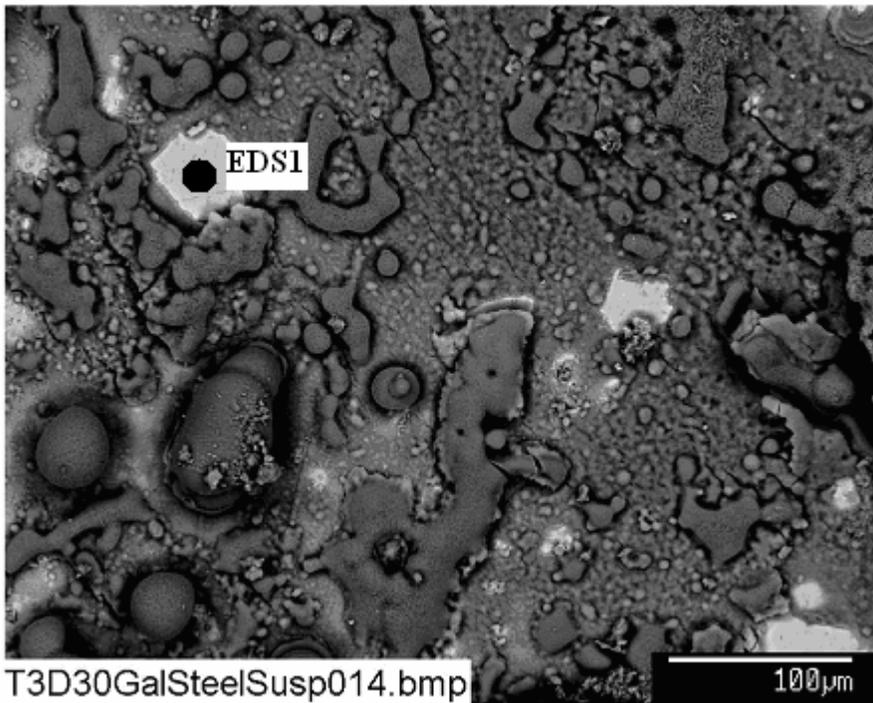


Figure E3-4. Annotated backscattered SEM image magnified 250 times for a Test #3, Day-30 suspended galvanized steel coupon. (T3D30GalSteelSusp014)

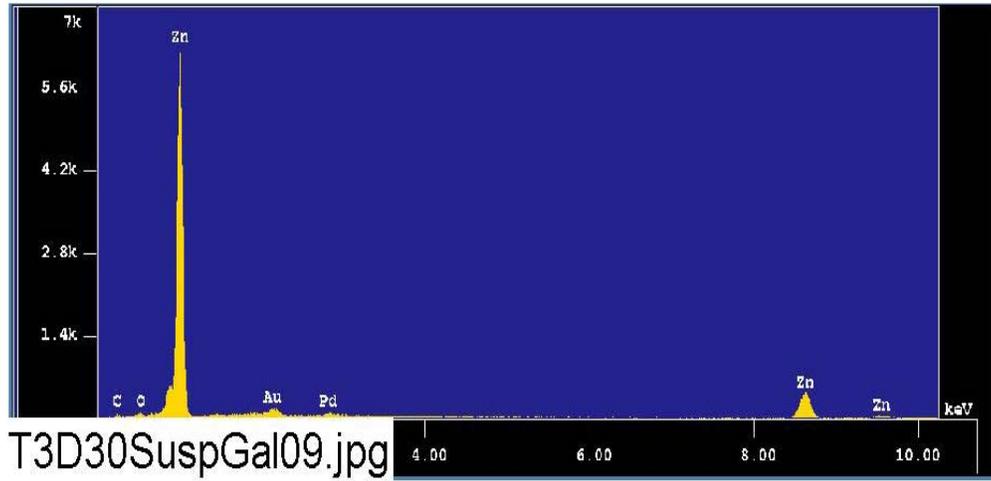


Figure E3-5. EDS counting spectrum for the white spot (EDS1) shown in Figure E3-4. (T3D30SuspGal09)

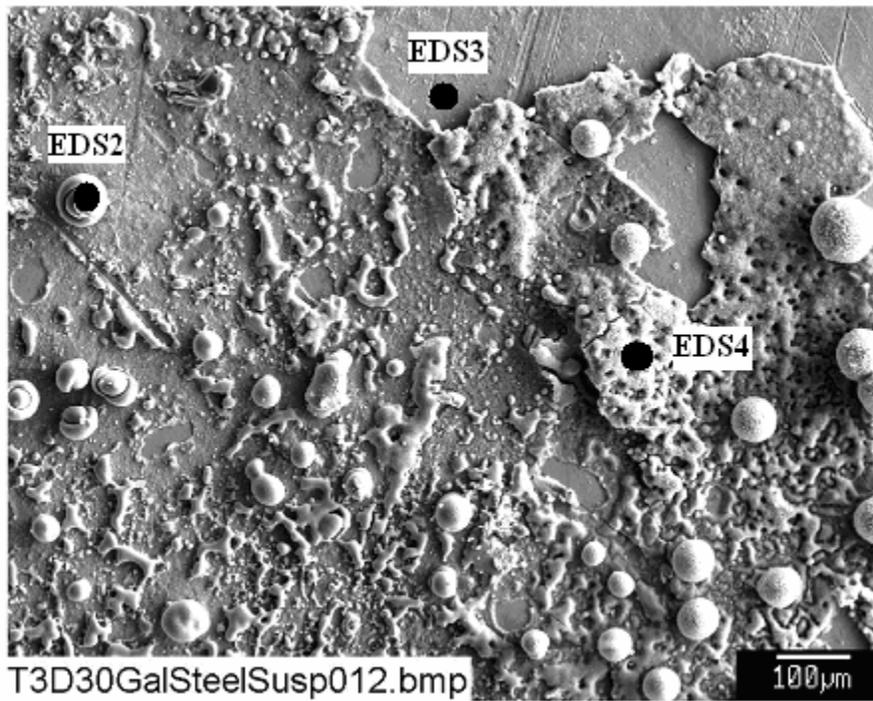


Figure E3-6. Annotated SEM image magnified 100 times for a Test #3, Day-30 suspended galvanized steel coupon. (T3D30GalSteelSusp012)

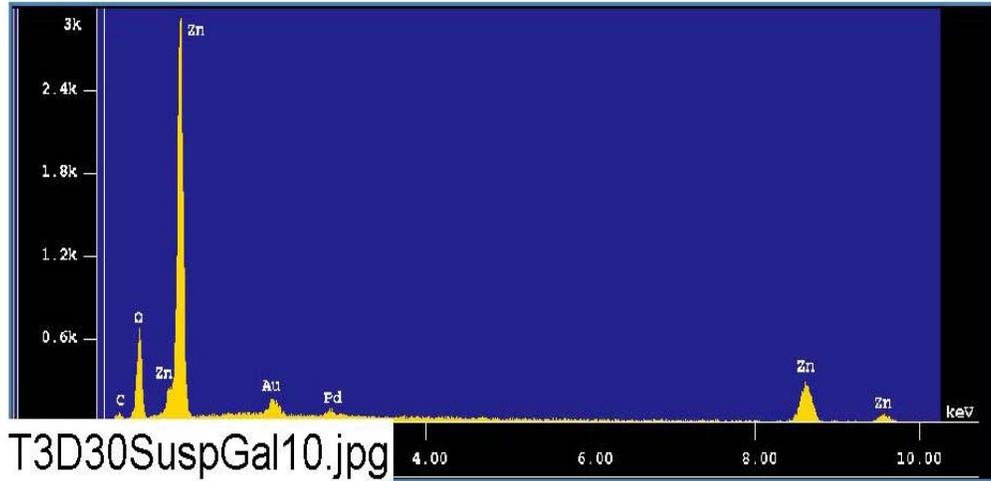


Figure E3-7. EDS counting spectrum for an egg shaped particle (EDS2) shown in Figure E3-6 (T3D30SuspGal10)

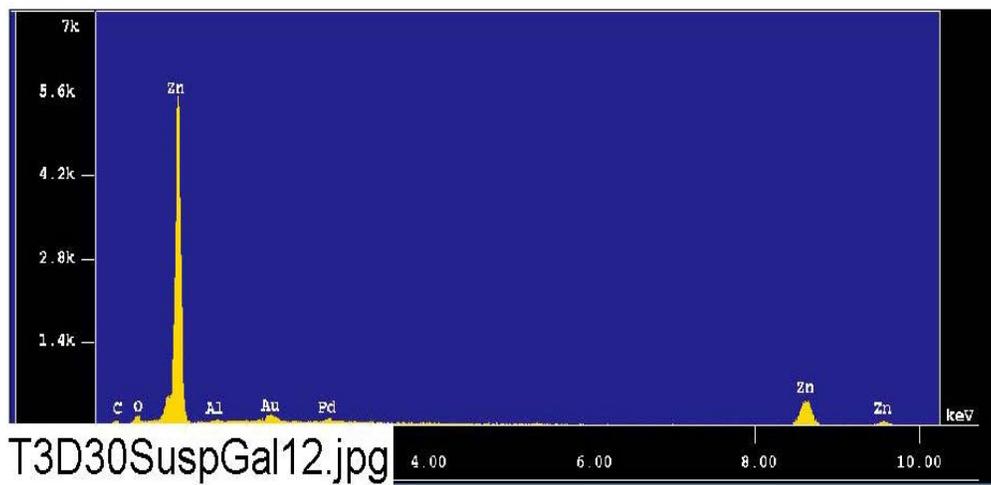


Figure E3-8. EDS counting spectrum for the smooth surface (EDS3) shown in Figure E3-6. (T3D30SuspGal12)

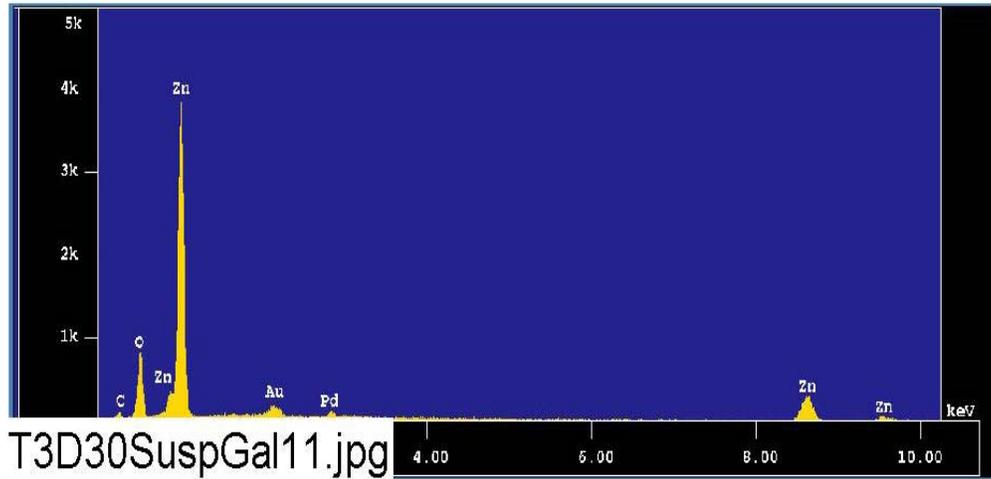


Figure E3-9. EDS counting spectrum for a porous irregular particle (EDS4) shown in Figure E3-6. (T3D30SuspGal11)

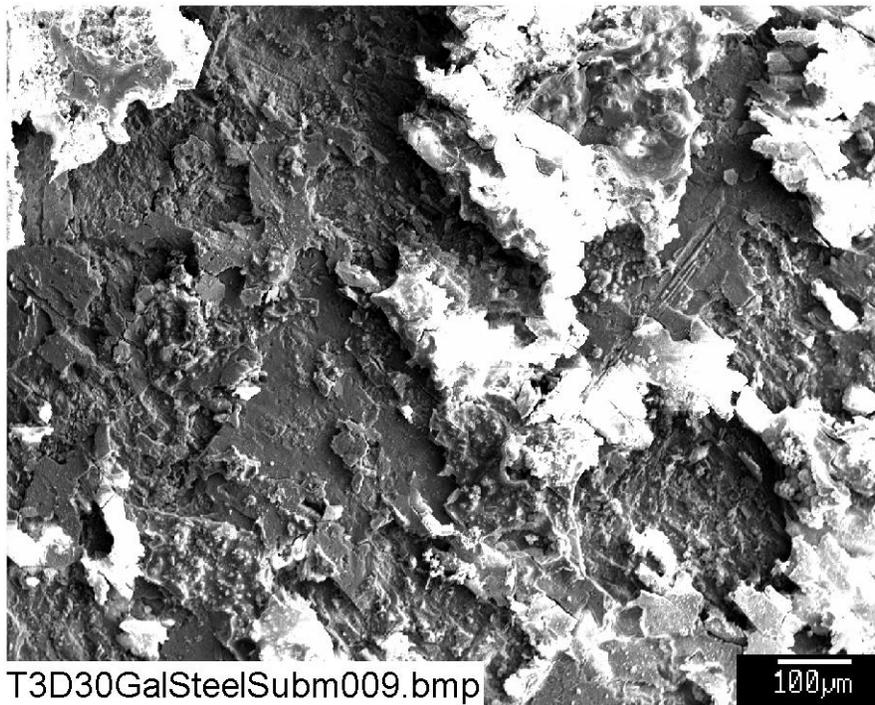
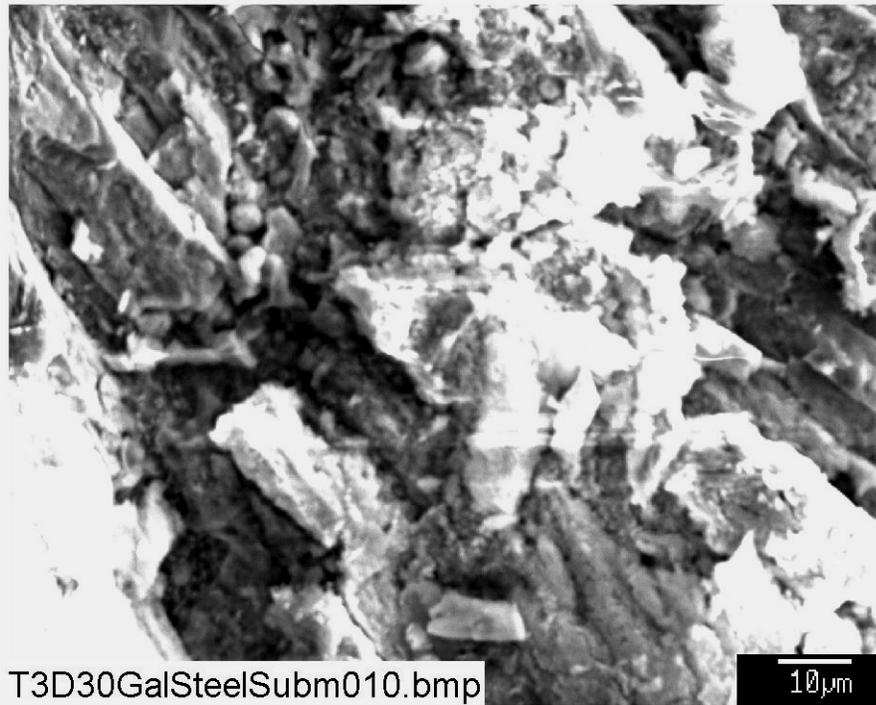
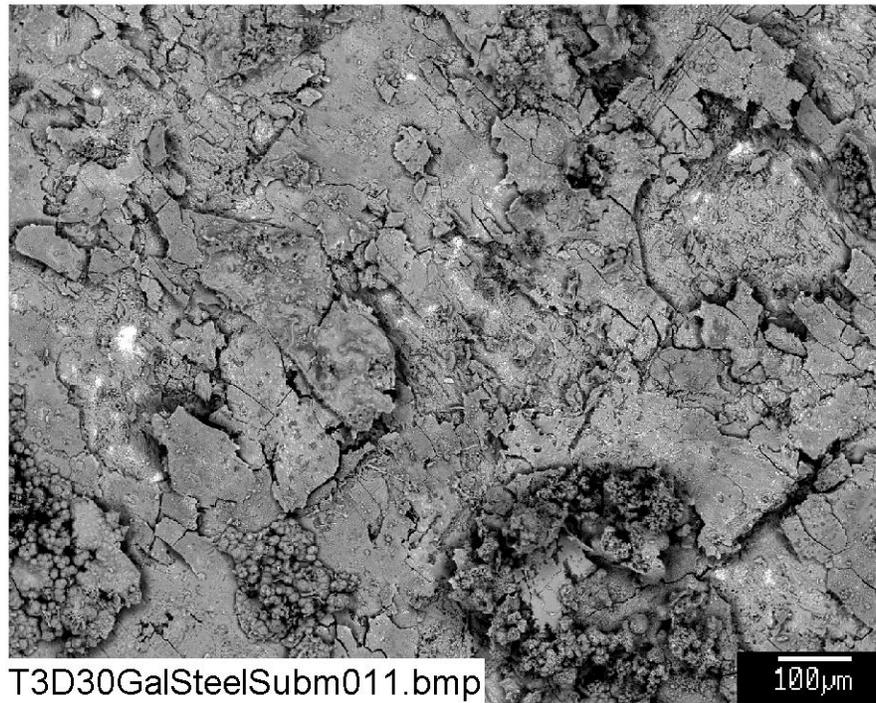


Figure E3-10. SEM image magnified 100 times for a Test #3, Day-30 submerged galvanized steel coupon. (T3D30GalSteelSubm009)



**Figure E3-11.** SEM image magnified 1000 times for a Test #3, Day-30 submerged galvanized steel coupon. (T3D30GalSteelSubm010)



**Figure E3-12.** Backscattered SEM image magnified 100 times for a Test #3, Day-30 submerged galvanized steel coupon. (T3D30GalSteelSubm011)

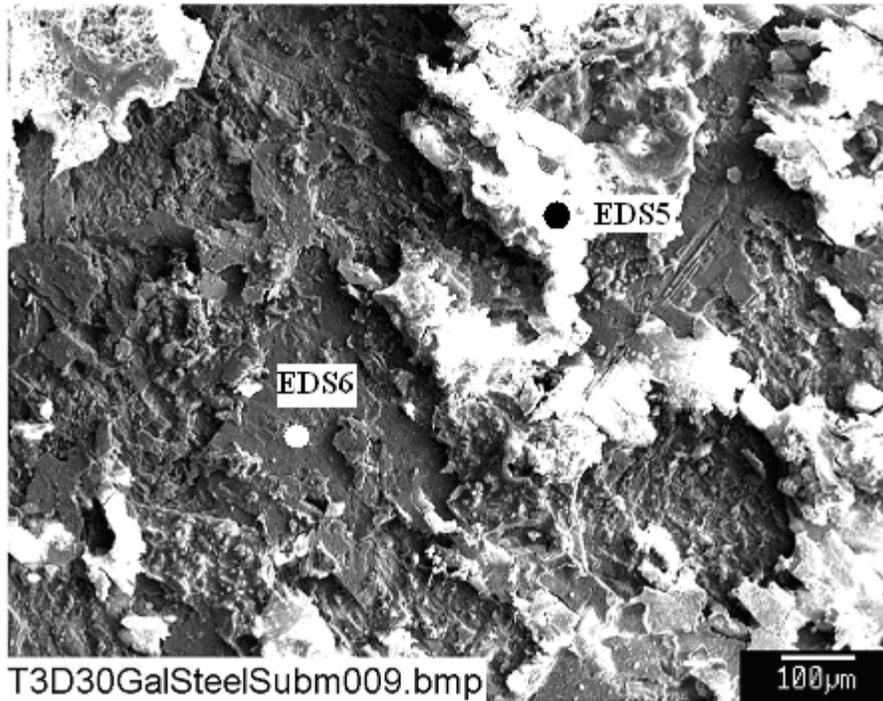


Figure E3-13. Annotated SEM image magnified 100 times for a Test #3, Day-30 submerged galvanized steel coupon. (T3D30GalSteelSubm009)

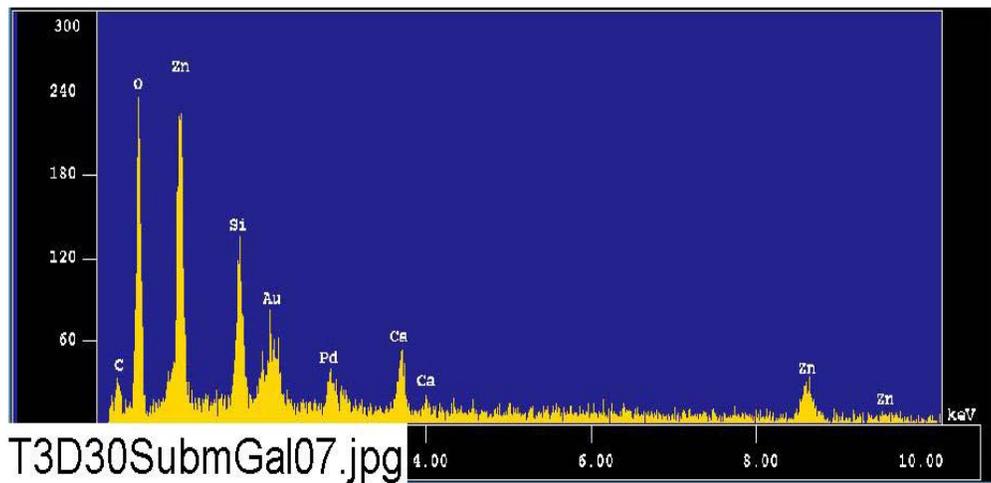


Figure E3-14. EDS counting spectrum for the white surface (EDS5) shown in Figure E3-13. (T3D30SubmGal07)

The results from the chemical composition analysis for T3D30SubmGal07 are given in Table E3-1.

**Table E3-1. Chemical Compositions for T3D30SubmGal07, Figure E3-14**

May 17 2005

```

Group      : NRC
Sample     : Test3 ID# : 10
Comment    : Submerged Galsteel
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec Aperture # : 2
             Acc. Volt  : 15.0 KV Probe Current : 7.359E-09 A
             Stage Point : X=47.136 Y=56.832 Z=10.582
             Acq. Date  : Tue May 17 12:05:14 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
O K	Normal	0.25- 0.77	6.4123	0.0018	1466 /	24
Si K	Normal	1.50- 2.05	1.1657	0.0004	1031 /	33
Ca K	Normal	3.40- 4.30	0.9216	0.0044	396 /	16
Zn K	Normal	8.22-10.03	5.9921	0.0061	396 /	3
C K	Normal	0.09- 0.46	0.0000	0.0000	0 /	42

-----  
 Chi\_square = 7.3085

Element	Mass%	Atomic%	ZAF	Z	A	F
O	39.582	67.4180	0.9868	0.9165	1.0768	1.0000
Si	10.788	10.4670	1.4794	0.9181	1.6115	0.9999
Ca	5.422	3.6863	0.9405	0.9224	1.0205	0.9991
Zn	44.208	18.4286	1.1794	1.1810	0.9986	1.0000
C	0.000	0.0000	5.1734	0.9614	5.3811	1.0000

-----

Total	100.000	100.0000				
Normalization factor =		6.2556				
C	1.633	4.8654	5.2838	0.9099	5.8071	1.0000
P	2.298	2.6548	1.0399	1.0402	0.9998	0.9999
Fe	2.399	1.5375	0.9896	1.0503	1.0060	0.9366

-----  
 Total 100.000 100.0000  
 Normalization factor = 3.2486

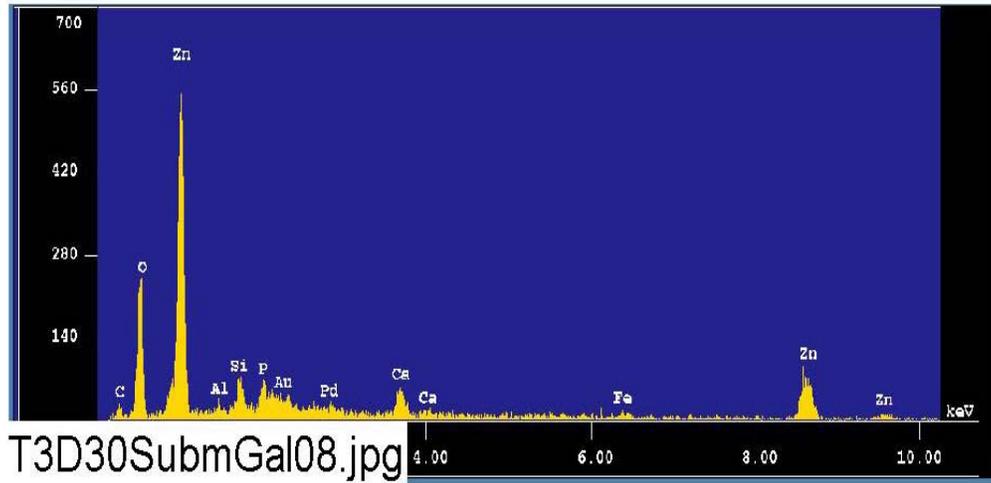


Figure E3-15. EDS counting spectrum for the dark surface (EDS6) shown in Figure E3-13. (T3D30SubmGal08)

The results from the chemical composition analysis for T3D30SubmGal08 are given in Table E3-2.

**Table E3-2. Chemical Compositions for T3D30SubmGal08, Figure E3-15**

May 17 : 2005

Group : NRC  
 Sample : Test3 ID# : 11  
 Comment : Submerged Galsteel dark surface  
 Condition : Full Scale : 20KeV(10eV/ch,2Kch)  
           Live Time : 60.000 sec Aperture # : 2  
           Acc. Volt : 15.0 KV Probe Current : 7.561E-09 A  
           Stage Point : X=47.136 Y=56.832 Z=10.582  
           Acq. Date : Tue May 17 12:11:13 2005

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
O K	Normal	0.25- 0.77	6.9828	0.0019	1640 /	20
Al K	Normal	1.26- 1.78	0.0611	0.0004	60 /	29
Si K	Normal	1.50- 2.05	0.4753	0.0003	432 /	28
Ca K	Normal	3.40- 4.30	0.8741	0.0049	386 /	10
Zn K	Normal	8.22-10.03	18.5840	0.0084	1260 /	2
C K	Normal	0.09- 0.46	0.0951	0.0003	33 /	45
P K	Normal	1.75- 2.38	0.6802	0.0018	381 /	36
Fe K	Normal	6.00- 7.44	0.7464	0.0009	134 /	10

-----  
 Chi\_square = 5.2540

Element	Mass%	Atomic%	ZAF	Z	A	F
O	21.727	48.5961	0.9578	0.8671	1.1047	0.9999
Al	0.371	0.4925	1.8718	0.8784	2.1318	0.9996
Si	2.465	3.1407	1.5964	0.8673	1.8413	0.9996
Ca	2.557	2.2833	0.9006	0.8692	1.0376	0.9986
Zn	66.549	36.4297	1.1023	1.1023	1.0000	1.0000
C	1.633	4.8654	5.2838	0.9099	5.8071	1.0000
P	2.298	2.6548	1.0399	1.0402	0.9998	0.9999
Fe	2.399	1.5375	0.9896	1.0503	1.0060	0.9366

-----  
 Total 100.000 100.0000  
 Normalization factor = 3.2486

## Appendix E4

### SEM/EDS Data for Test #3, Day-30 Steel Coupons

#### Figures

Figure E4-1. SEM image magnified 100 times for a Test #3, Day-30 suspended carbon steel coupon. (T3D30SteelSusp033) .....	E4-5
Figure E4-2. Annotated SEM image magnified 100 times for a Test #3, Day-30 suspended carbon steel coupon. (T3D30SteelSusp033) .....	E4-5
Figure E4-3. EDS counting spectrum for the convex surface (EDS1) shown in Figure E4-2. (T3D30SuspSteel19).....	E4-6
Figure E4-4. EDS counting spectrum for the lower surface (EDS2) shown in Figure E4-2. (T3D30SuspSteel21) .....	E4-6
Figure E4-5. Backscattered SEM image magnified 100 times for a Test #3, Day-30 suspended steel coupon. (T3D30SteelSusp034) .....	E4-7
Figure E4-6. Annotated backscattered SEM image magnified 100 times for a Test #3, Day-30 suspended steel coupon. (T3D30SteelSusp034) .....	E4-7
Figure E4-7. EDS counting spectrum for a dark particle close to the lower edge (EDS3) of Figure E4-6. (T3D30SuspSteel20) .....	E4-8
Figure E4-8. SEM image magnified 1000 times for a Test #3, Day-30 suspended carbon steel coupon. (T3D30SteelSusp035).....	E4-8
Figure E4-9. SEM image magnified 100 times for a Test #3, Day-30 submerged carbon steel coupon. (T3D30SteelSubm015) .....	E4-9
Figure E4-10. Backscattered SEM image magnified 100 times for a Test #3, Day-30 submerged carbon steel coupon. (T3D30SteelSubm016).....	E4-9
Figure E4-11. Annotated backscattered SEM image magnified 100 times for a Test #3, Day-30 submerged carbon steel coupon. (T3D30SteelSubm016).E4-10	
Figure E4-12. EDS counting spectrum for a dark spot (EDS4) shown in Figure E4-11. (T3D30SubmSteel13).....	E4-10

Figure E4-13. EDS counting spectrum for a light spot (EDS5) shown in Figure  
E4-11. (T3D30SubmSteel14).....E4-11

Figure E4-14. SEM image magnified 1000 times for a Test #3, Day-30 submerged  
carbon steel coupon. (T3D30SteelSubm017) .....E4-11

This appendix shows the SEM/EDS results for the metal steel coupons under two categories: (1) suspended and (2) submerged. Suspended refers to coupons located above the water level of the solution during ICET tests. Suspended coupons were contacted with the solution only during the 4-hour spraying period at the initial date of the test. In addition, the surface of the suspended coupons may also be affected by the moisture in the test chamber gas space during the test. Submerged refers to the coupons that were submerged in the solution during the test.

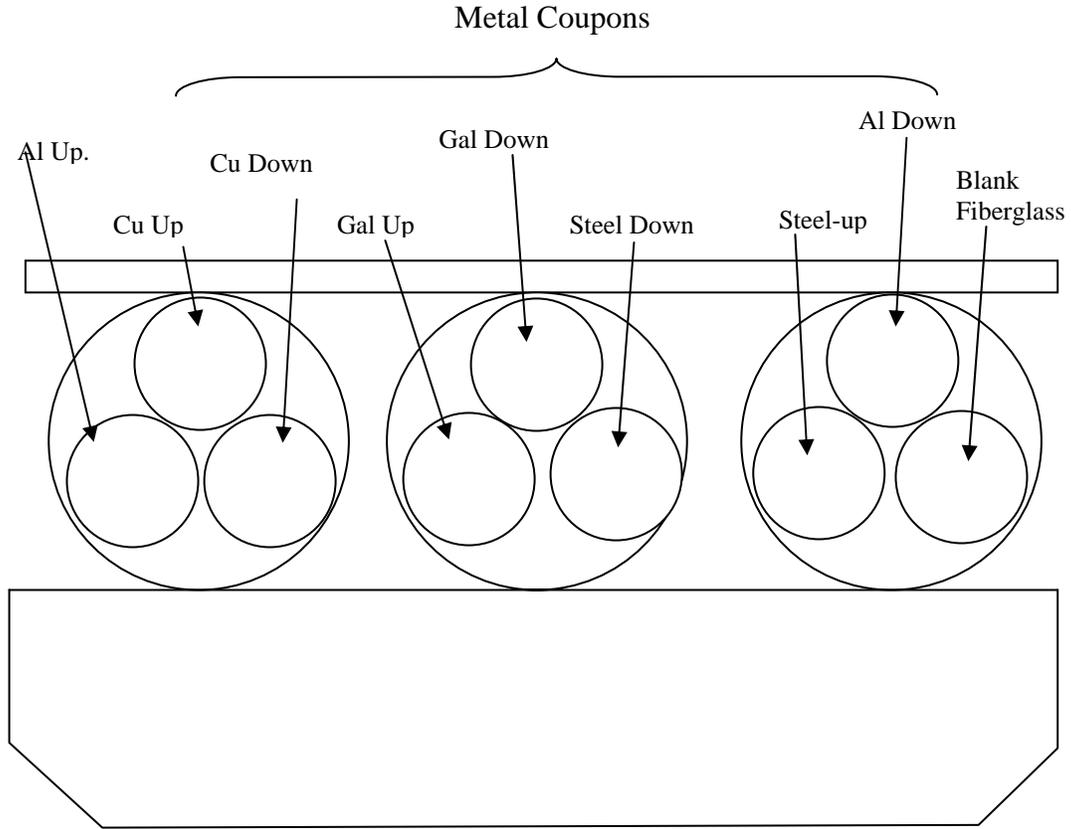
The coupon samples were collected on the date that Test #3 was shut down, May 5, 2005. The steel coupon samples were dried in air before coating with Au/Pd for SEM examination. SEM results present the surface condition of the steel coupons. In addition, EDS results provide a semi-quantitative elemental analysis of the coupon surface and the corrosion products. Available logbook entries for this laboratory session are included in this appendix as transcribed notes.

This page intentionally left blank.

## Transcribed Laboratory Log

Laboratory session from May 17, 2005.

Test #3, Day-30 Metal Coupons



\*\*Coat with Gold

### Suspended Steel

Image:	T3D30SteelSusp033	100 ×	SEM image	Figure E4-1
	T3D30SteelSusp033	100 ×	Annotated SEM image	Figure E4-2
EDS:	T3D30SuspSteel19		Convex on 033	Figure E4-3
	T3D30SuspSteel21		White flat surface on 033	Figure E4-4
Image:	T3D30SteelSusp034	100 ×	Backscattered	Figure E4-5
	T3D30SteelSusp034	100 ×	Annotated backscatter image	Figure E4-6
EDS:	T3D30SuspSteel20		Dark particle on 034	Figure E4-7
Image:	T3D30SteelSusp035	1000 ×		Figure E4-8

## Submerged Steel

Image:	T3D30SteelSubm015	100 ×		Figure E4-9
	T3D30SteelSubm016	100 ×	Backscattered image	Figure E4-10
	T3D30SteelSubm016	100 ×	Annotated backscattered image	Figure E4-11
EDS:	T3D30SubmSteel13		Dark spot on 016	Figure E4-12
	T3D30SubmSteel14		White spot on 016	Figure E4-13
Image:	T3D30SteelSubm017	1000 ×		Figure E4-14

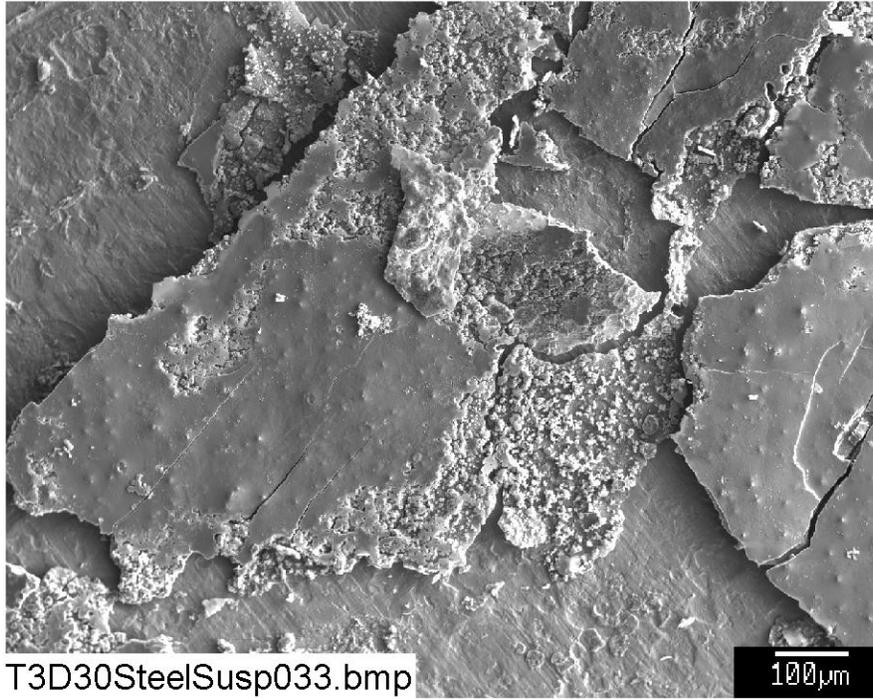


Figure E4-1. SEM image magnified 100 times for a Test #3, Day-30 suspended carbon steel coupon. (T3D30SteelSusp033)

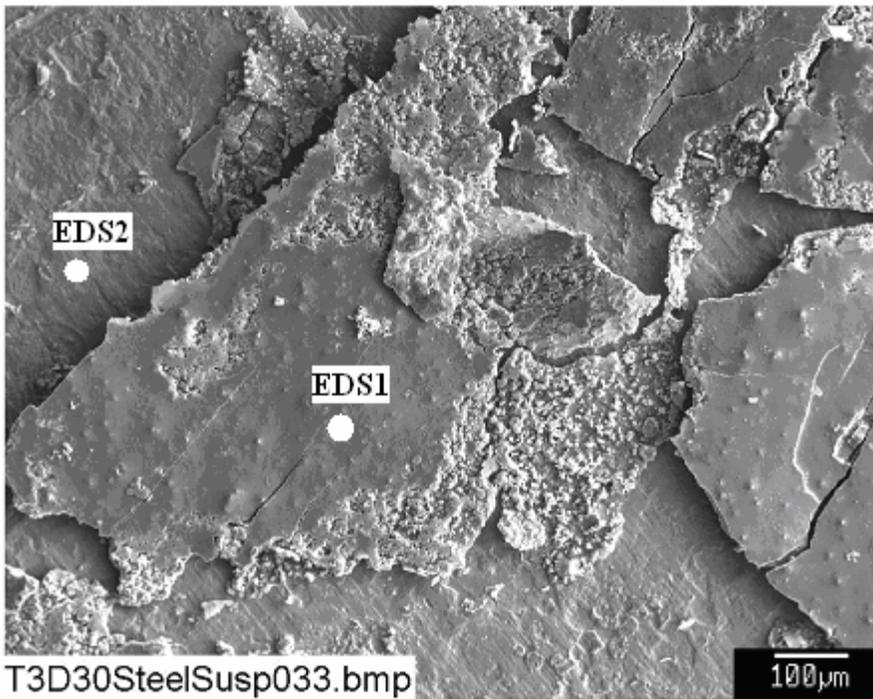


Figure E4-2. Annotated SEM image magnified 100 times for a Test #3, Day-30 suspended carbon steel coupon. (T3D30SteelSusp033)

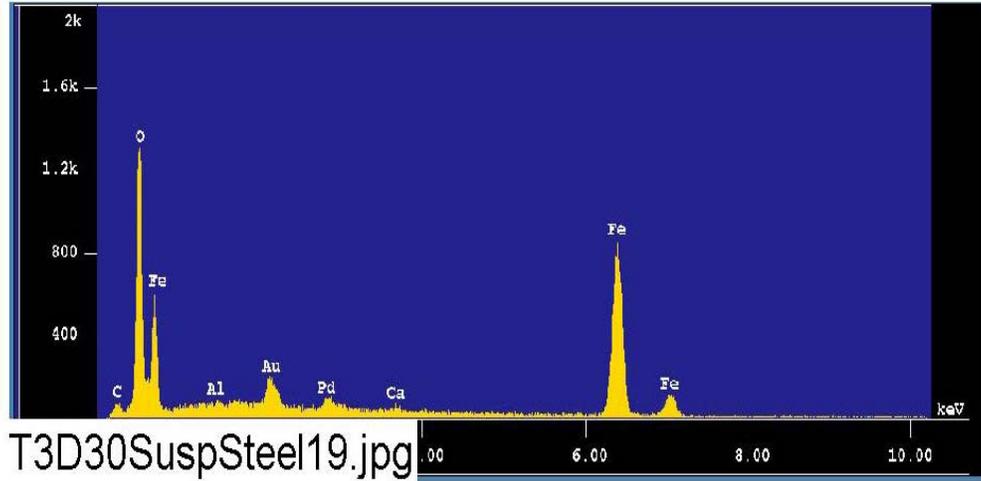


Figure E4-3. EDS counting spectrum for the convex surface (EDS1) shown in Figure E4-2. (T3D30SuspSteel19)

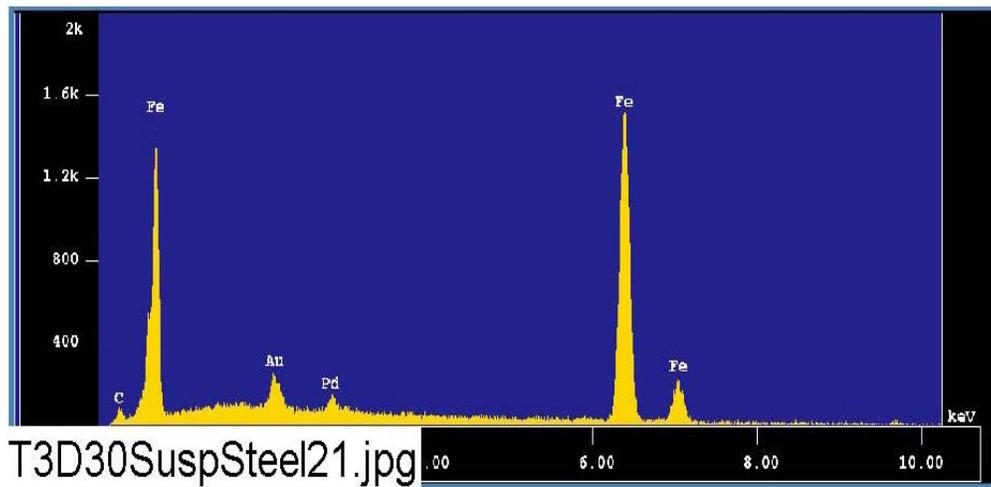


Figure E4-4. EDS counting spectrum for the lower surface (EDS2) shown in Figure E4-2. (T3D30SuspSteel21)

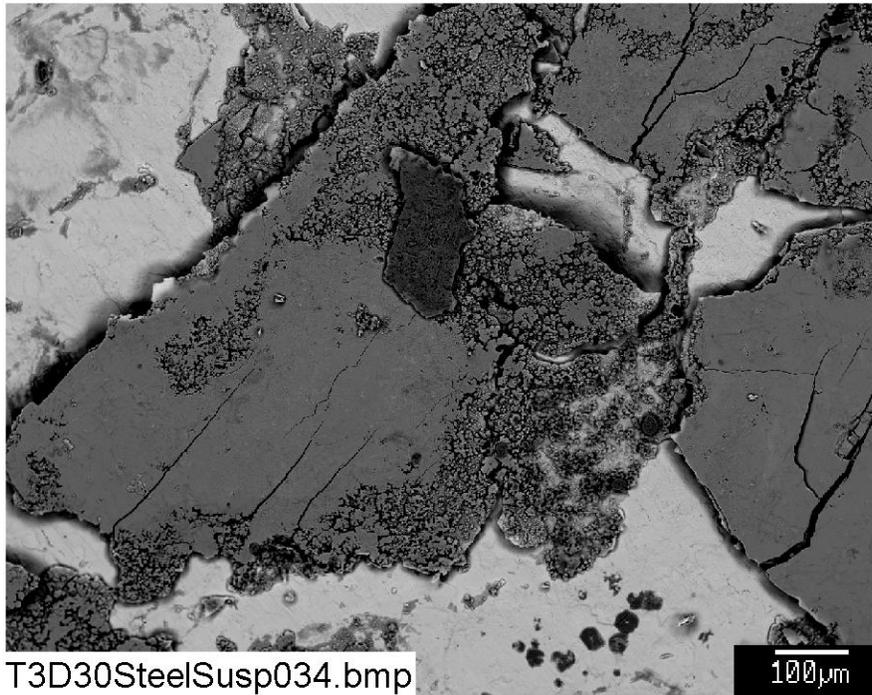


Figure E4-5. Backscattered SEM image magnified 100 times for a Test #3, Day-30 suspended steel coupon. (T3D30SteelSusp034)

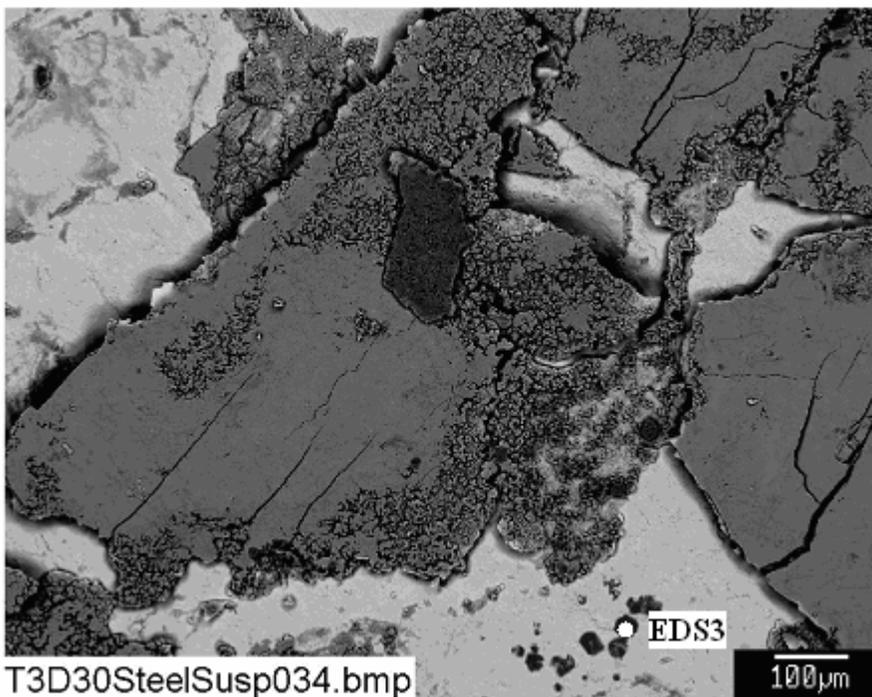
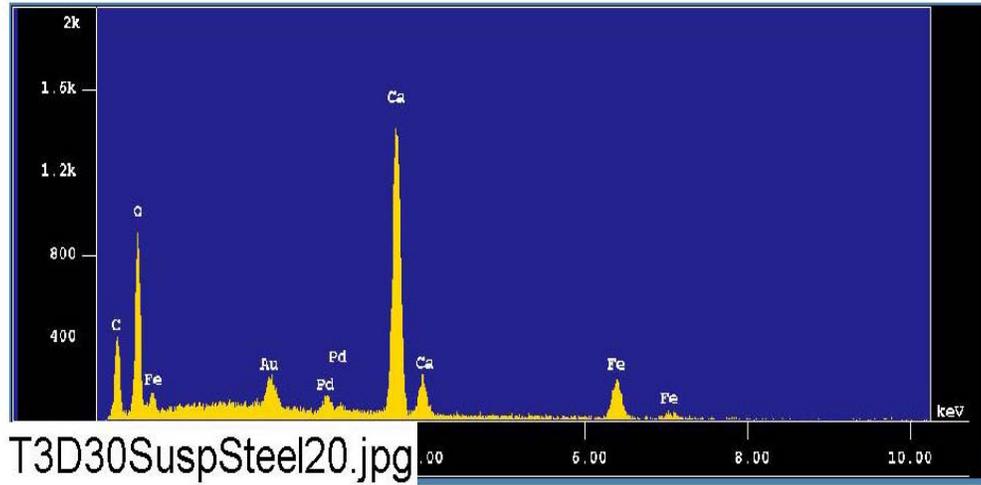
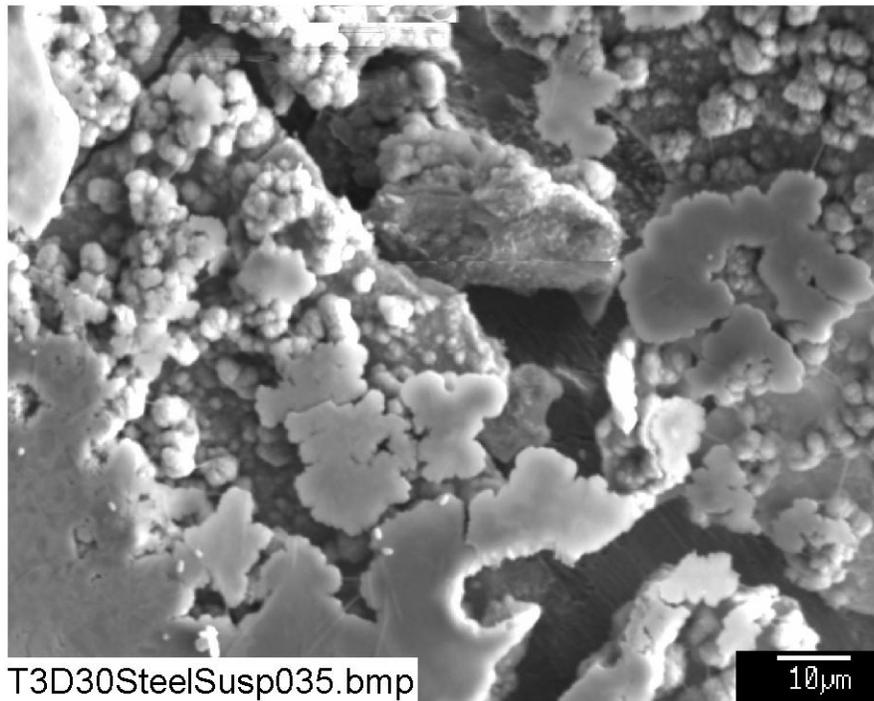


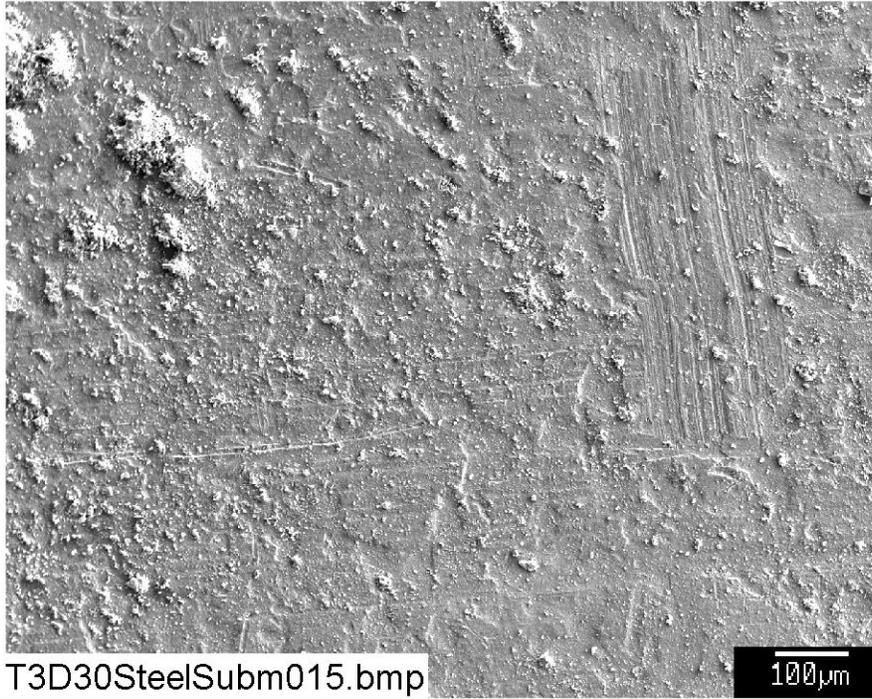
Figure E4-6. Annotated backscattered SEM image magnified 100 times for a Test #3, Day-30 suspended steel coupon. (T3D30SteelSusp034)



**Figure E4-7.** EDS counting spectrum for a dark particle close to the lower edge (EDS3) of Figure E4-6. (T3D30SuspSteel20)

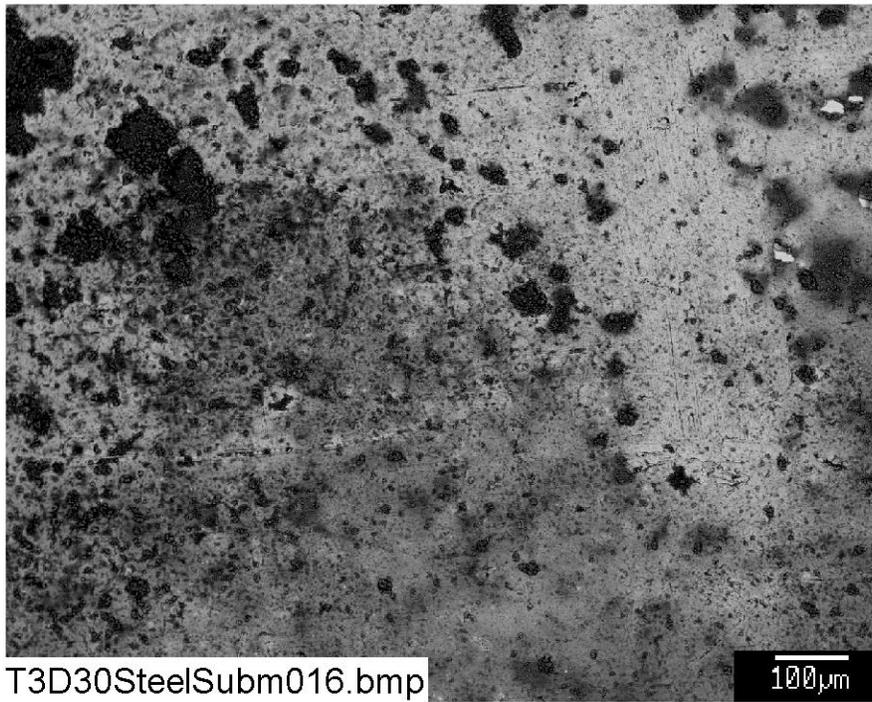


**Figure E4-8.** SEM image magnified 1000 times for a Test #3, Day-30 suspended carbon steel coupon. (T3D30SteelSusp035)



T3D30SteelSubm015.bmp

Figure E4-9. SEM image magnified 100 times for a Test #3, Day-30 submerged carbon steel coupon. (T3D30SteelSubm015)



T3D30SteelSubm016.bmp

Figure E4-10. Backscattered SEM image magnified 100 times for a Test #3, Day-30 submerged carbon steel coupon. (T3D30SteelSubm016)

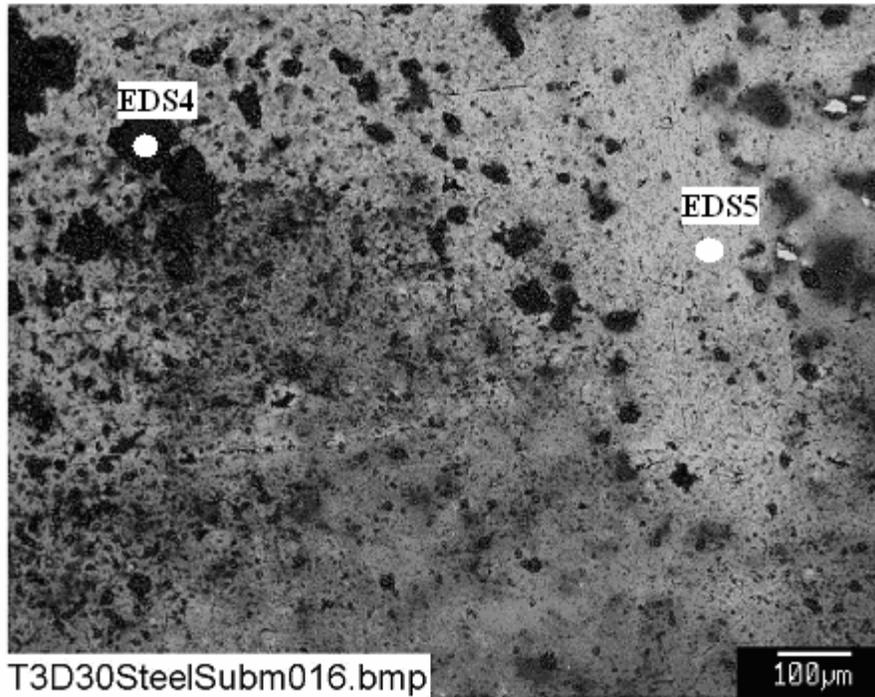


Figure E4-11. Annotated backscattered SEM image magnified 100 times for a Test #3, Day-30 submerged carbon steel coupon. (T3D30SteelSubm016)

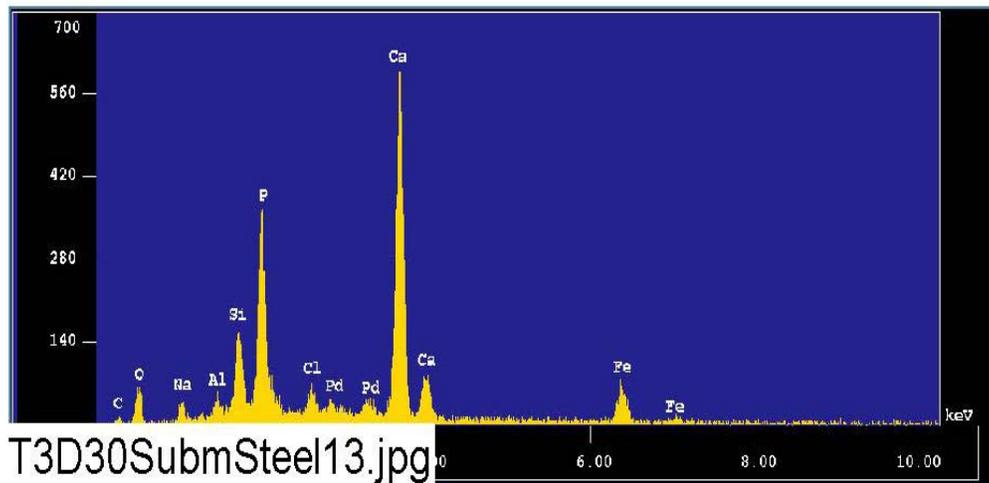


Figure E4-12. EDS counting spectrum for a dark spot (EDS4) shown in Figure E4-11. (T3D30SubmSteel13)

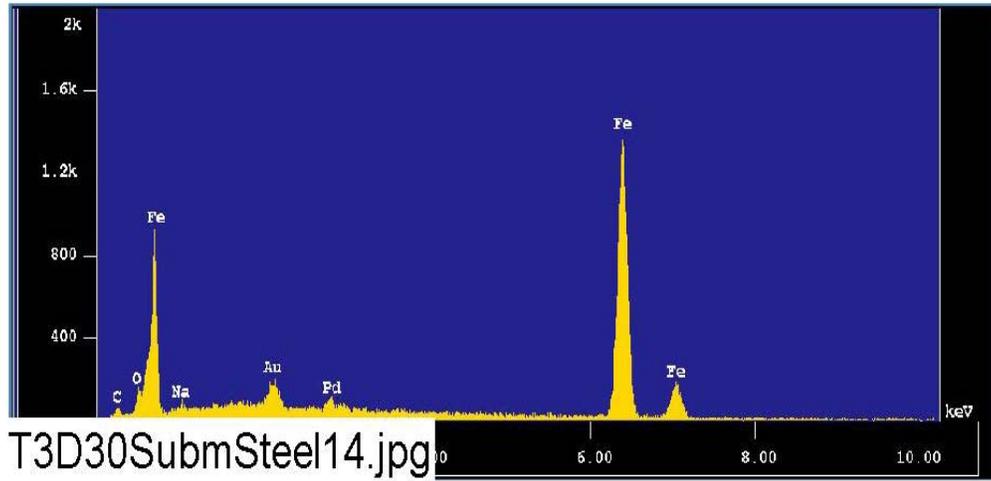


Figure E4-13. EDS counting spectrum for a light spot (EDS5) shown in Figure E4-11. (T3D30SubmSteel14)

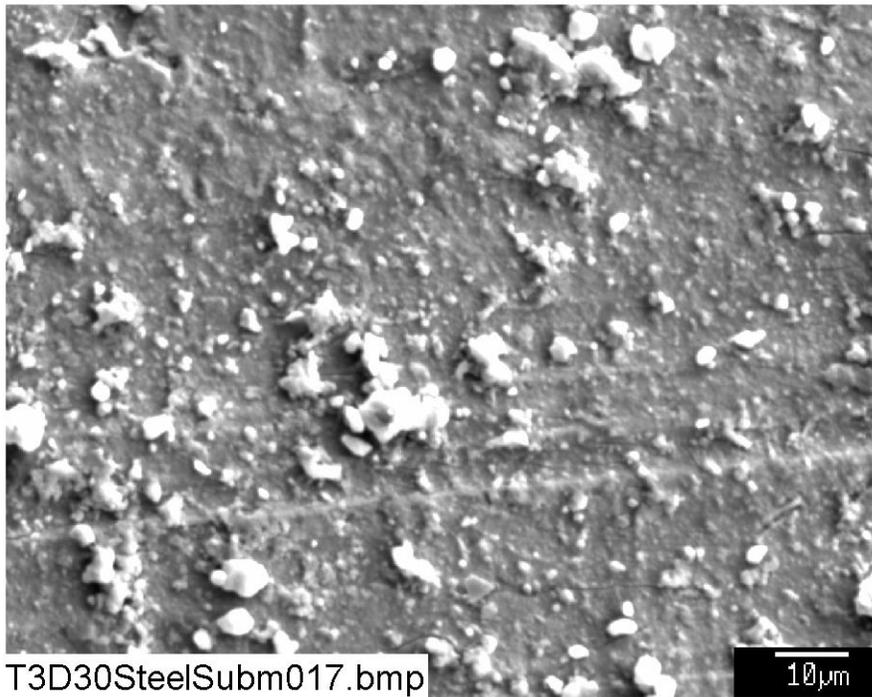


Figure E4-14. SEM image magnified 1000 times for a Test #3, Day-30 submerged carbon steel coupon. (T3D30SteelSubm017)

This page intentionally left blank.