

Appendix E1

SEM/EDS Data for Test #5, Day-30 Aluminum Coupons

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This appendix shows the SEM/EDS results for the metal aluminum coupons under two categories: (1) unsubmerged and (2) submerged. Unsubmerged refers to coupons located above the water level of the test tank during ICET tests. Unsubmerged coupons were contacted with the solution only during the initial 4-hour spray phase. In addition, the surface of the unsubmerged coupons may be affected during the test by the moist air in the tank gas space. Submerged refers to the coupons submerged in the solution during the test.

The coupon samples were collected on August 25, 2005 (the date Test #5 was shut down), and examined by SEM/EDS on August 30 and September 6, 2005. The aluminum coupon samples were dried in air before coating with Au/Pd for SEM examination. SEM results present the surface condition of the aluminum coupons. In addition, EDS results provide a semi-quantitative elemental analysis of the coupon surface and the corrosion products.

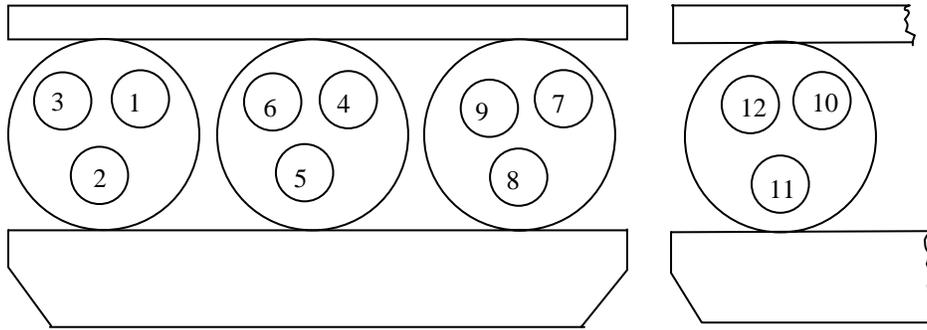
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Transcribed Laboratory Log

Laboratory session from September 6, 2005.

SEM Test #5, Day-30 Aluminum Coupons

Conditions: e=15.0kV, WD=11mm



1--Yellow Deposits on Submerged Rack	2--Sediment (T5D30)	3--Al-Unsubmerged
4--Al-Submerged	5--Gal-Steel Unsubmerged	6--Gal-Steel Submerged
7--Cu Unsubmerged	8--Cu-Submerged	9--Steel-Unsubmerged
10--Steel-Submerged	11--Drain Collar Interior	12--Drain Collar Outside Ext.

Unsubmerged Aluminum Coupons

Image:	T5D30SuspAl007	100 ×	SEM image	Figure E1-1
	T5D30SuspAl008	500 ×	SEM image	Figure E1-2
EDS:	T5D30SuspAl_flat		EDS on flat surface in 008	Figure E1-3
	T5D30SuspAl_Granul		EDS on particle in 008	Figure E1-4
Image:	T5D30SuspAl009	1000 ×	SEM image higher magnification	Figure E1-5

Submerged Al Coupon

Image:	T5D30SubmAl010	250 ×	SEM image	Figure E1-6
	T5D30SubmAl011	500 ×	SEM image higher magnification	Figure E1-7
	T5D30SubmAl012	1200 ×	SEM annotated	Figure E1-8
EDS:	T5D30SubmAl_dark01		EDS of dark structure in 012	Figure E1-9
	T5D30SubmAl_light02		EDS of light particle in 012	Figure E1-10

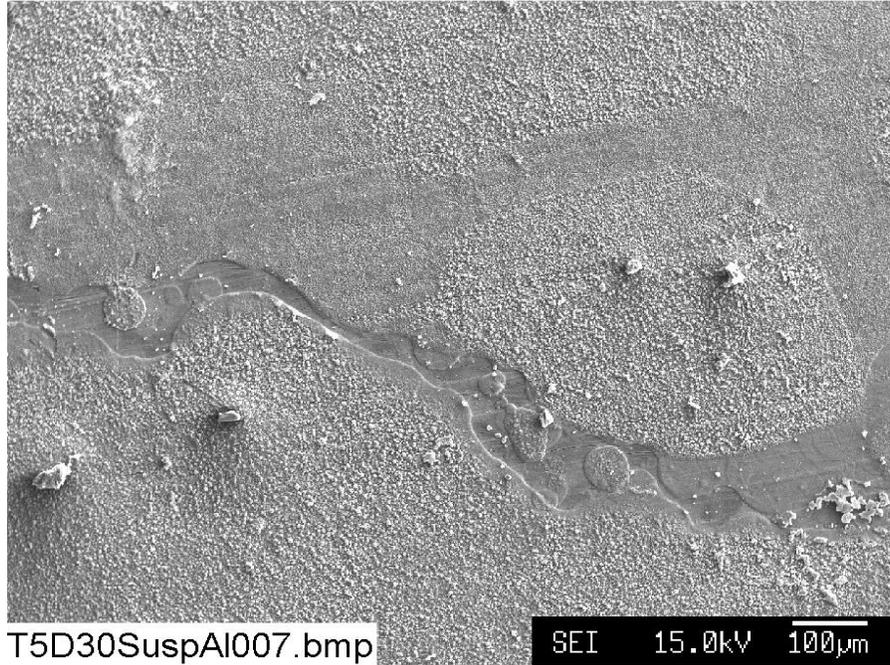


Figure E1-1. SEM image magnified 100 times for a Test #5, Day-30 unsubmerged aluminum coupon sample. (T5D30SuspAl007.bmp)

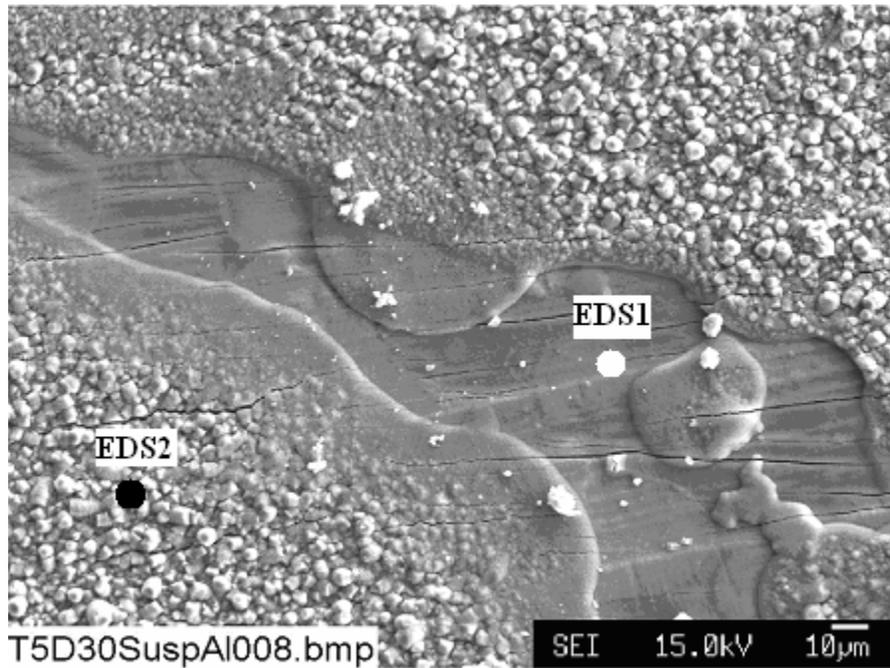


Figure E1-2. SEM image magnified 500 times for a Test #5, Day-30 unsubmerged aluminum coupon sample. (T5D30SuspAl008.bmp)

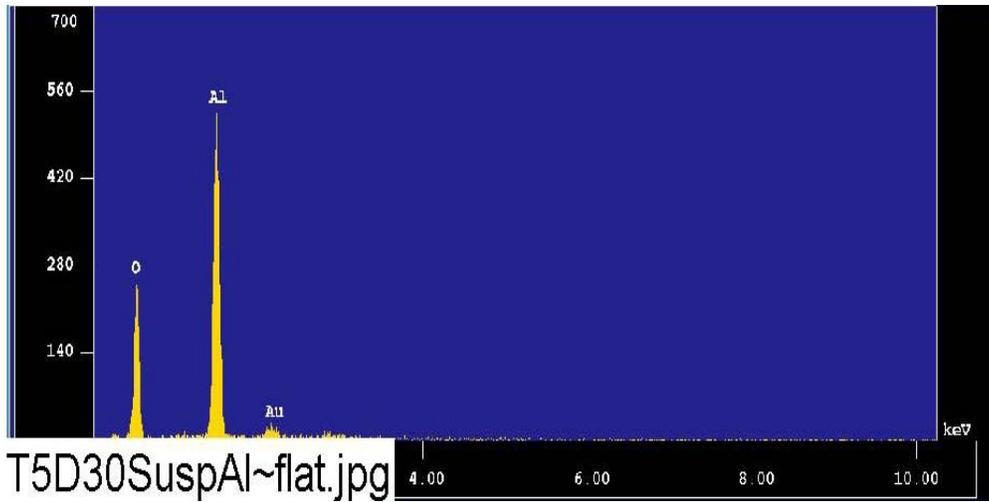


Figure E1-3. EDS counting spectrum for the smooth surface (EDS1) of the aluminum coupon shown in Figure E1-2. (T5D30SuspAl~flat.jpg)

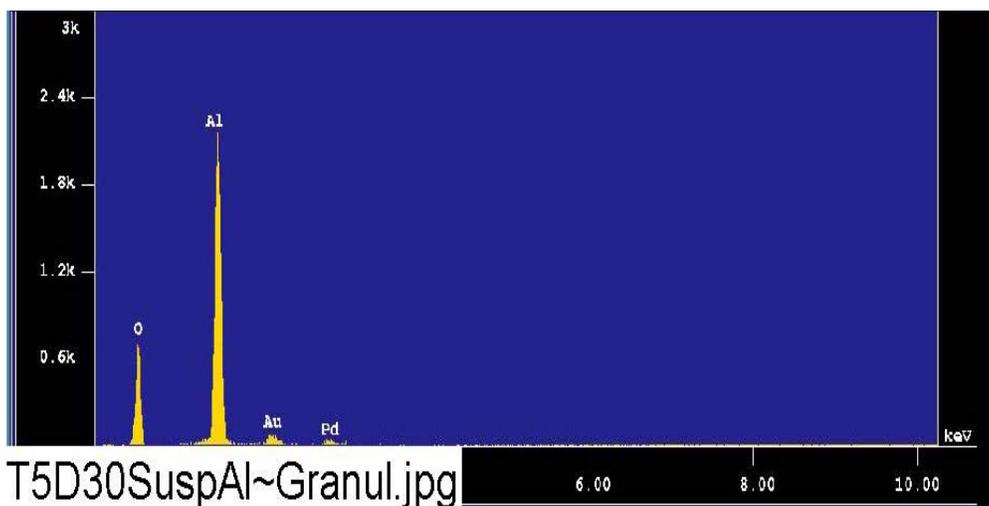


Figure E1-4. EDS counting spectrum for the granular particles (EDS2) on the aluminum coupon surface shown in Figure E1-2. (T5D30SuspAl~Granul.jpg)

The results from the chemical composition analysis for T5D30SuspAl_Granul.jpg are given in Table E1-1.

Table E1-1. Chemical Compositions for T5D30SuspAl~Granul.jpg, Figure E1-4

```

Group      : NRC
Sample    : T5D30 ID# : 5
Comment   : Granular particles on suspended Al
Condition : Full Scale : 20KeV(10eV/ch,2Kch)
           Live Time  : 60.000 sec      Aperture #   : 1
           Acc. Volt  : 15.0 KV        Probe Current : 1.006E-09 A
           Stage Point : X=88.063 Y=64.383 Z=11.848
           Acq. Date  : Tue Aug 30 13:44:34 2005

Element    Mode      ROI (KeV)  K-ratio(%)  +/-      Net/Background
Al K       Normal    1.26- 1.78  16.5329    0.0023   18452 / 29
O K        Normal    0.31- 0.74  20.9428    0.0107   19756 / 12
-----
                        Chi_square = 45.7092

Element  Mass%    Atomic%    ZAF        Z        A        F
Al       46.210   33.7485   1.0224     1.0020   1.0203   1.0000
O        53.790   66.2515   0.9395     1.0018   0.9377   1.0000
-----
Total    100.000  100.0000
Normalization factor = 2.7339

```

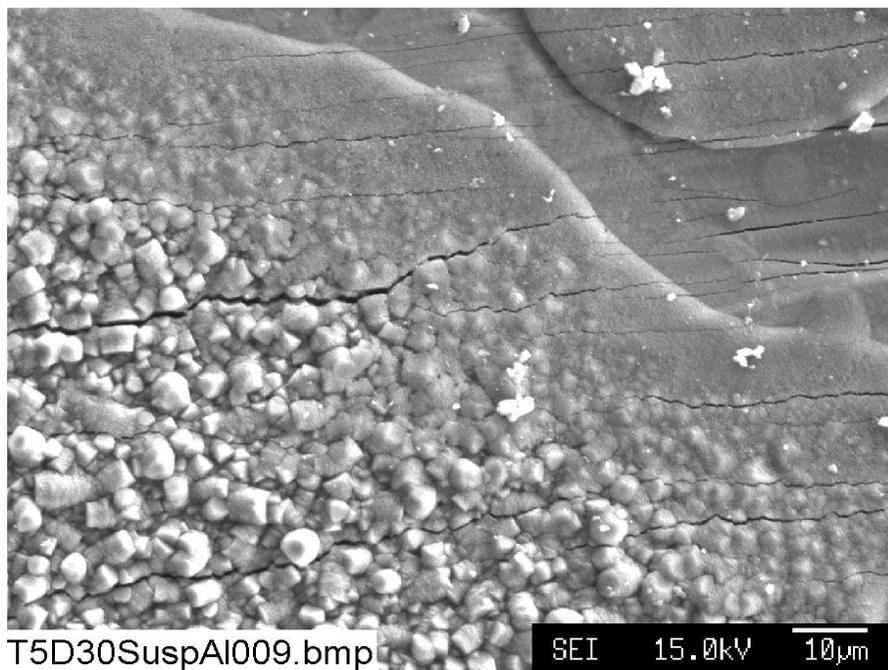


Figure E1-5. SEM image magnified 1000 times for a Test #5, Day-30 unsubmerged aluminum coupon sample. (T5D30SuspAl009.bmp)

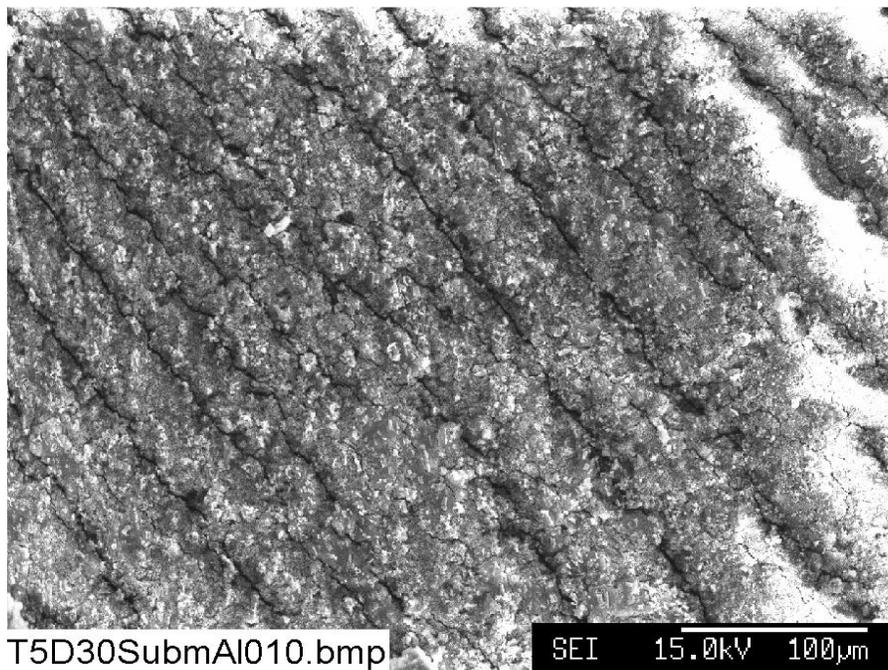


Figure E1-6. SEM image magnified 250 times for a Test #5, Day-30 submerged aluminum coupon sample. (T5D30SubmAl010.bmp)

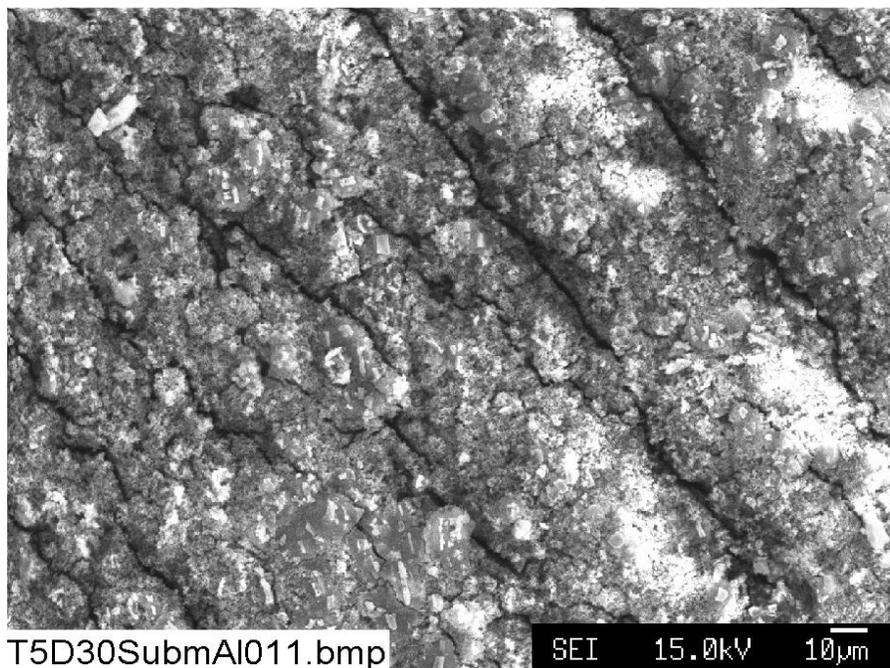


Figure E1-7. SEM image magnified 500 times for a Test #5, Day-30 submerged aluminum coupon sample. (T5D30SubmAl011.bmp)

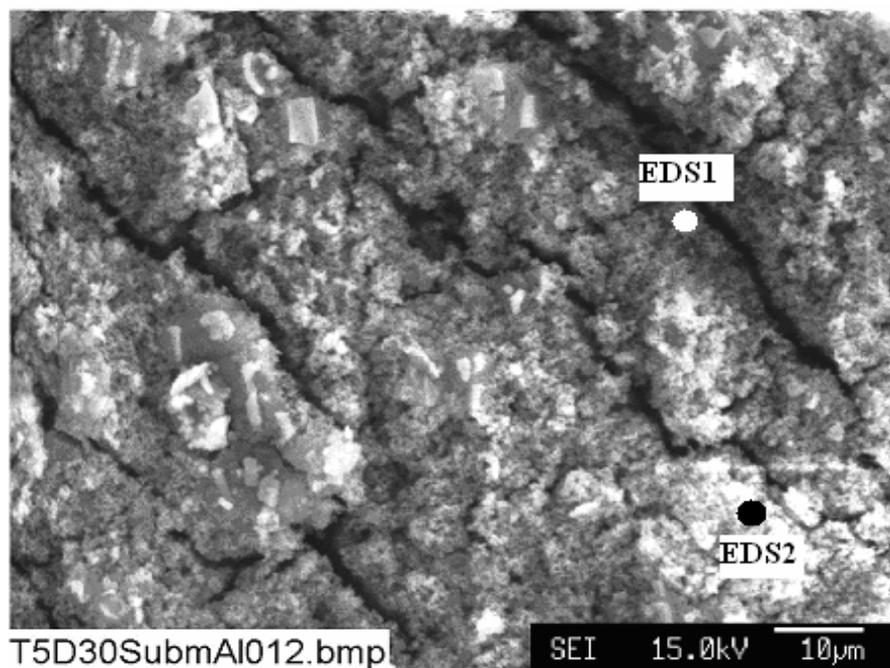


Figure E1-8. Annotated SEM image magnified 1200 times for a Test #5, Day-30 submerged aluminum coupon sample. (T5D30SubmAl012.bmp)

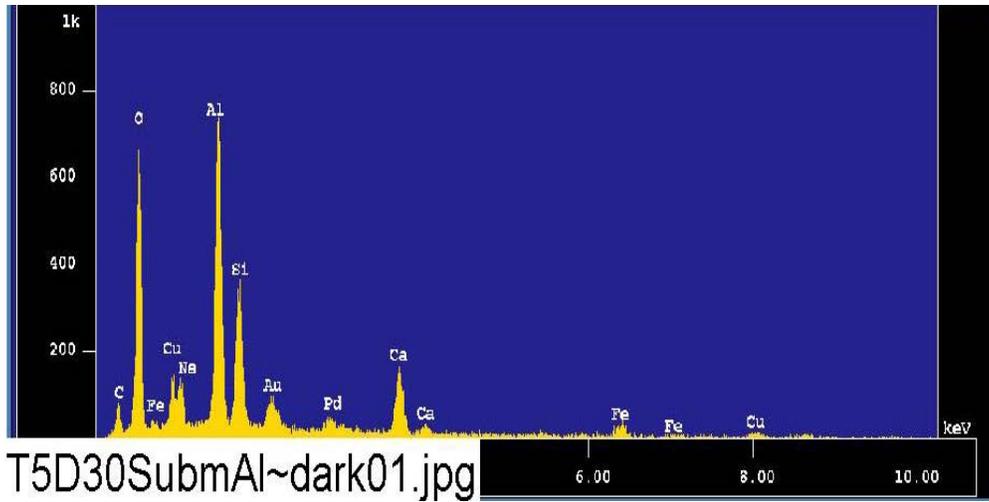


Figure E1-9. EDS counting spectrum for the dark porous surface (EDS1) of the aluminum coupon shown in Figure E1-8. (T5D30SubmAl~dark01.jpg)

The results from the chemical composition analysis for T5D30SubmAl~dark01.jpg are given in Table E1-2.

Table E1-2. Chemical Compositions for T5D30SubmAl~dark01.jpg, Figure E1-9

```

Group      : NRC
Sample     : T5D30 ID# : 7
Comment    : Dark porous layer on submerged Al
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
            Live Time  : 60.000 sec      Aperture #   : 1
            Acc. Volt  : 15.0 KV        Probe Current : 1.006E-09 A
            Stage Point: X=50.175 Y=52.147 Z=11.848
            Acq. Date  : Tue Aug 30 14:03:41 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
Na K	Normal	0.83- 1.28	0.9587	0.0065	710 /	37
Al K	Normal	1.26- 1.78	5.5632	0.0015	6209 /	133
Si K	Normal	1.50- 2.07	2.4170	0.0006	2961 /	364
Ca K	Normal	3.40- 4.30	3.2624	0.0073	1925 /	13
Fe K	Normal	6.04- 7.40	1.5120	0.0023	402 /	9
C K	Normal	0.11- 0.47	50.6476	0.0123	511 /	98
O K	Normal	0.31- 0.74	21.2659	0.0113	20061 /	35
Cu K	Normal	7.61- 9.28	0.9478	0.0014	138 /	3

Chi_square = 4.7269

Element	Mass%	Atomic%	ZAF	Z	A	F
Na	1.838	1.3545	1.1743	0.9804	1.1967	1.0009
Al	10.097	6.3412	1.1119	0.9887	1.1261	0.9987
Si	4.972	2.9996	1.2602	0.9810	1.2848	0.9999
Ca	5.147	2.1761	0.9665	0.9913	0.9757	0.9992
Fe	2.971	0.9016	1.2039	1.2151	0.9962	0.9946
C	23.844	33.6407	0.2884	0.9910	0.2911	1.0000
O	49.149	52.0575	1.4159	0.9878	1.4334	1.0000
Cu	1.982	0.5287	1.2814	1.2850	0.9972	1.0000

Total 100.000 100.0000
 Normalization factor = 1.6323

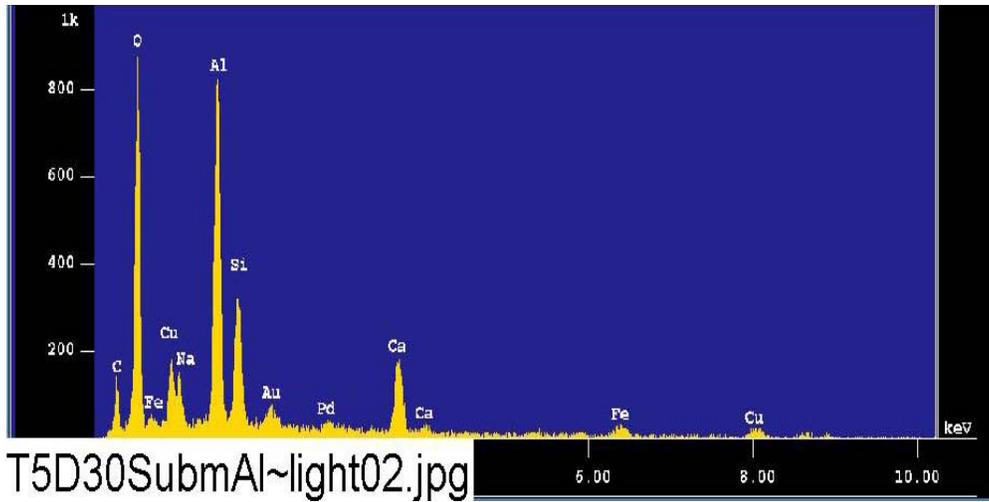


Figure E1-10. EDS counting spectrum for the light powder (EDS2) on the aluminum coupon surface shown in Figure E1-8. (T5D30SubmAl~light02.jpg)

The results from the chemical composition analysis for T5D30SubmAl~light02.jpg are given in Table E1-3.

Table E1-3. Chemical Compositions for T5D30SubmAl~light02.jpg, Figure E1-9

```

Group      : NRC
Sample     : T5D30 ID# : 8
Comment    : Bright layer on submerged Al
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec      Aperture #   : 1
             Acc. Volt   : 15.0 KV        Probe Current : 1.006E-09 A
             Stage Point : X=46.894 Y=50.390 Z=11.848
             Acq. Date   : Tue Aug 30 14:12:44 2005

```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background
Na K	Normal	0.83- 1.28	0.9222	0.0067	683 / 43
Al K	Normal	1.26- 1.78	6.2283	0.0015	6951 / 132
Si K	Normal	1.50- 2.07	2.3139	0.0006	2834 / 415
Ca K	Normal	3.40- 4.30	3.6587	0.0078	2159 / 22
O K	Normal	0.31- 0.74	27.0711	0.0128	25537 / 34
C K	Normal	0.11- 0.47	74.5273	0.0149	752 / 144
Fe K	Normal	6.04- 7.40	1.1269	0.0022	299 / 4
Cu K	Normal	7.61- 9.28	2.3661	0.0016	345 / 3

Chi_square = 5.7109

Element	Mass%	Atomic%	ZAF	Z	A	F
Na	1.431	1.0376	1.2008	0.9788	1.2256	1.0010
Al	9.046	5.5894	1.1241	0.9871	1.1399	0.9990
Si	3.757	2.2298	1.2564	0.9794	1.2830	0.9999
Ca	4.554	1.8942	0.9633	0.9899	0.9737	0.9994
O	49.656	51.7418	1.4196	0.9861	1.4395	1.0000
C	25.910	35.9628	0.2691	0.9893	0.2720	1.0000
Fe	1.738	0.5188	1.1936	1.2136	0.9954	0.9881
Cu	3.909	1.0256	1.2785	1.2835	0.9962	1.0000

Total 100.000 100.0000
Normalization factor = 1.2921

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Appendix E2

SEM/EDS Data for Test #5, Day-30 Copper Coupons

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This appendix shows the SEM/EDS results for the metal copper coupons under two categories: (1) unsubmerged and (2) submerged. Unsubmerged coupons were contacted with the solution only during the initial 4-hour spray phase. In addition, the surface of the unsubmerged coupons may be affected during the test by the moist air in the tank gas space. Submerged refers to the coupons submerged in the solution during the test.

The coupon samples were collected on August 25, 2005 (the date Test #5 was shut down), and examined by SEM/EDS on August 30 and September 6, 2005. The copper coupon samples were dried in air before being coated with Au/Pd for SEM examination. SEM results present the surface condition of the copper coupons. In addition, EDS results provide a semi-quantitative elemental analysis of the coupon surface and the corrosion products.

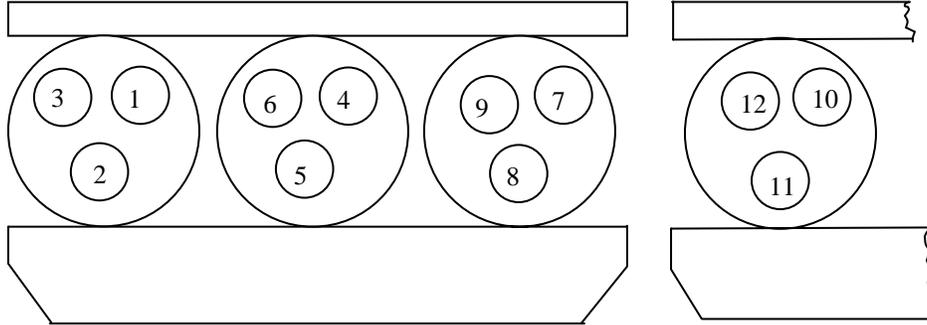
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Transcribed Laboratory Log

Laboratory session from September 6, 2005.

SEM Test #5, Day-30 Copper Coupons

Conditions: e=15.0kV, WD=11mm



- | | | |
|--------------------------------------|---------------------------|-------------------------------|
| 1--Yellow Deposits on Submerged Rack | 2--Sediment (T5D30) | 3--Al-Unsubmerged |
| 4--Al-Submerged | 5--Gal-Steel Unsubmerged | 6--Gal-Steel Submerged |
| 7--Cu Unsubmerged | 8--Cu-Submerged | 9--Steel-Unsubmerged |
| 10--Steel-Submerged | 11--Drain Collar Interior | 12--Drain Collar Outside Ext. |

Unsubmerged Copper Coupons

Image:	T5D30SuspCu017	100 ×	SEM image	Figure E2-1
	T5D30SuspCu018	1000 ×	SEM Annotated image higher magnification	Figure E2-2
EDS:	T5D30SuspCu particle07		On light particles shown in 018	Figure E2-3
	T5D30SuspCu Surface08		On coupon surface shown in 018	Figure E2-4

Submerged Copper Coupon

Image:	T5D30SubmCu019	100 ×	SEM image of fiberglass	Figure E2-5
	T5D30SubmCu020	1000 ×	SEM image higher magnification	Figure E2-6
EDS:	T5D30Subm Cu surface09		EDS of smooth particles in 020	Figure E2-7
	T5D30Subm Cu particle10		EDS of white particles in 020	Figure E2-8

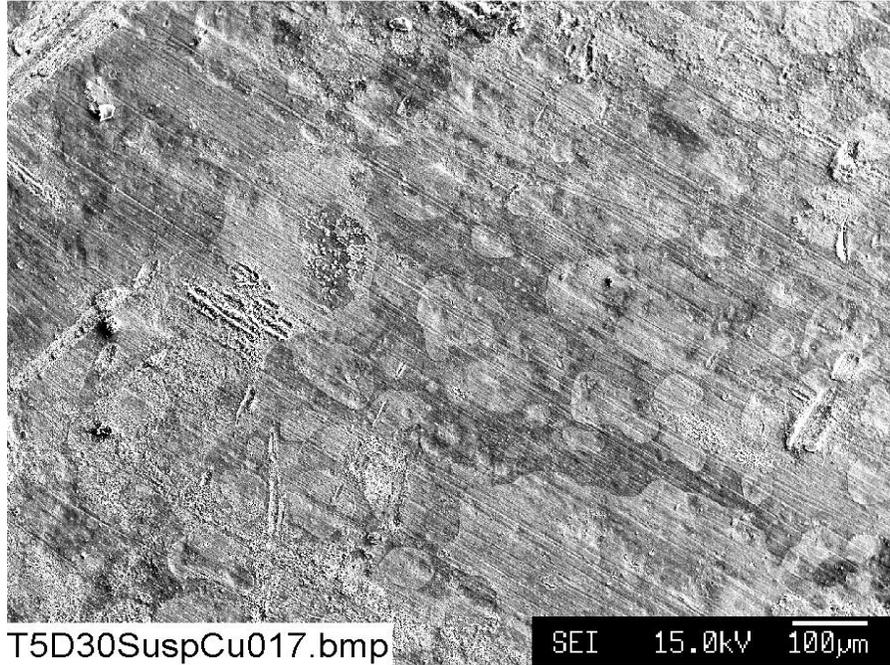


Figure E2-1. SEM image magnified 100 times for a Test #5, Day-30 unsubmerged copper coupon sample. (T5D30SuspCu017.bmp)

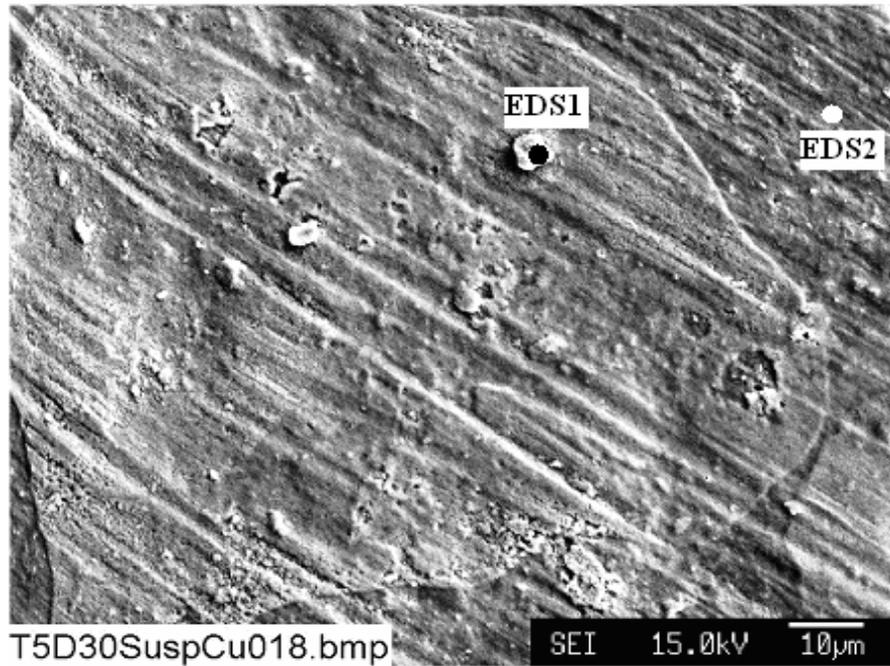


Figure E2-2. Annotated SEM image magnified 1000 times for a Test #5, Day-30 unsubmerged copper coupon sample. (T5D30SuspCu018.bmp)

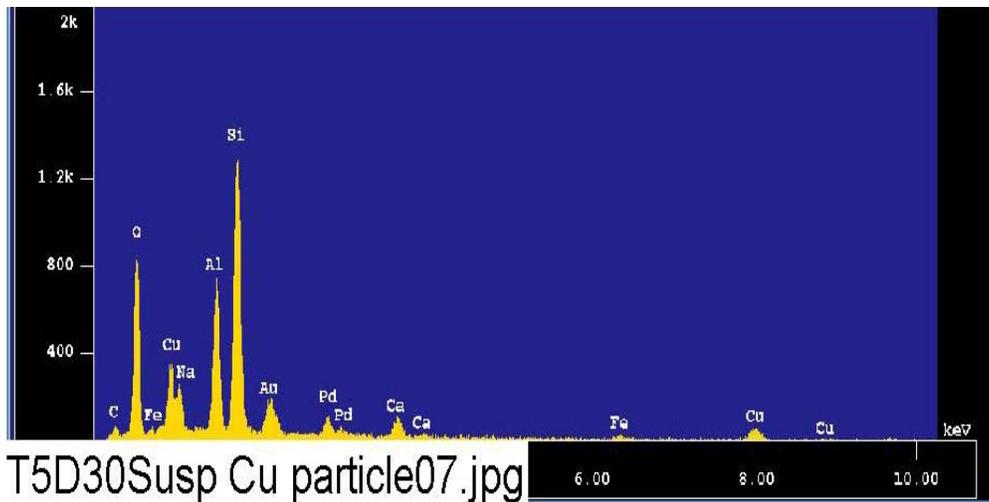


Figure E2-3. EDS counting spectrum for the light particle (EDS1) on the copper coupon surface shown in Figure E2-2. (T5D30Susp Cu particle07.jpg)

The results from the chemical composition analysis for T5D30Susp Cu particle07.jpg are given in Table E2-1.

Table E2-1. Chemical Compositions for T5D30Susp Cu particle07.jpg, Figure E2-3

```

Group      : NRC
Sample     : T5D30 ID# : 13
Comment    : Particles on suspended Cu
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
             Live Time  : 60.000 sec      Aperture #   : 1
             Acc. Volt   : 15.0 KV        Probe Current : 1.005E-09 A
             Stage Point : X=16.143 Y=53.149 Z=11.848
             Acq. Date   : Tue Aug 30 15:04:14 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background
Na K	Normal	0.83- 1.28	2.3307	0.0092	1724 / 64
Al K	Normal	1.26- 1.78	5.5249	0.0015	6160 / 395
Si K	Normal	1.50- 2.07	9.9056	0.0011	12122 / 391
Ca K	Normal	3.40- 4.30	1.8982	0.0067	1119 / 16
Fe K	Normal	6.04- 7.40	0.8441	0.0021	224 / 9
Cu K	Normal	7.61- 9.28	5.2252	0.0023	760 / 7
O K	Normal	0.31- 0.74	28.9157	0.0133	27250 / 37
C K	Normal	0.11- 0.47	22.6341	0.0128	228 / 155

Chi_square = 4.3581

Element	Mass%	Atomic%	ZAF	Z	A	F
Na	3.761	3.1269	1.2445	0.9775	1.2722	1.0008
Al	8.435	5.9747	1.1773	0.9854	1.1993	0.9962
Si	16.555	11.2653	1.2888	0.9775	1.3185	0.9999
Ca	2.419	1.1534	0.9827	0.9864	0.9968	0.9994
Fe	1.290	0.4413	1.1781	1.2064	0.9981	0.9783
Cu	8.607	2.5887	1.2701	1.2739	0.9971	1.0000
O	46.196	55.1835	1.2320	0.9852	1.2504	1.0000
C	12.737	20.2662	0.4339	0.9886	0.4390	1.0000

Total 100.000 100.0000
 Normalization factor = 1.2968

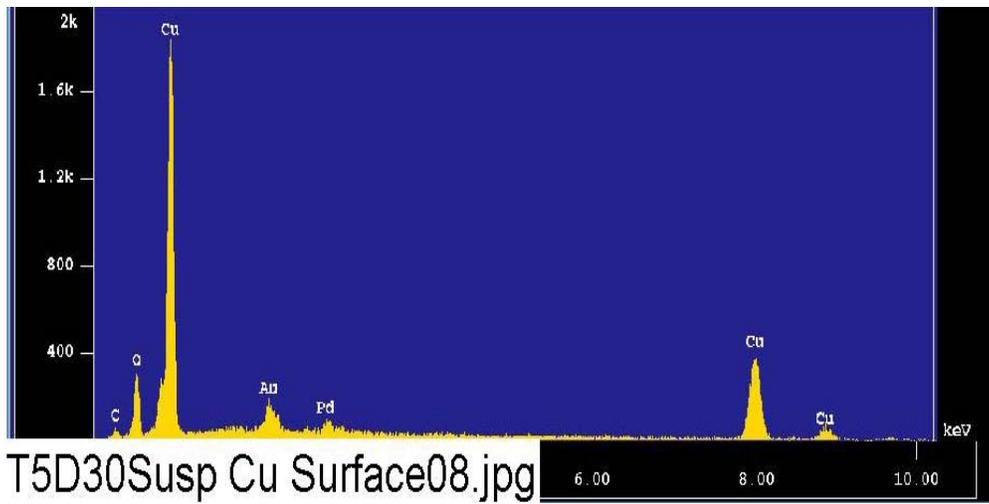


Figure E2-4. EDS counting spectrum for the copper coupon surface (EDS2) shown in Figure E2-2. (T5D30Susp Cu Surface08.jpg)

The results from the chemical composition analysis for T5D30Susp Cu Surface08.jpg are given in Table E2-2.

Table E2-2. Chemical Compositions for T5D30Susp Cu Surface08.jpg, Figure E2-4

```

Group      : NRC
Sample     : T5D30 ID# : 14
Comment    : Surface of suspended Cu
Condition  : Full Scale : 20KeV(10eV/ch,2Kch)
            Live Time  : 60.000 sec      Aperture #   : 1
            Acc. Volt   : 15.0 KV        Probe Current  : 1.005E-09 A
            Stage Point : X=16.143 Y=53.149 Z=11.848
            Acq. Date   : Tue Aug 30 15:09:59 2005
    
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
Cu K	Normal	7.61- 9.28	37.9341	0.0051	5518 /	9
O K	Normal	0.31- 0.74	9.8150	0.0087	9250 /	52
C K	Normal	0.11- 0.47	26.8105	0.0098	270 /	60

Chi_square = 2.8337

Element	Mass%	Atomic%	ZAF	Z	A	F
Cu	67.862	31.6586	1.1006	1.1031	0.9978	1.0000
O	17.836	33.0455	1.1180	0.8760	1.2764	0.9999
c	14.302	35.2958	0.3282	0.8796	0.3731	1.0000

Total 100.000 100.0000
 Normalization factor = 1.6254

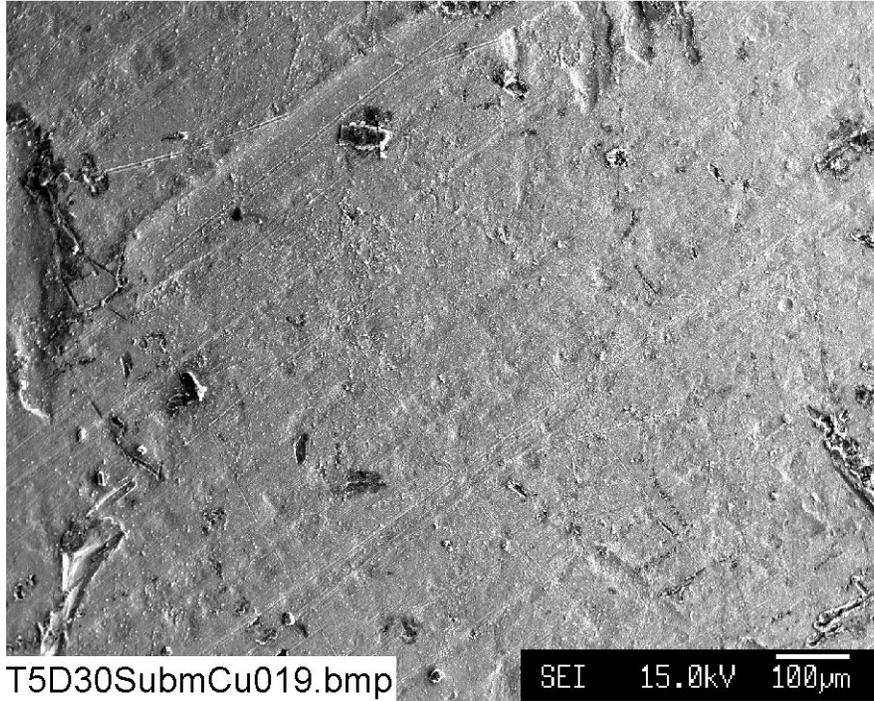


Figure E2-5. SEM image magnified 100 times for a Test #5, Day-30 submerged copper coupon sample. (T5D30SubmCu019.bmp)

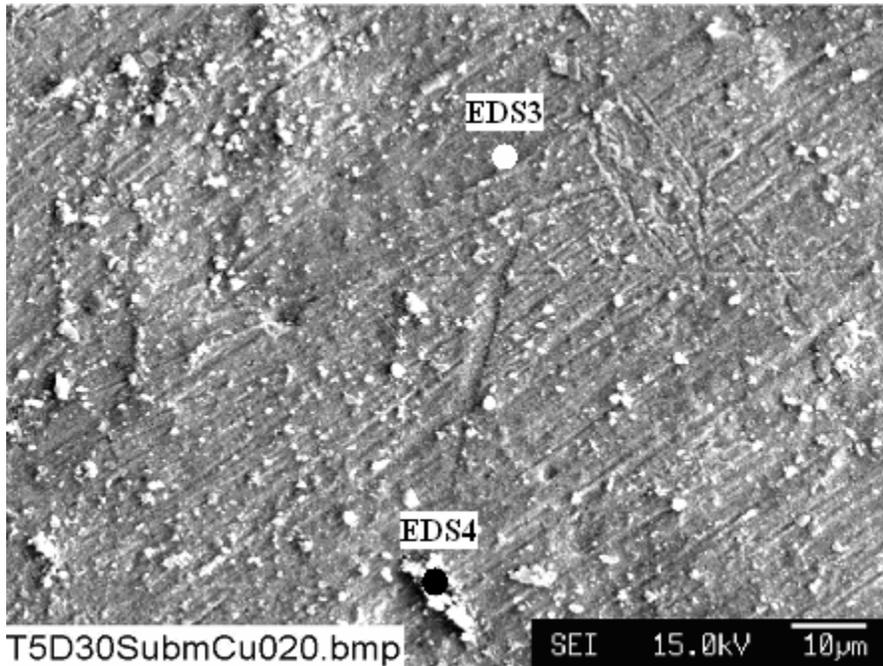


Figure E2-6. SEM image magnified 1000 times for a Test #5, Day-30 submerged copper coupon sample. (T5D30SubmCu020.bmp)

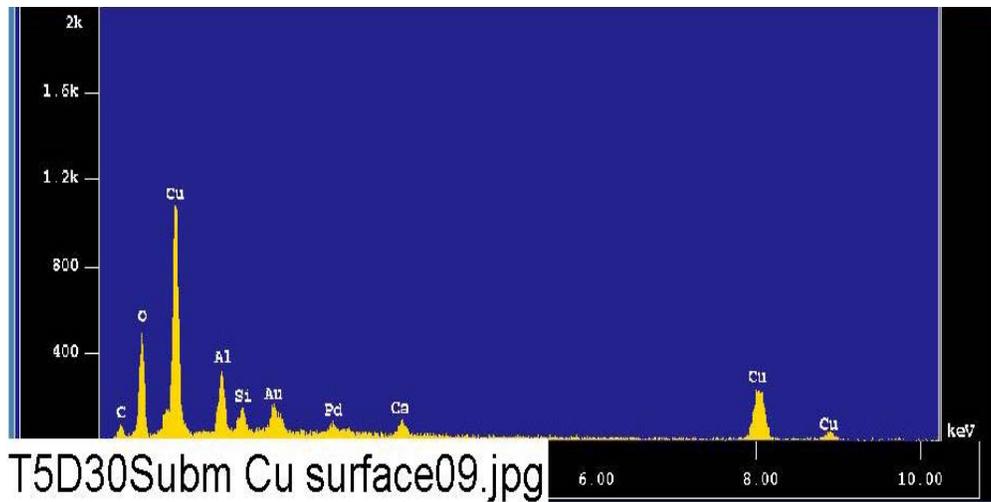


Figure E2-7. EDS counting spectrum for the grey copper coupon surface (EDS3) shown in Figure E2-6. (T5D30Subm Cu surface09.jpg)

The results from the chemical composition analysis for T5D30Subm Cu surface09.jpg are given in Table E2-3.

Table E2-3. Chemical Compositions for T5D30Subm Cu surface09.jpg, Figure E2-7

```

Group      : NRC
Sample    : T5D30 ID# : 15
Comment   : Surface of submerged Cu
Condition : Full Scale : 20KeV(10eV/ch,2Kch)
           Live Time  : 60.000 sec      Aperture #   : 1
           Acc. Volt  : 15.0 KV         Probe Current : 1.005E-09 A
           Stage Point: X=11.640 Y=63.166 Z=11.848
           Acq. Date  : Tue Aug 30 15:20:19 2005

```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
Al K	Normal	1.26- 1.78	2.1463	0.0010	2393 /	79
Si K	Normal	1.50- 2.07	0.7437	0.0005	910 /	189
Ca K	Normal	3.40- 4.30	1.2241	0.0066	722 /	24
Cu K	Normal	7.61- 9.28	24.4152	0.0042	3551 /	9
O K	Normal	0.31- 0.74	15.7405	0.0101	14834 /	41
C K	Normal	0.11- 0.47	37.1593	0.0132	375 /	85

Chi_square = 3.4035

Element	Mass%	Atomic%	ZAF	Z	A	F
Al	4.915	4.1748	1.5037	0.9203	1.6344	0.9997
Si	1.647	1.3440	1.4543	0.9126	1.5937	1.0000
Ca	1.717	0.9819	0.9211	0.9183	1.0049	0.9982
Cu	43.542	15.7063	1.1711	1.1747	0.9969	1.0000
O	29.739	42.6032	1.2406	0.9212	1.3468	1.0000
C	18.441	35.1897	0.3259	0.9247	0.3524	1.0000

Total 100.000 100.0000
Normalization factor = 1.5228

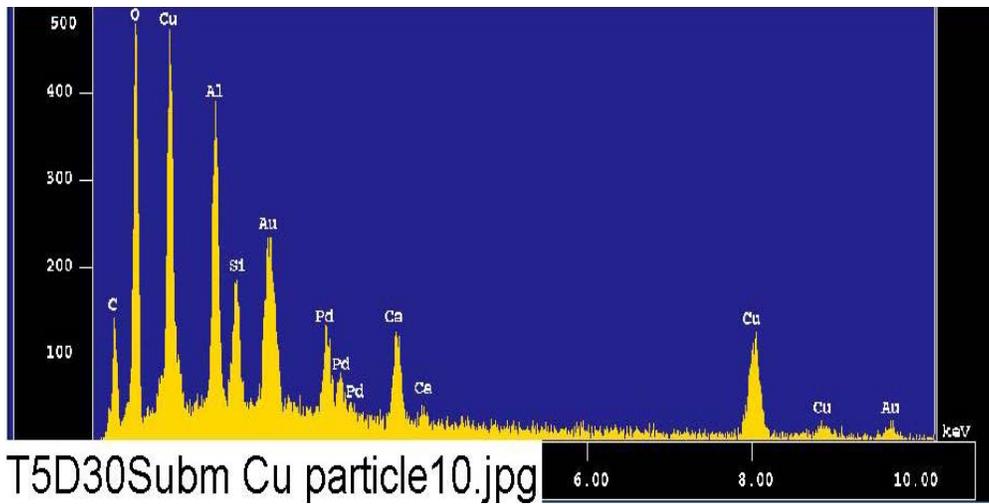


Figure E2-8. EDS counting spectrum for the light particles (EDS4) on the coupon surface shown in Figure E2-6. (T5D30Subm Cu particle10.jpg)

The results from the chemical composition analysis for T5D30Subm Cu particle10.jpg are given in Table E2-4.

Table E2-4. Chemical Compositions for T5D30Subm Cu particle10.jpg, Figure E2-8

```

Group      : NRC
Sample    : T5D30 ID# : 16
Comment   : Particles on submerged Cu
Condition : Full Scale : 20KeV(10eV/ch,2Kch)
           Live Time  : 60.000 sec   Aperture #   : 1
           Acc. Volt  : 15.0 KV      Probe Current : 1.005E-09 A
           Stage Point: X=11.640 Y=63.166 Z=11.848
           Acq. Date  : Tue Aug 30 15:24:43 2005
  
```

Element	Mode	ROI (KeV)	K-ratio(%)	+/-	Net/Background	
Al K	Normal	1.26- 1.78	2.6588	0.0011	2964 /	85
Si K	Normal	1.50- 2.07	1.0195	0.0005	1248 /	247
Ca K	Normal	3.40- 4.30	2.2751	0.0071	1341 /	27
Cu K	Normal	7.61- 9.28	11.1316	0.0031	1619 /	7
C K	Normal	0.11- 0.47	69.2823	0.0160	698 /	88
O K	Normal	0.31- 0.74	15.1166	0.0099	14246 /	38

Chi_square = 4.8904

Element	Mass%	Atomic%	ZAF	Z	A	F
Al	5.525	3.7131	1.2874	0.9559	1.3474	0.9995
Si	2.175	1.4045	1.3219	0.9482	1.3942	0.9999
Ca	3.453	1.5625	0.9405	0.9570	0.9839	0.9988
Cu	22.087	6.3036	1.2293	1.2346	0.9957	1.0000
c	30.146	45.5152	0.2696	0.9588	0.2812	1.0000
O	36.614	41.5011	1.5007	0.9555	1.5705	1.0000

Total 100.000 100.0000
 Normalization factor = 1.6140