Appendix F2

SEM/EDS Data for Test #4 Day-30 Copper Coupons

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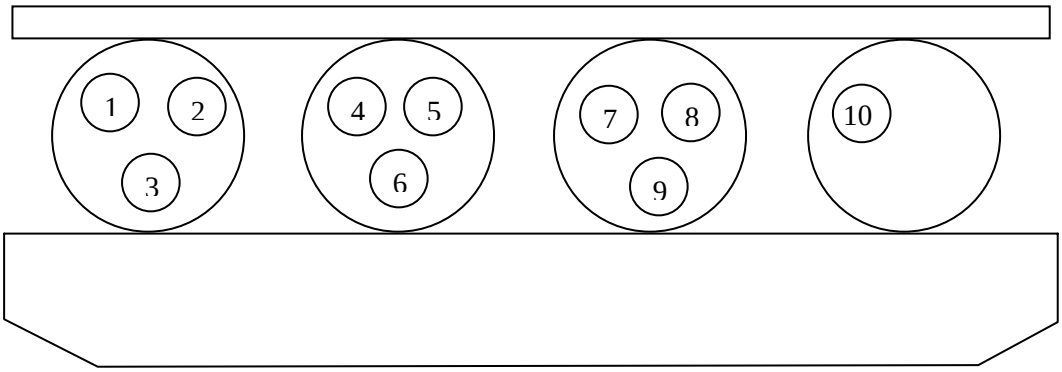
This appendix shows the SEM/EDS results for the metal copper coupons under two categories: (1) unsubmerged and (2) submerged. Unsubmerged refers to coupons held in the test tank gas space above the water level of the solution during ICET tests. Unsubmerged coupons were contacted by the solution only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

The coupon samples were collected on June 23, 2005 (the date Test #4 was shut down) and by SEM/EDS on June 29, 2005. The copper coupon samples were dried in air before coating 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.

Transcribed Laboratory Log

Laboratory session from June 29, 2005.
SEM Test #4 Day-30 Copper Coupons

1. Unsubmerged Al	3. Sus. Cu	5. Sus. Gal-Steel	7. Sus. Steel
2. Submerged Al	4. Sub. Cu	6. Sub. Gal Steel	8. Sub. Steel
9. Sediment	10. Powder on sub. Rack		



Unsubmerged Copper Coupon

Image:	T4D30CuSusp008	100 ×	SEM image	Figure F2-1
	T4D30CuSusp009	500 ×	SEM image higher magnification	Figure F2-2
	T4D30CuSusp010	1500 ×	SEM annotated image	Figure F2-3
EDS:	T4D30CuSusp05		On particles in T4D30CuSusp010	Figure F2-4

Submerged Copper Coupon

Image:	T4D30CuSubm011	100 ×	SEM image of fiberglass	Figure F2-5
	T4D30CuSubm012	500 ×	SEM image higher magnification	Figure F2-6
	T4D30CuSubm013	1800 ×	SEM annotated image	Figure F2-7
EDS:	T4D30CuSubm06		On bright particles shown in 013	Figure F2-8
	T4D30CuSubm07		Surface shown in 013	Figure F2-9

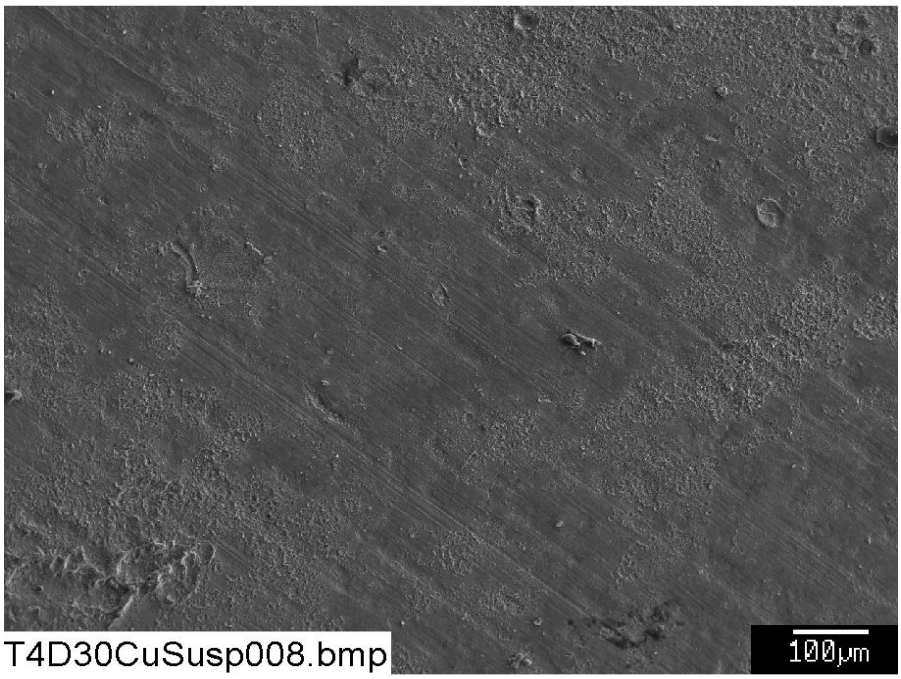


Figure F2-1: SEM image magnified 100 times for a Test #4 Day-30 unsubmerged copper coupon sample. (T4D30CuSusp008.bmp)

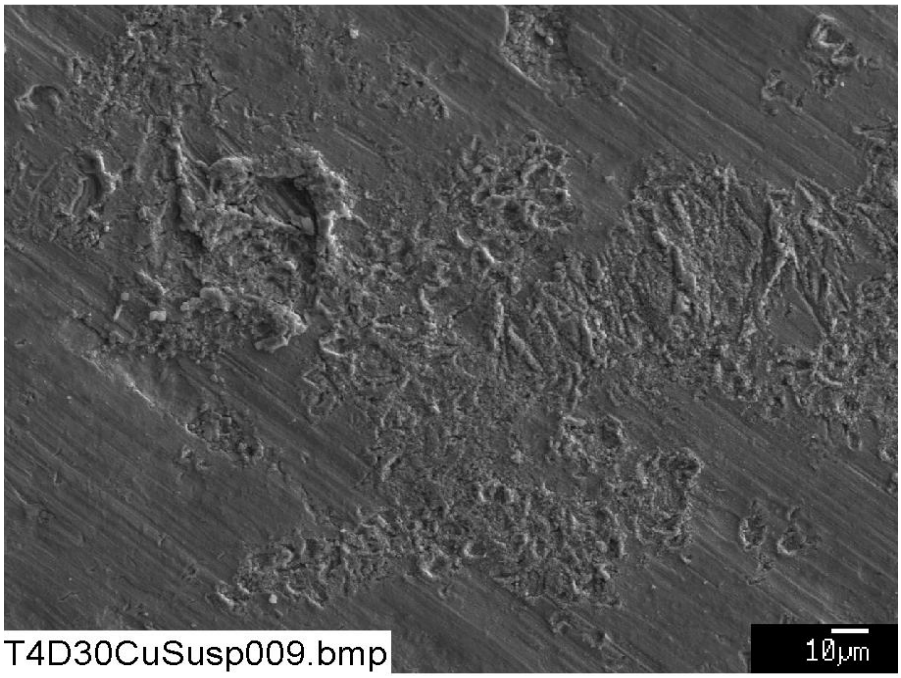


Figure F2-2: SEM image magnified 500 times for a Test #4 Day-30 unsubmerged copper coupon sample. (T4D30CuSusp009.bmp)

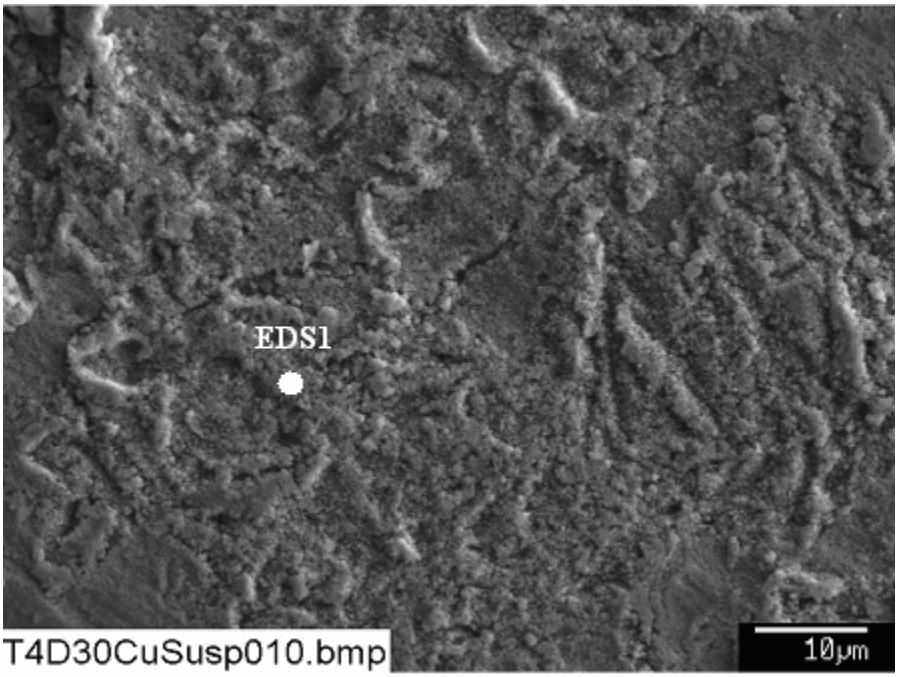


Figure F2-3: Annotated SEM image magnified 1500 times for a Test #4 Day-30 unsubmerged copper coupon sample. (T4D30CuSusp010.bmp)

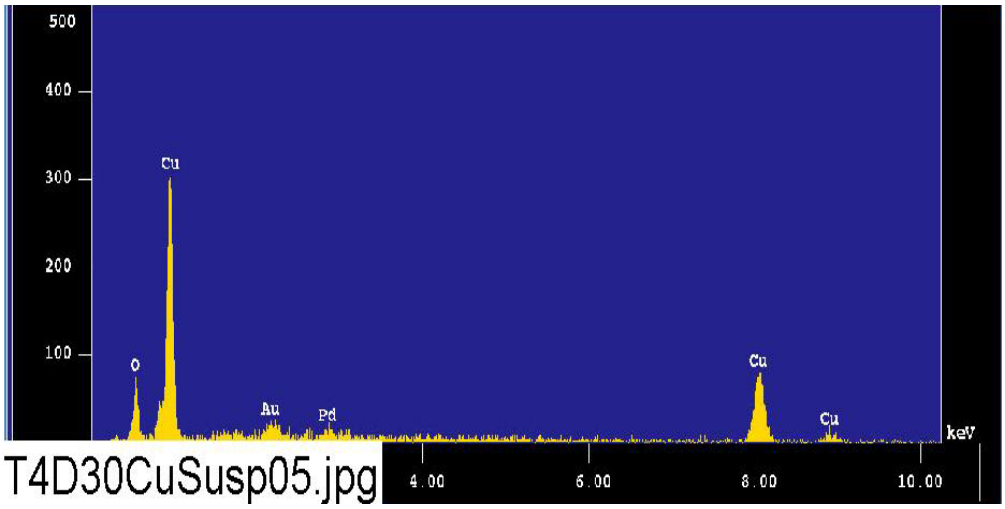


Figure F2-4: EDS counting spectrum for the deposits (EDS1) on the coupon surface shown in Figure F2-3. (T4D30CuSusp05.jpg)

The results from the chemical composition analysis for T4D30CuSusp05.jpg are given in Table F2-1.

Table F2-1. Chemical Compositions for T4D30CuSusp05.jpg, Figure F2-4.

```
Jun 29 13:44 2005  /tmp/eds_pout.log Page 1


 Group     : NRC
 Sample    : T4D30  ID# : 5
 Comment   : particles on suspended Cu
 Condition : Full Scale  : 20KeV(10eV/ch,2Kch)
             Live Time   :  60.000 sec    Aperture #    : 2
             Acc. Volt   : 15.0 KV        Probe Current : 1.065E-09 A
             Stage Point : X=81.233 Y=71.962 Z=10.786
             Acq. Date   : Wed Jun 29 13:41:34 2005

 Element     Mode     ROI(KeV)   K-ratio(%)  +/-    Net/Background
   O K      Normal   0.25- 0.77   16.7471   0.0012      554 /      13
  Cu K      Normal   7.63- 9.27  105.3640   0.0057     1327 /       2
-----------------------------------------------------------------------
                              Chi_square =  1.3920

 Element Mass%    Atomic%   ZAF      Z      A      F
     O   11.102  33.1531 0.8154 0.8265 0.9868 0.9998
    Cu   88.898  66.8469 1.0378 1.0386 0.9993 1.0000
-----------------------------------------------------------------------
 Total   100.000 100.0000
 Normalization factor =  0.8130
```

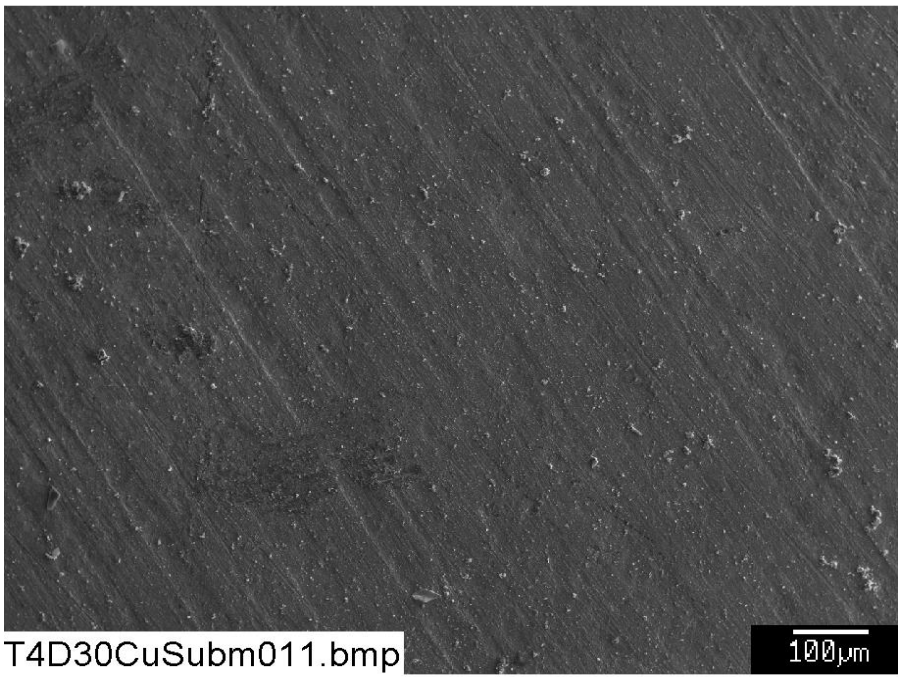


Figure F2-5: SEM image magnified 100 times for a Test #4 Day-30 submerged copper coupon sample. (T4D30CuSubm011.bmp)

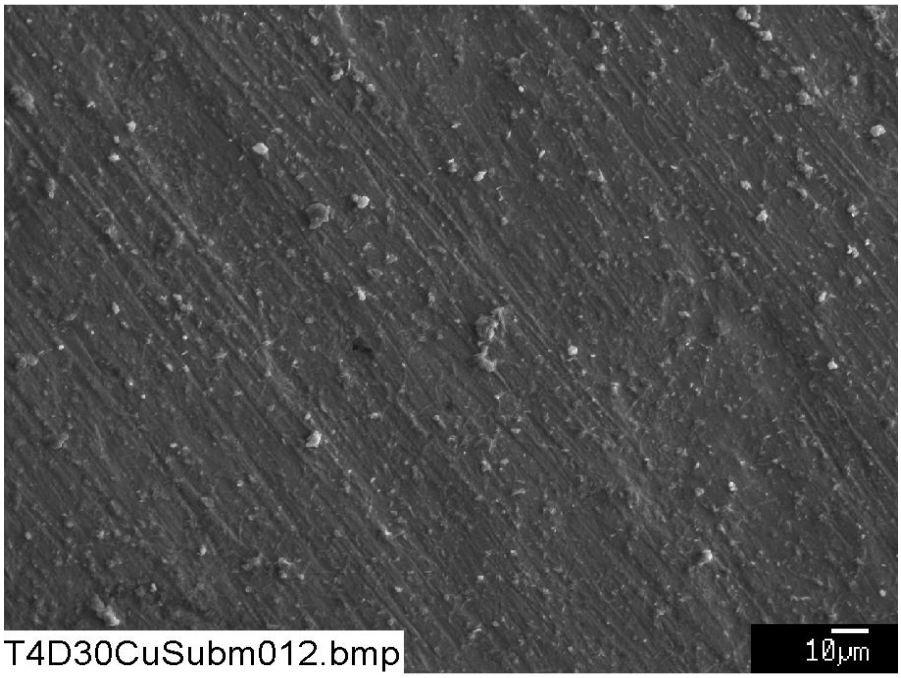


Figure F2-6: SEM image magnified 500 times for a Test #4 Day-30 submerged copper coupon sample. (T4D30CuSubm012.bmp)

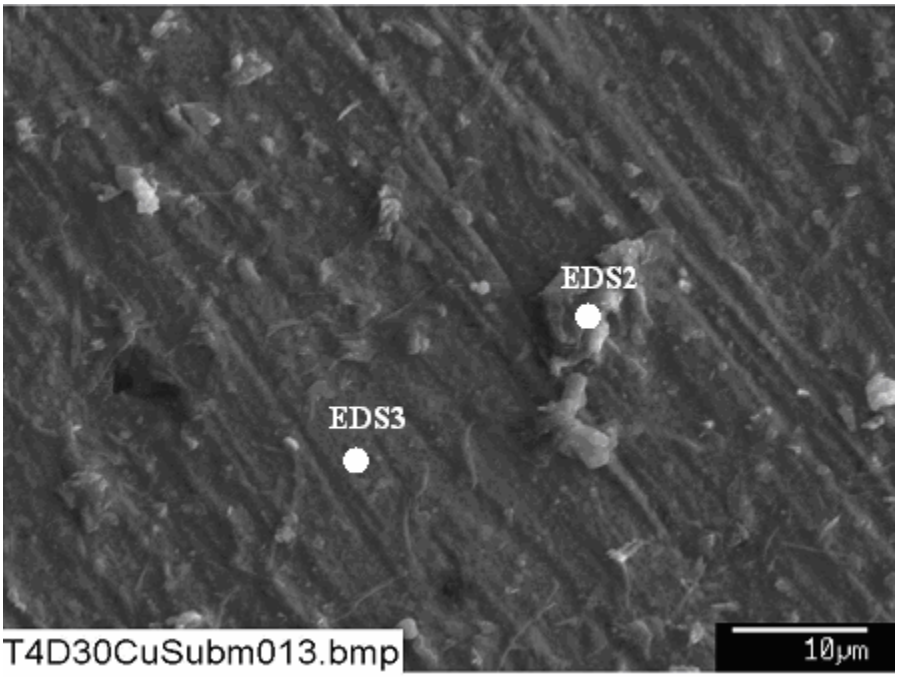


Figure F2-7: Annotated SEM image magnified 1800 times for a Test #4 Day-30 submerged copper coupon sample. (T4D30CuSubm013.bmp)

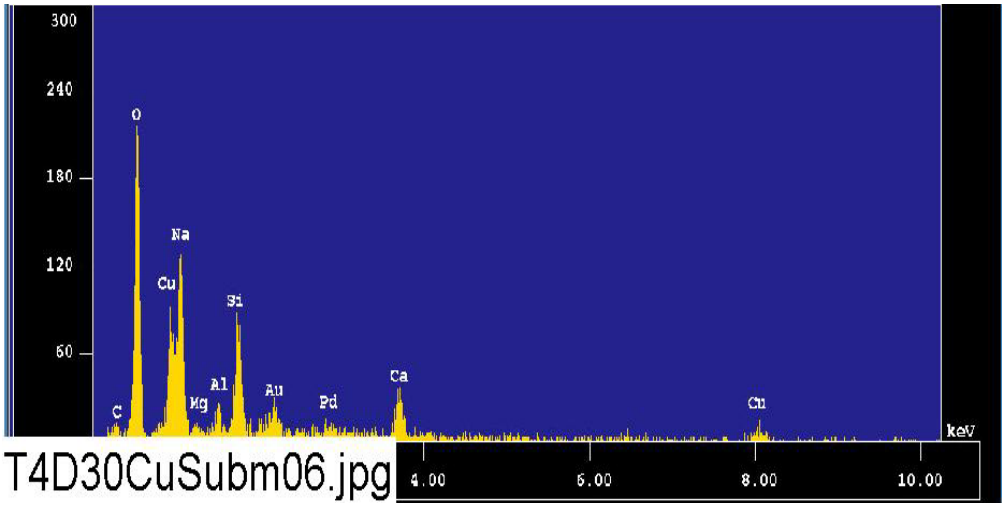


Figure F2-8: EDS counting spectrum for the deposit (EDS2) on the coupon surface shown in Figure F2-7. (T4D30CuSubm06.jpg)

The results from the chemical composition analysis for T4D30CuSubm06.jpg are given in Table F2-2.

Table F2-2. Chemical Compositions for T4D30CuSubm06.jpg, Figure F2-8.

```
Jun 29 13:57 2005  /tmp/eds_pout.log Page 1


 Group     : NRC
 Sample    : T4D30  ID# : 6
 Comment   : light particles on submerged Cu
 Condition : Full Scale  : 20KeV(10eV/ch,2Kch)
             Live Time   :  60.000 sec    Aperture #    : 2
             Acc. Volt   : 15.0 KV        Probe Current : 1.065E-09 A
             Stage Point : X=57.699 Y=58.376 Z=10.786
             Acq. Date   : Wed Jun 29 13:54:39 2005


 Element     Mode     ROI(KeV)   K-ratio(%)  +/-    Net/Background
   O K      Normal   0.25- 0.77   55.2961   0.0018     1829 /      10
  Na K      Normal   0.81- 1.27   11.0827   0.0010     1053 /      13
  Al K      Normal   1.26- 1.78    1.1553   0.0003      159 /      32
  Si K      Normal   1.50- 2.07    4.0896   0.0005      523 /      17
  Ca K      Normal   3.40- 4.30    4.2931   0.0035      267 /       6
  Cu K      Normal   7.63- 9.27    9.7062   0.0023      122 /       2
   C K      Normal   0.09- 0.46    0.0000   0.0000        0 /      16
  Mg K      Normal   0.97- 1.57    0.0718   0.0001       10 /      36
-----------------------------------------------------------------------
                                Chi_square =  2.6388

 Element Mass%    Atomic%   ZAF      Z      A      F
     O   52.039  67.6839 0.8346 0.9692 0.8612 0.9999
    Na   20.992  19.0006 1.6798 1.0227 1.6423 1.0001
    Al    1.925   1.4848 1.4779 0.9846 1.5028 0.9988
    Si    6.377   4.7251 1.3829 0.9729 1.4216 0.9999
    Ca    4.710   2.4453 0.9729 0.9809 0.9925 0.9994
    Cu   13.788   4.5154 1.2597 1.2639 0.9967 1.0000
     C    0.000   0.0000 4.0970 1.0163 4.0314 0.9999
    Mg    0.169   0.1449 2.0917 0.9627 2.1740 0.9994
-----------------------------------------------------------------------
 Total   100.000 100.0000
 Normalization factor =  1.1276
```

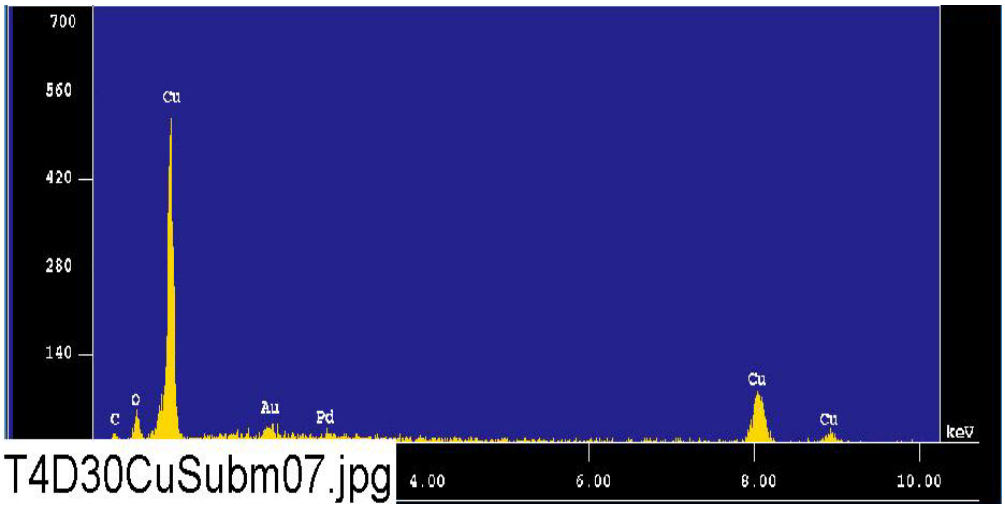


Figure F2-9: EDS counting spectrum for the flat coupon surface (EDS3) shown in Figure F2-7. (T4D30CuSubm07.jpg)

The results from the chemical composition analysis for T4D30CuSubm07.jpg are given in Table F2-3.

Table F2-3. Chemical Compositions for T4D30CuSubm07.jpg, Figure F2-9.

```
Jun 29 14:02 2005  /tmp/eds_pout.log Page 1


 Group     : NRC
 Sample    : T4D30  ID# : 7
 Comment   : surface of submerged Cu
 Condition : Full Scale  : 20KeV(10eV/ch,2Kch)
             Live Time   :  60.000 sec    Aperture #     : 2
             Acc. Volt   : 15.0 KV        Probe Current : 1.065E-09 A
             Stage Point : X=57.699 Y=58.376 Z=10.786
             Acq. Date   : Wed Jun 29 13:59:37 2005


 Element     Mode     ROI(KeV)   K-ratio(%)  +/-    Net/Background
   O K      Normal   0.25- 0.77   12.2183   0.0011      404 /      21
  Cu K      Normal   7.63- 9.27  113.6477   0.0061     1432 /       0
   C K      Normal   0.09- 0.46    2.1513   0.0001      106 /       4
-------------------------------------------------------------------
                              Chi_square =  0.9631

 Element Mass%    Atomic%   ZAF      Z      A      F
     O    7.923  20.9480 0.8970 0.8301 1.0807 0.9998
    Cu   85.861  57.1606 1.0450 1.0460 0.9991 1.0000
     C    6.216  21.8914 3.9968 0.8712 4.5876 1.0000
-------------------------------------------------------------------
 Total   100.000 100.0000
 Normalization factor =  0.7229
```