Appendix C2

SEM/EDS Data for Unused and Test-2 Day-30 Copper Coupons

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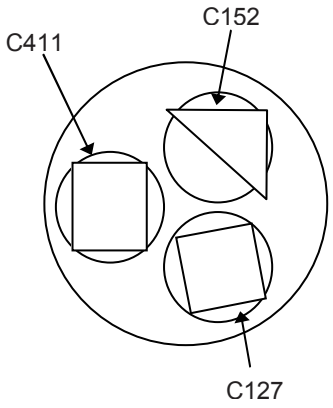
This appendix shows SEM/EDS results for the metal copper coupons in three different catagories: (1) unused; (2) suspended or unsubmerged; and (3) submerged. *Unused* refers to the coupon condition before being subjected to ICET test conditions. *Suspended* or *unsubmerged* refers to coupons located above the water level of the solution during ICET tests. Suspended coupons contacted the solution only during the 4-hour spray period at the start of the test. In addition, the surface of the suspended coupons may also be affected by moisture in the test chamber gas space. *Submerged* refers to the coupons that were immersed in the test solution for the entire test.

The coupon samples were collected on March 7, 2005 (the date Test #2 was shut down) and examined by SEM/EDS on April 4, 2005. The copper coupon samples were dried in air before being coated with carbon for SEM examination. SEM results present the surface condition of the copper coupon. In addition, EDS results provide a semiquantitative elemental analysis of the coupon surface and the corrosion products that are present.

Transcribed Laboratory Log

Laboratory session from April 4, 2005

Copper Samples



Conditions: 15-kV, 1-nA beam current, Aperture = 2

Metal	Sample	Test
Copper:	C411	Unused C411
	C152	Test #2 Unsubmerged C152
	C127	Test #2 Submerged C127

Note: All samples were carbon coated.

Sample C411 Copper Blank (unused)

Image:	C411052	40 ×	SEI	Figure C2-1
	C411053	150 ×	SEI	Figure C2-2
	C411054	1000 ×	SEI	Figure C2-3

Sample C152 Test 2 Unsubmerged Copper

Image:	C152055	40 ×	SEI	Figure C2-4
	C152056	150 ×	SEI	Figure C2-5
	C152057	1000 ×	SEI	Figure C2-6
	C152058	1000 ×	BEI	Figure C2-7
EDS:	CEDS30		Dark spot on T2D30 unsubmerged Cu sample	Figure C2-8

Sample C127 Test 2 Submerged Copper

Image:	C127059	40 ×	SEI	Figure C2-9
	C127060	150 ×	SEI	Figure C2-10
	C127061	150 ×	BEI	Figure C2-11
	C127062	1000 ×	SEI	Figure C2-12
EDS:	CEDS31		Dark spot on T2D30 submerged Cu	Figure C2-13
	CEDS32		Light spot on T2D30 submerged Cu	Figure C2-14
	CEDS33		Lathlike crystals on T2D30 submerged Cu	Figure C2-15

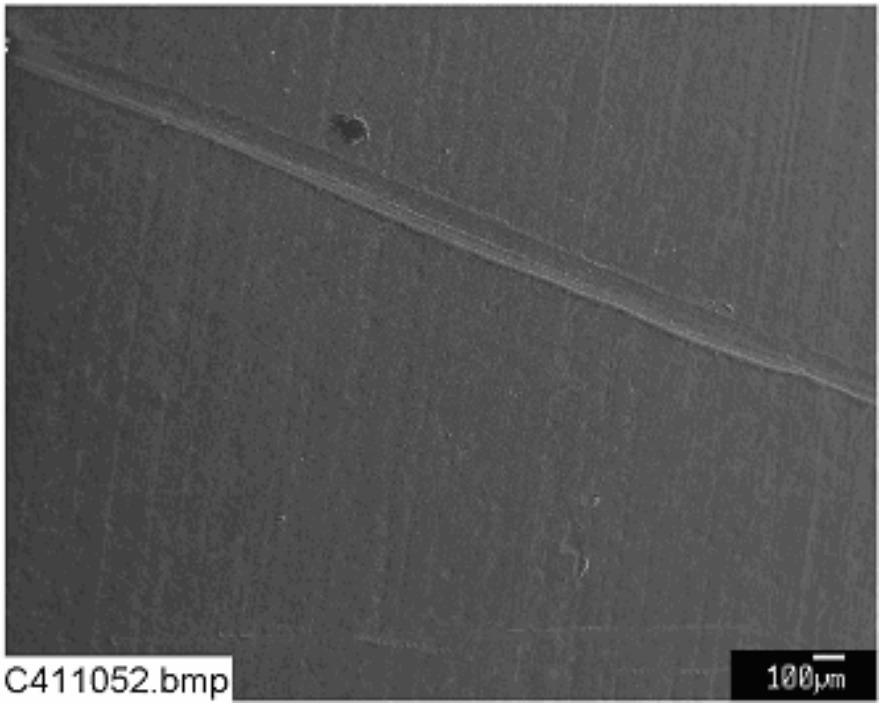


Figure C2-1. SEM image for an unused copper coupon (C411052).

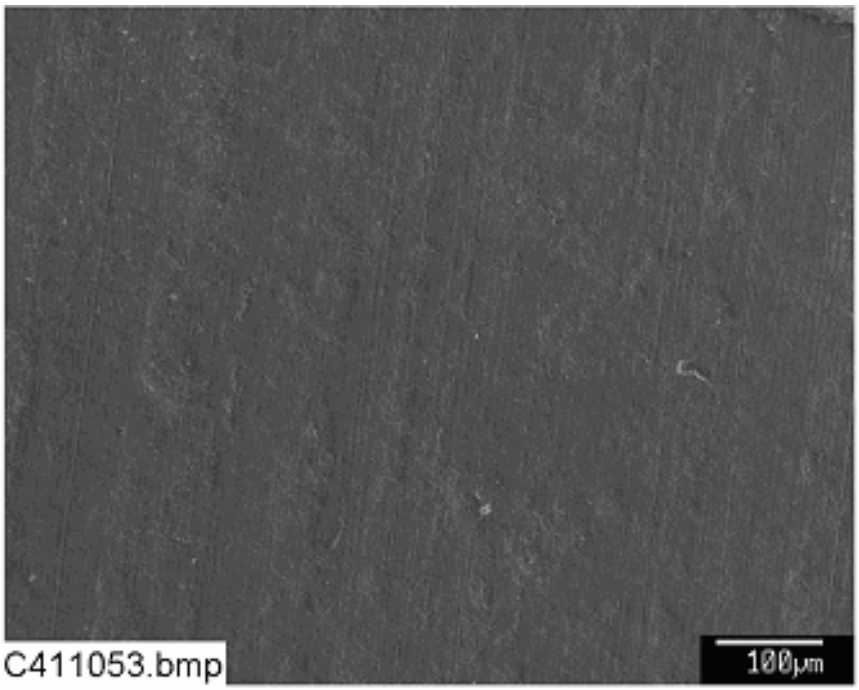


Figure C2-2. SEM image for an unused copper coupon (C411053).

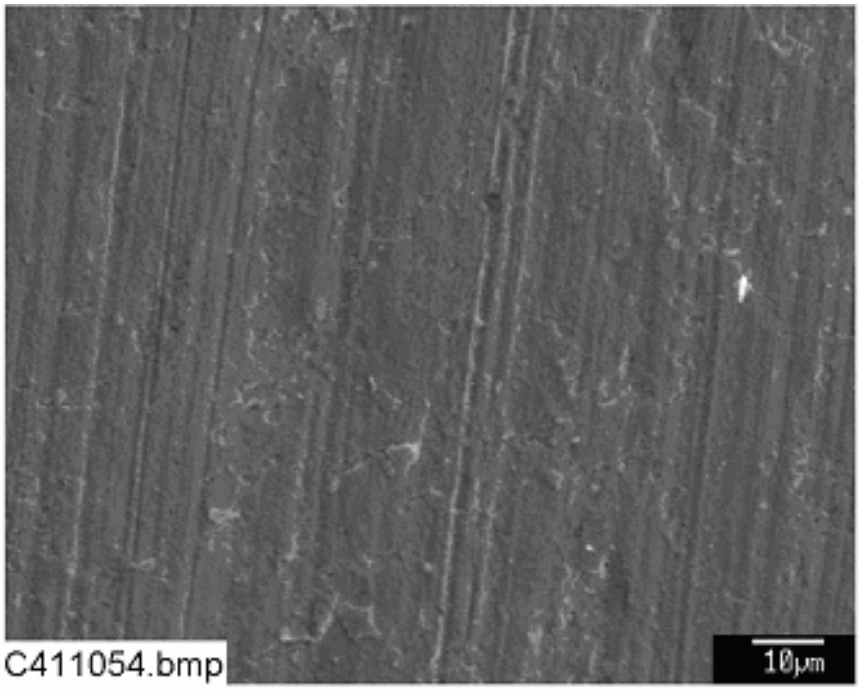


Figure C2-3. SEM image for an unused copper coupon (C411054).

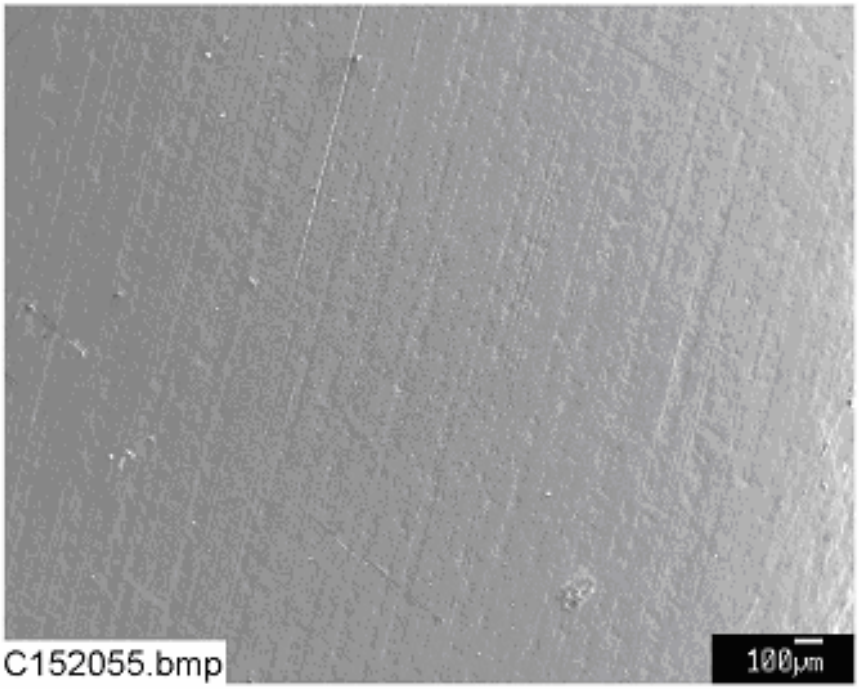


Figure C2-4. SEM image for a Test-2 Day-30 unsubmerged copper coupon (C152055).

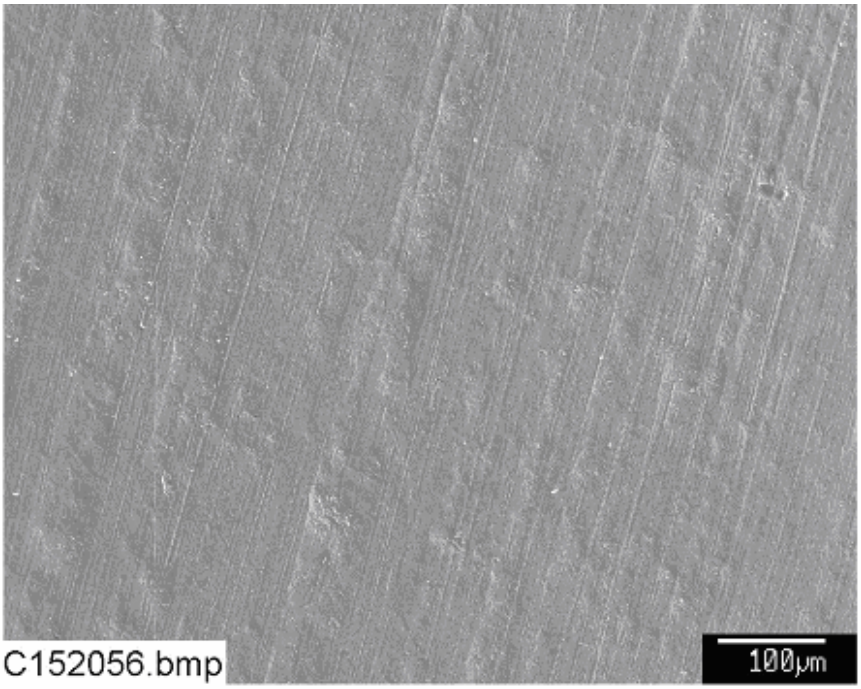


Figure C2-5. SEM image for a Test-2 Day-30 unsubmerged copper coupon (C152056).

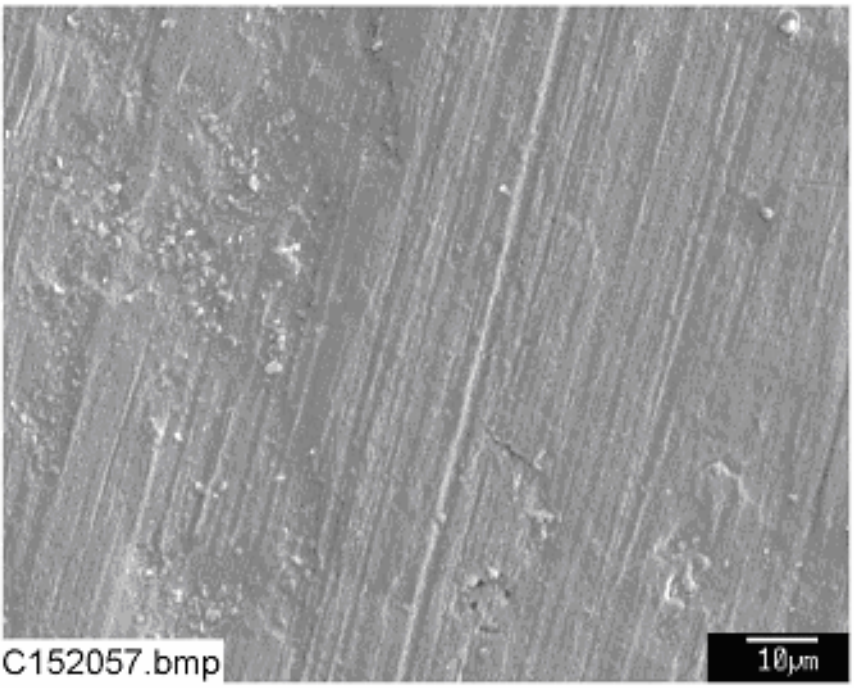


Figure C2-6. SEM image for a Test-2 Day-30 unsubmerged copper coupon (C152057).

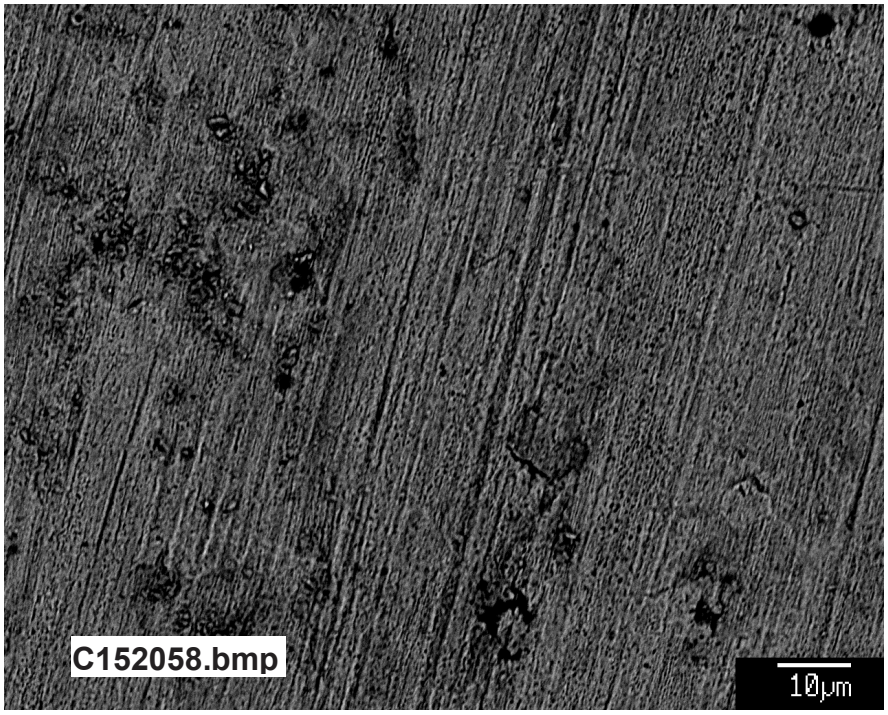


Figure C2-7. Backscattered SEM image for a Test-2 Day-30 unsubmerged copper coupon (C152058).

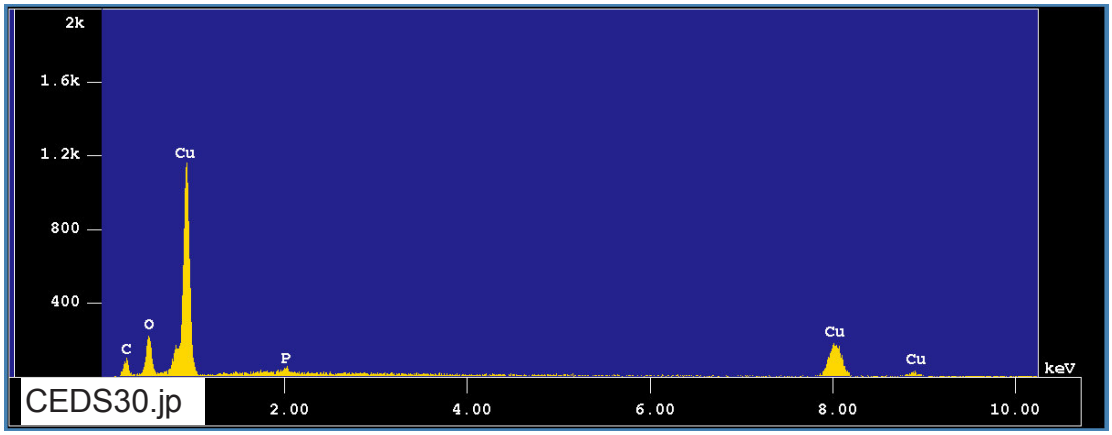


Figure C2-8. EDS counting spectrum for one of the dark spots shown in Figure C2-7 (CEDS30).

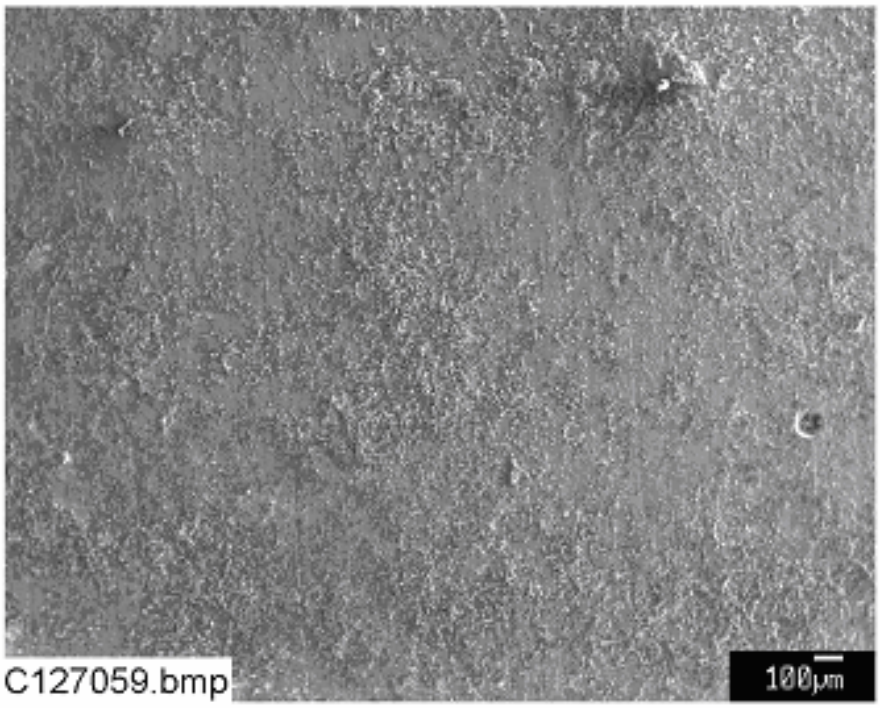


Figure C2-9. SEM image for a Test-2 Day-30 submerged copper coupon (C127059).

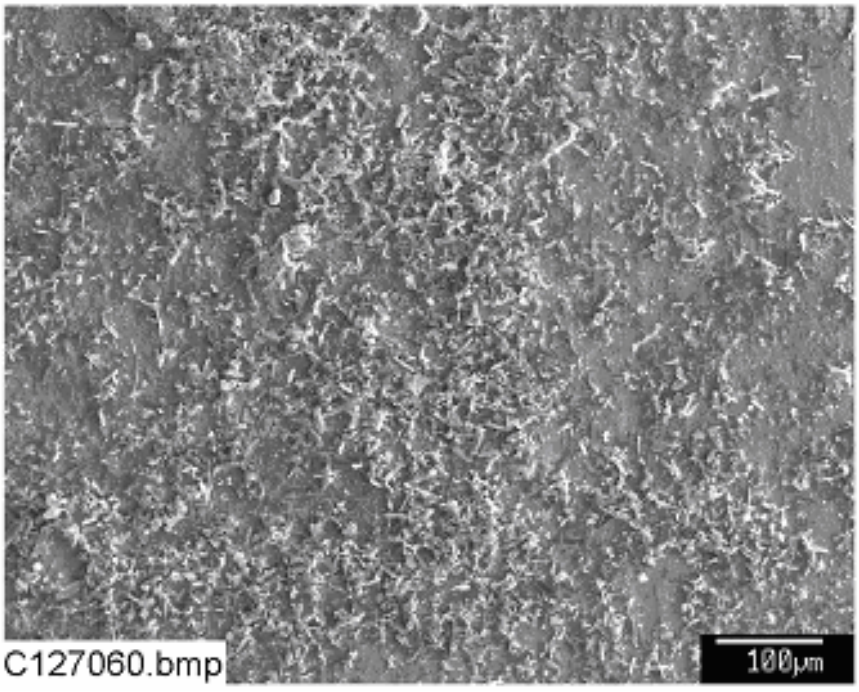


Figure C2-10. SEM image for a Test-2 Day-30 submerged copper coupon (C127060).

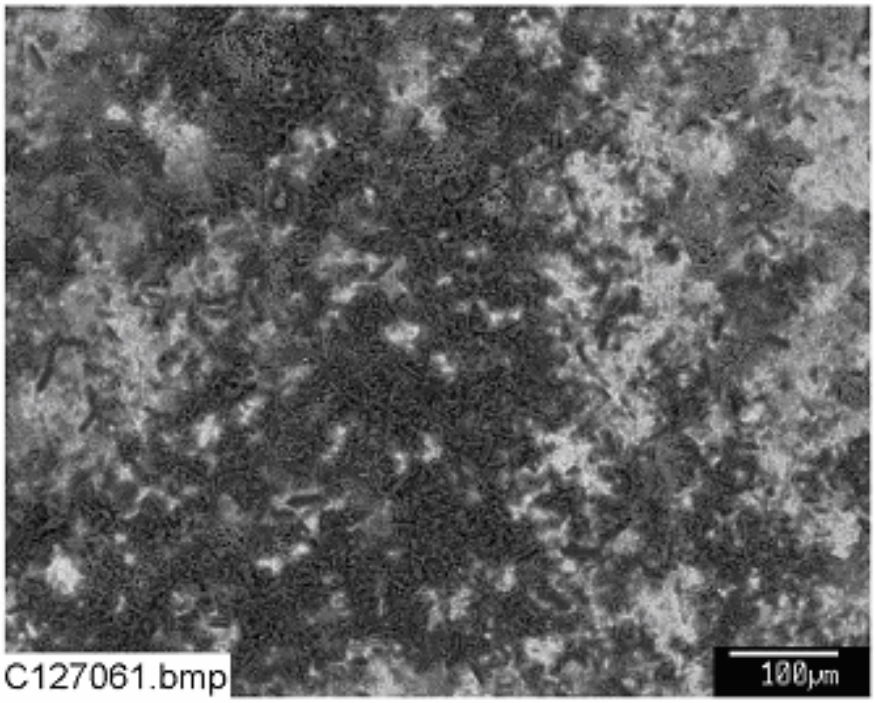


Figure C2-11. Backscattered SEM image for a Test-2 Day-30 submerged copper coupon (C127061).

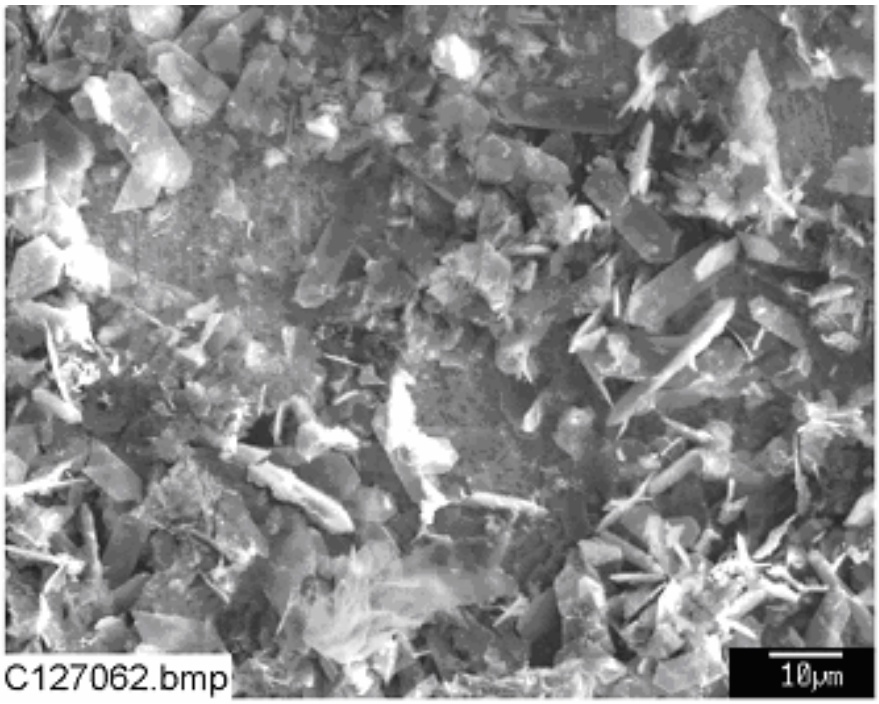


Figure C2-12. SEM image for a Test-2 Day-30 submerged copper coupon (C127062).

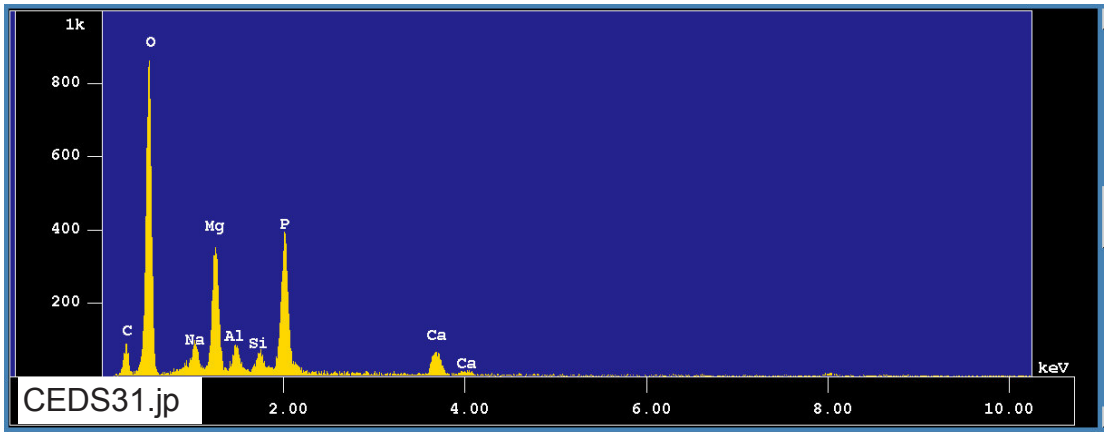


Figure C2-13. EDS counting spectrum for the dark patches shown in Figure C2-11 (CEDS31).

The results from the chemical composition analysis for CEDS31 are given in Table C2-1.

Table C2-1. The Chemical Composition for CEDS31 (Figure C2-13)

Apr 4 13:52 2005 /tmp/eds_pout.log Page 1

Group : NRC
Sample : Metals ID# : 31
Comment : Dark spot on T2D30 submged Cu
Condition : Full Scale : 20KeV(10eV/ch,2Kch)
Live Time : 60.000 sec Aperture # : 1
Acc. Volt : 15.0 KV Probe Current : 5.546E-10 A
Stage Point : X=42.970 Y=70.696 Z=11.000
Acq. Date : Mon Apr 4 13:48:30 2005

Element	Mode	ROI(KeV)	K-ratio(%)	+/-	Net/Background
O K	Normal	0.25- 0.77	38.8311	0.0031	5041 / 52
Na K	Normal	0.81- 1.27	1.2974	0.0009	484 / 136
Mg K	Normal	0.97- 1.57	4.9621	0.0004	2689 / 34
Al K	Normal	1.19- 1.83	0.7808	0.0003	421 / 79
Si K	Normal	1.50- 2.05	0.9519	0.0003	478 / 116
P K	Normal	1.75- 2.38	11.7319	0.0033	3637 / 37
Ca K	Normal	3.39- 4.30	3.3210	0.0012	811 / 5

Chi_square = 45.5460

Element	Mass%	Atomic%	ZAF	Z	A	F
O	59.978	72.8049	0.9785	0.9908	0.9877	1.0000
Na	2.826	2.3873	1.3800	1.0457	1.3215	0.9986
Mg	11.431	9.1315	1.4595	0.9845	1.4842	0.9988
Al	1.789	1.2876	1.4515	1.0179	1.4298	0.9974
Si	1.887	1.3046	1.2557	0.9952	1.2690	0.9943
P	16.716	10.4809	0.9027	1.1946	0.7558	0.9997
Ca	5.372	2.6032	1.0249	1.0161	1.0086	1.0000
Total	100.000	100.0000				

Normalization factor = 1.5785

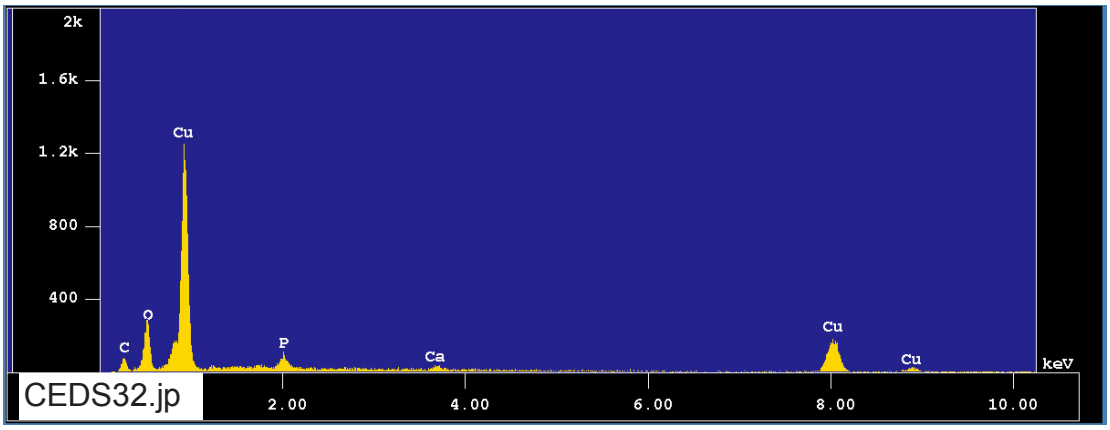


Figure C2-14. EDS counting spectrum for the light patches shown in Figure C2-11 (CEDS32).

The results from the chemical composition analysis for CEDS32 are given in Table C2-2.

Table C2-2. The Chemical Composition for CEDS32 (Figure C2-14).

```
Apr  4 14:01 2005  /tmp/eds_pout.log Page 1


 Group     : NRC
 Sample    : Metals  ID# : 32
 Comment   : Light spot on T2D30 submged Cu
 Condition : Full Scale  : 20KeV(10eV/ch,2Kch)
             Live Time   :  60.000 sec    Aperture #    : 1
             Acc. Volt   : 15.0 KV        Probe Current : 5.518E-10 A
             Stage Point : X=42.970 Y=70.696 Z=11.000
             Acq. Date   : Mon Apr  4 13:58:47 2005


 Element     Mode     ROI(KeV)   K-ratio(%)  +/-    Net/Background
   O K      Normal   0.25- 0.77   15.4064   0.0023     1990 /      92
   P K      Normal   1.75- 2.38    2.0745   0.0020      640 /      26
  Ca K      Normal   3.39- 4.30    1.1910   0.0011      289 /      14
  Cu K      Normal   7.63- 9.27   61.8655   0.0086     3043 /       4
-------------------------------------------------------------------
                              Chi_square =  7.3941

 Element Mass%    Atomic%   ZAF      Z      A      F
      O   16.042  42.1700 0.8549 0.8436 1.0136 0.9998
      P    2.528   3.4327 1.0005 1.0112 0.9894 1.0000
     Ca    1.293   1.3565 0.8912 0.8542 1.0459 0.9975
     Cu   80.137  53.0408 1.0634 1.0641 0.9994 1.0000
-------------------------------------------------------------------
 Total   100.000 100.0000
 Normalization factor =  1.2181
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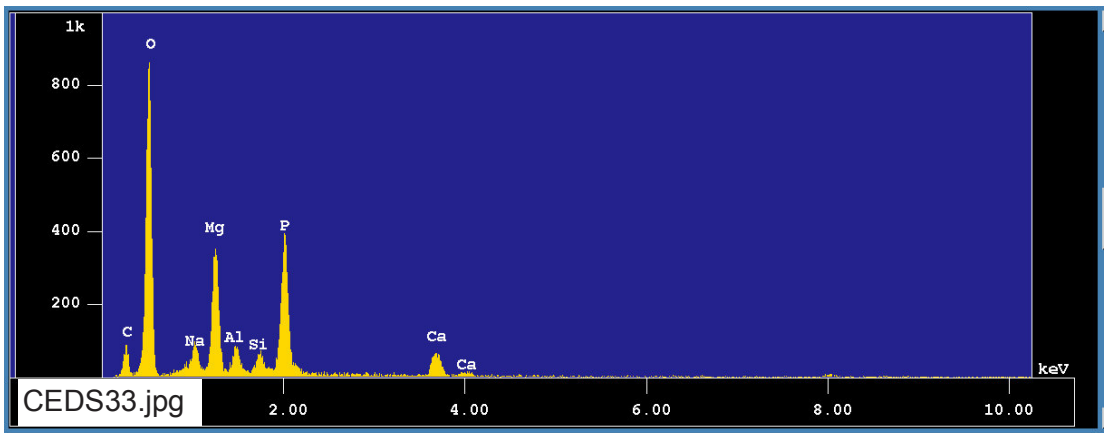

Figure C2-15. EDS counting spectrum for the lathlike crystals shown in Figure C2-12 (CEDS33).