

# Notes on Scanning Electron Microscope Analysis of 25-Cell W-Band Structure

## Introduction

E. Colby 8/14/98

The 25-cell OFHC copper W-band structure (numbered 1), "bottom" half was examined for contamination and other defects by both scanning electron microscopy and secondary electron emission. The sample was placed as-is into the microscope chamber without additional cleaning or preparation and examined. The object under study is entirely made of copper, and hence, self-grounding.

The scanning electron microscope images require careful interpretation as the images resemble optical microscope images in many respects, save a few: (1) Insulating materials tend to charge, deflecting the illuminating electron stream, giving the appearance of a bright source with a dark halo; (2) conductors in poor electrical contact can also charge (3) the electron beam at high magnification has sufficient power density to melt small, thermally isolated objects.

The secondary emission spectra give an indication of the elemental composition of the illuminated subject, but with signal contamination from the underlying surface if the subject is thin enough for the electrons to penetrate, or small enough to be only one part of the emitting region. The spectra shown here are all dominated by copper peaks, indicating subject transparency in every case, and tainting the observed spectra.

## Images and Spectra

Ten electronic images, four Polaroid photographs and three secondary electron emission spectra were acquired. Images and spectra are electronically archived in two locations:

Sem.slac.stanford.edu:\sem\data\w-band  
On the NT network V:\ardb\w-band\SEM\_Analyses\980723

A summary of the images is provided in the table below. Spectra are secondary electron emission spectra obtained from very small subregions of the attached images, as described briefly below.

<u>File Name</u>	<u>Description</u>
<a href="#">000881.gif</a>	View into BC5 at 56X showing fiber and other large (>50 $\mu$ ) particles
<a href="#">000882.gif</a>	BC5 bottom at 500X, showing copious particulate matter, with spectrum of whole area
<a href="#">000883.gif</a>	View into BC5 at 81X showing location of imaging site for 000882
<a href="#">000884.gif</a>	Chlorine inclusion at 5000X on BI5,6 top, with spectrum of inclusion
<a href="#">000885.gif</a>	Insulating (organic?) flakes on BC6 bottom at 2500X, with spectrum of flake
<a href="#">000886.gif</a>	Tear in corner of BC7(?) at 1010X
<a href="#">000887.gif</a>	Particle at bottom of BC19 at 830X
<a href="#">000888.gif</a>	Particulate and needle gouge on bottom BC19 at 250X
<a href="#">000889.gif</a>	Splatter on BC14 bottom at 180X
<a href="#">000890.gif</a>	Silicon (?) sphere on splatter on bottom of BC13 at 4100X, with spectrum of sphere
<a href="#">000891.gif</a>	Splatter on BC10 bottom at 138X, with spectrum of splatter and background
<a href="#">000892.gif</a>	"Typical", clean non-EDM copper surface on bottom of BC2 at 1000X
<a href="#">000893.gif</a>	"Typical", clean EDM-cut copper surface on top of BI3,4 at 1000X

## Some Unsolicited Speculation

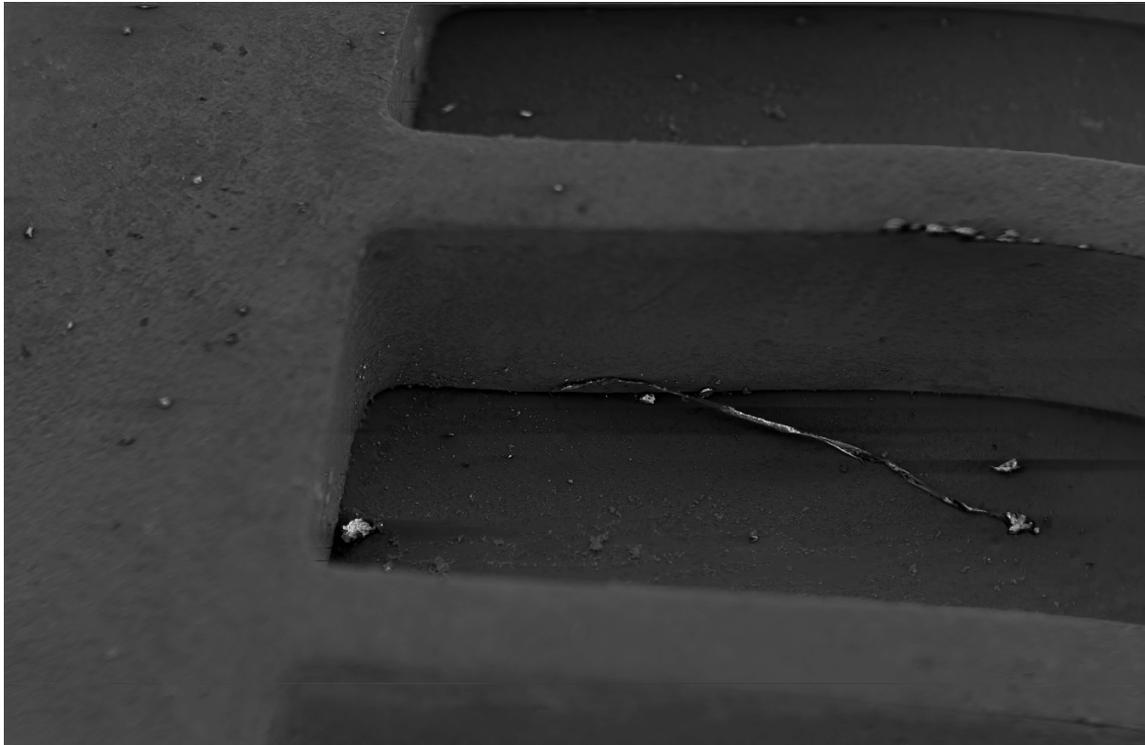
The general cleanliness of the 25-cell structure was appalling. Several fibers, a number of >50 m particles and a tremendous amount of finer particulate matter can be seen in most images, but particularly 000881 and 000882. The fibers melted under higher magnification.

Zinc was observed in all secondary electron emission spectra of copper surfaces (e.g. 000882), including the tops of irises where EDM cutting took place, and on the bottom of cells, where lapping had occurred subsequent to EDM cutting. An obvious source for the zinc is the EDM cutting wire, zinc-plated brass.

Chlorine inclusions of the type seen in 000884 were numerous only on the EDM-cut surfaces (see 000893), and never seen on any non-EDM cut surface. Testing of the EDM machine water at RWI was suggested to trace the source of the chlorine.

The tear seen in the wall of cell 7 (possibly cell 6 or 8) at the inside corner (image 000886) may be a sign of a more serious problem with EDM cutting of copper in general.

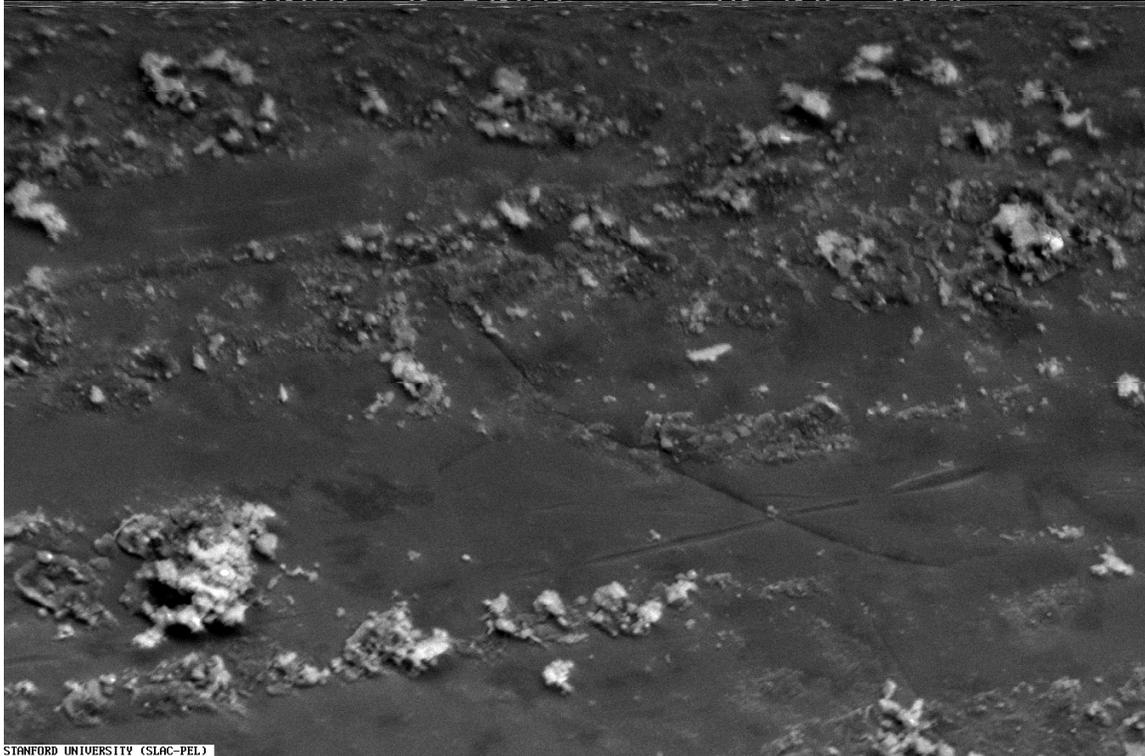
The splatter blotches, striking under optical illumination, are less so under electron illumination. (images 000889, 000890, 000891). Secondary electron emission spectra of the blotches (000891) did not show a significant change above the background. The splatter blotches appear to adhere well to the surface (000890) making removal potentially very difficult.



STANFORD UNIVERSITY (SLAC-PEL)

15kv .056kx 180µ 003

FILE: 000001  
DATE: 7/22/98 TIME: 13:37  
Structure 1, botton, cell 5

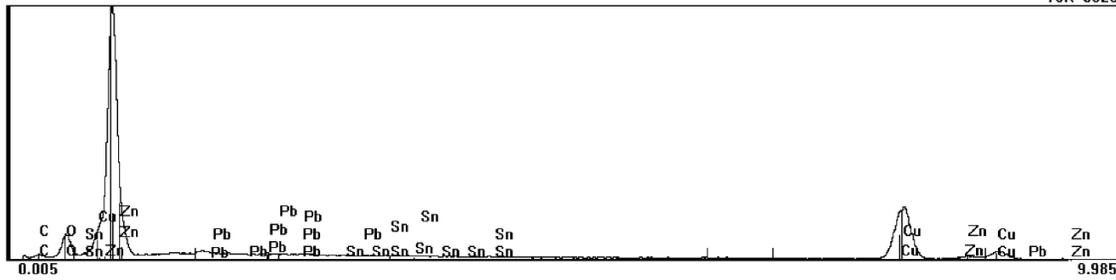


20kv 0.50kx 20.0µ 004

FILE: 980882  
 DATE: 7/22/98 TIME: 13:58  
 Structure 1, botton, cell 5, x-ray spectrum area

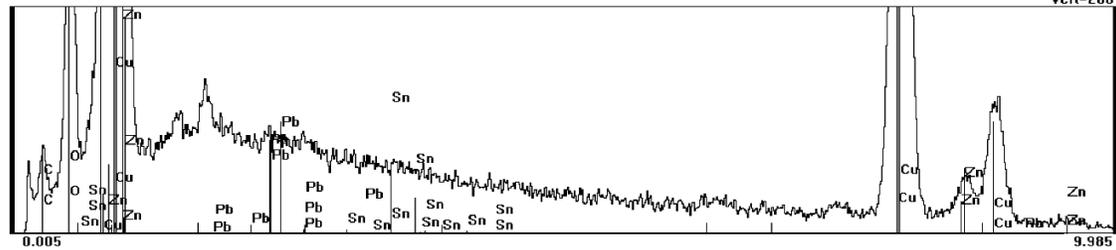
Spectrum: 98072201 Range:20keV

Vert=3628



Spectrum: 98072201 Range:20keV

Vert=200

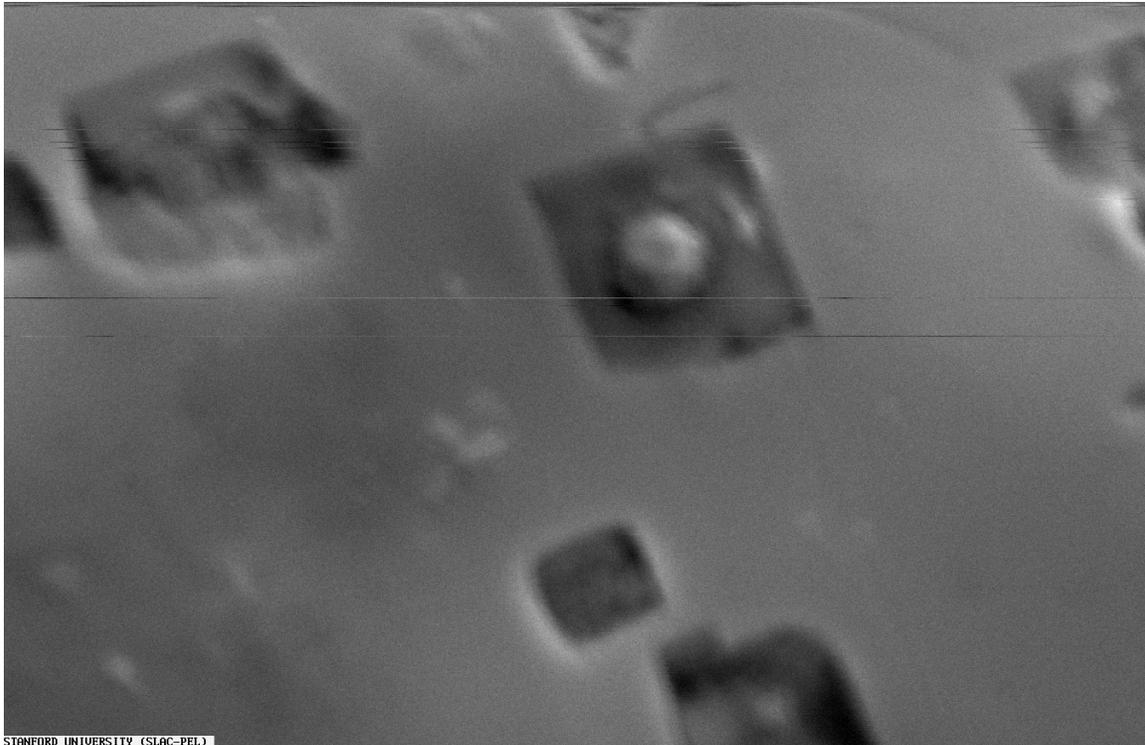




STANFORD UNIVERSITY (SLAC-PEL)

20kv .081kx 125µ 005

FILE: 000003  
DATE: 7/22/98 TIME: 14:18  
Structure 1, botton, cell 5, x-ray spectrum area

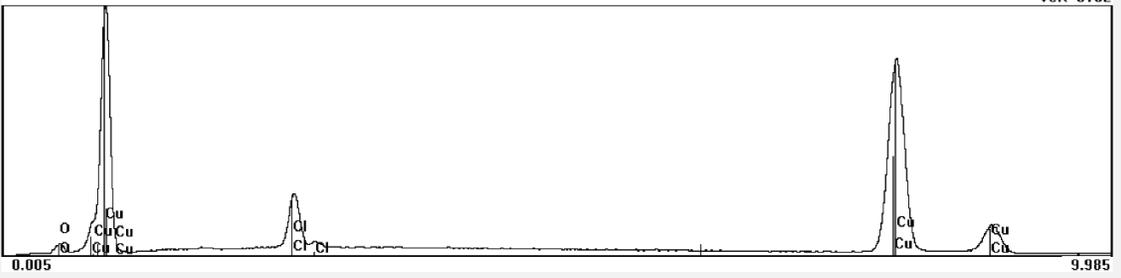


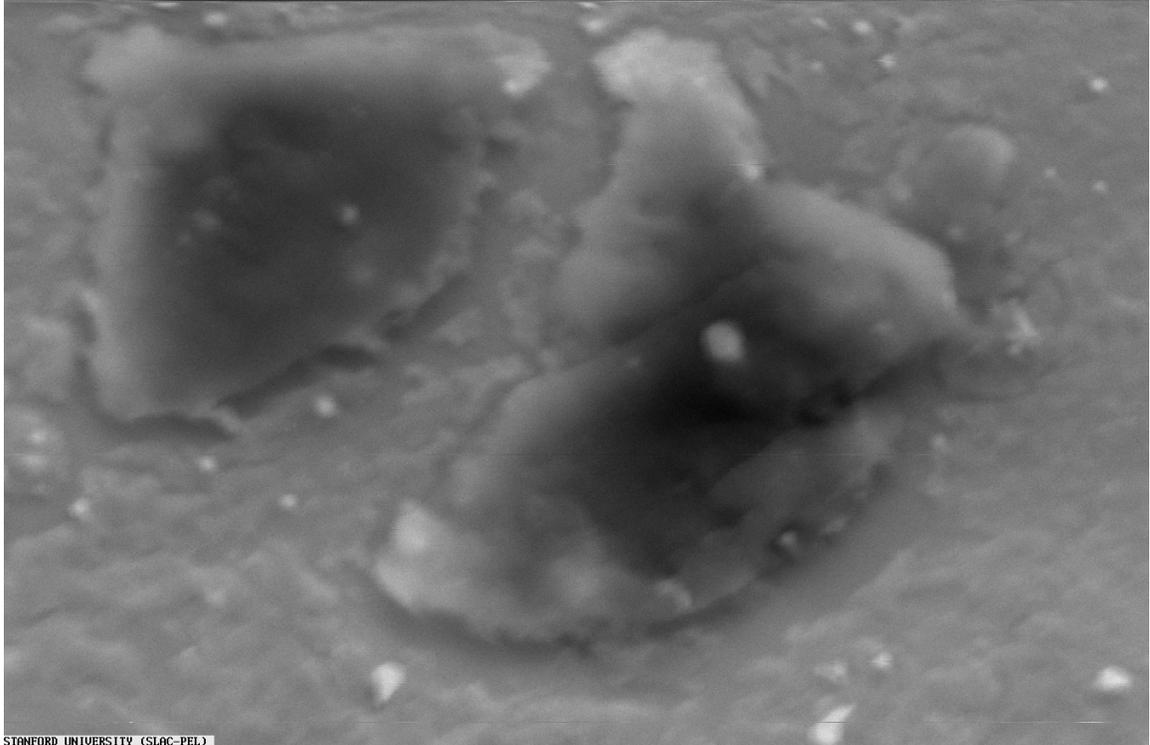
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20kv 5.0kx 2.00µ 006

FILE: 000004  
DATE: 7/22/98 TIME: 14:48  
Structure 1, iris BI 5/6,x-ray spectrum area,Cl featur

Spectrum: 98072202 Range:20keV Vert=6162





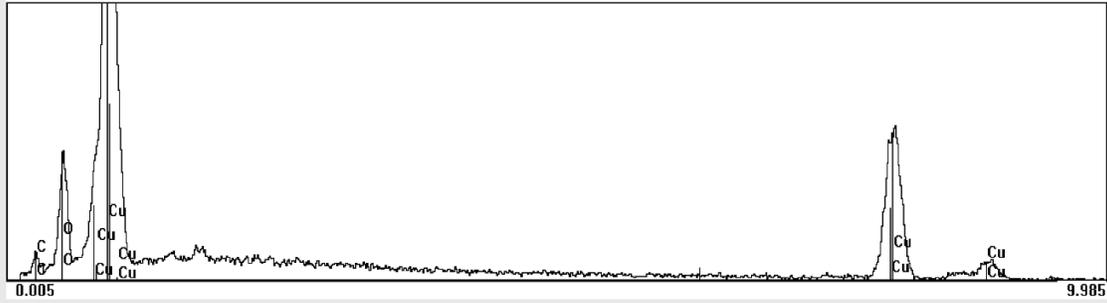
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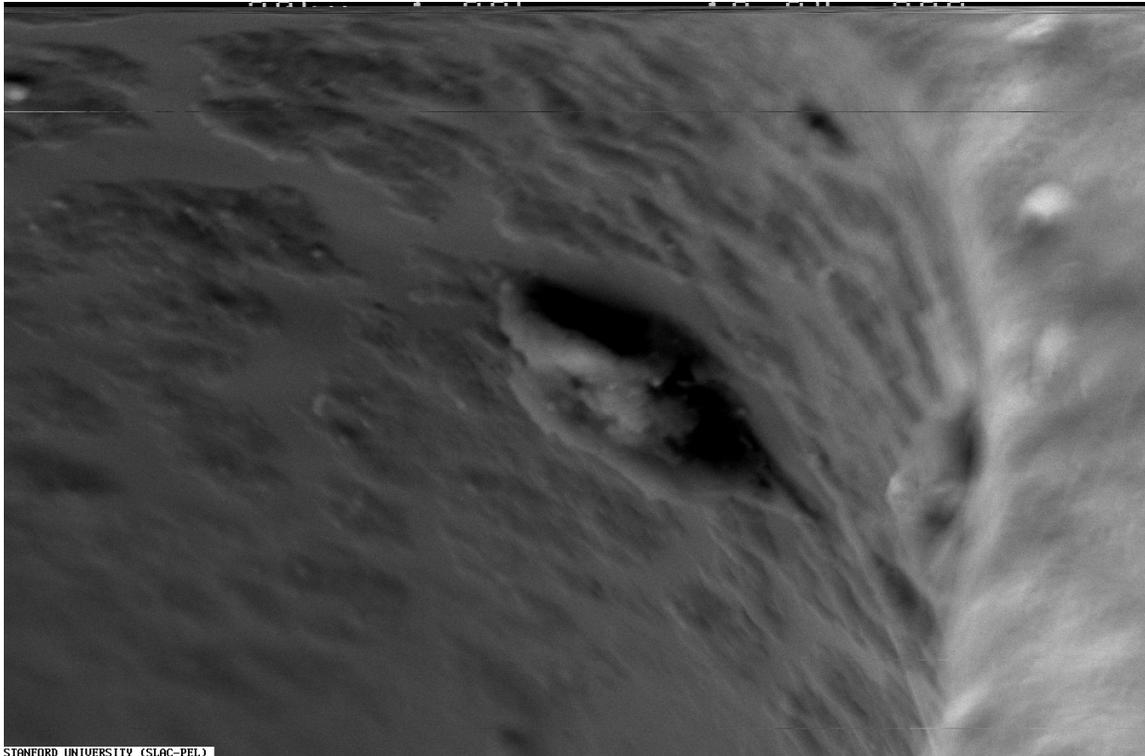
20kV 2.5kx 4.00µ 007

FILE: 000005  
DATE: 7/22/98 TIME: 15:01  
Structure 1, bottom of cell 6, ringed pit

Spectrum: 98072203 Range:20keV

Vert=500

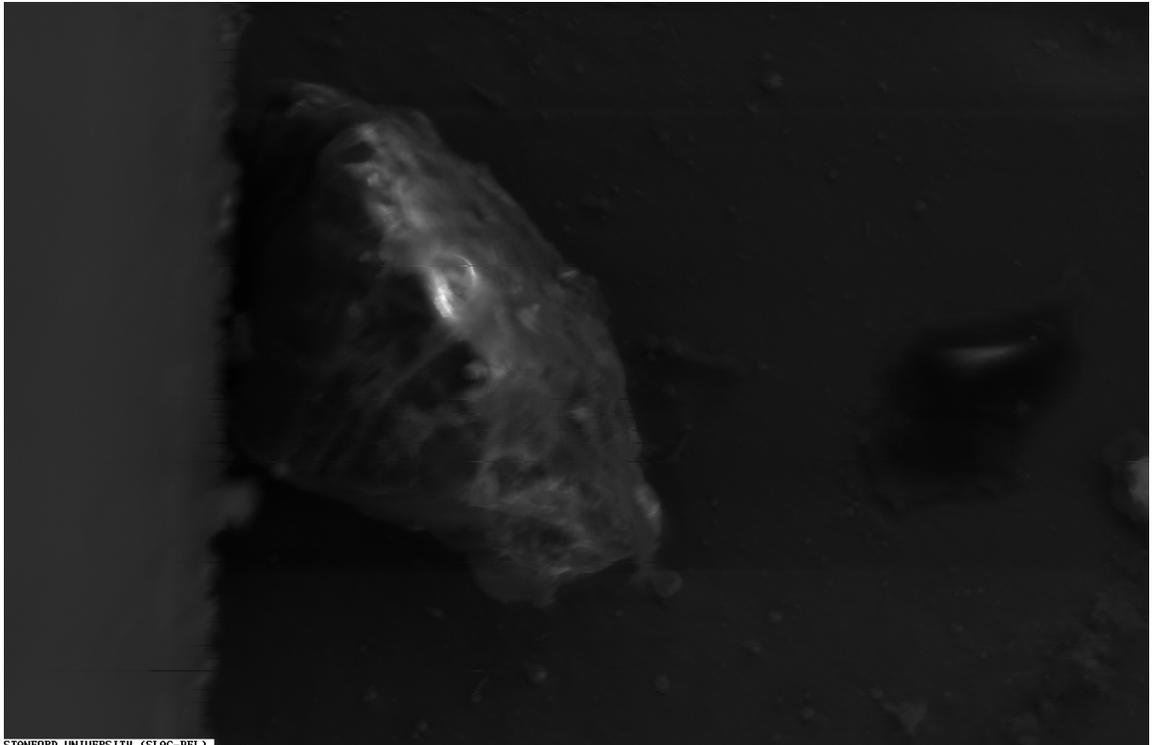




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20kv 1.01kx 10.0µ 008

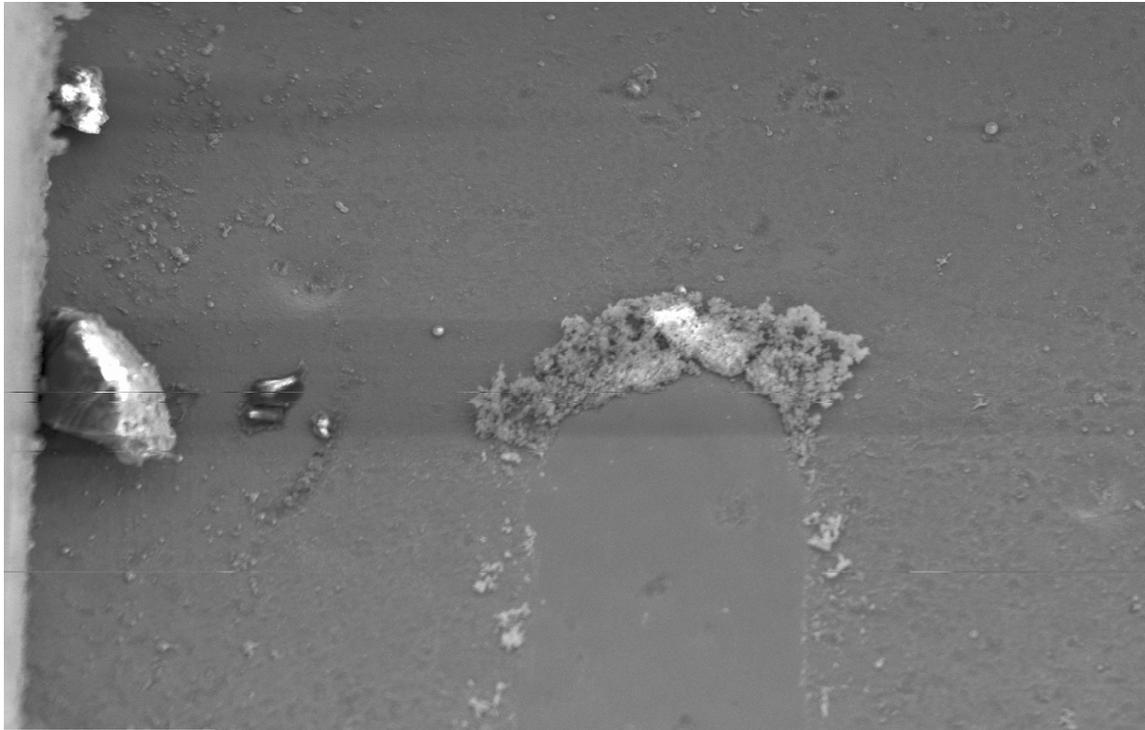
FILE: 000006  
DATE: 7/22/98 TIME: 15:31  
Cell corner, showing "tearout" area



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20kv 0.83kx 12.0P 009

FILE: 000007  
DATE: 7/23/98 TIME: 8:48  
BC19 bottom granule



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15kv 0.25kx 40.0P 010

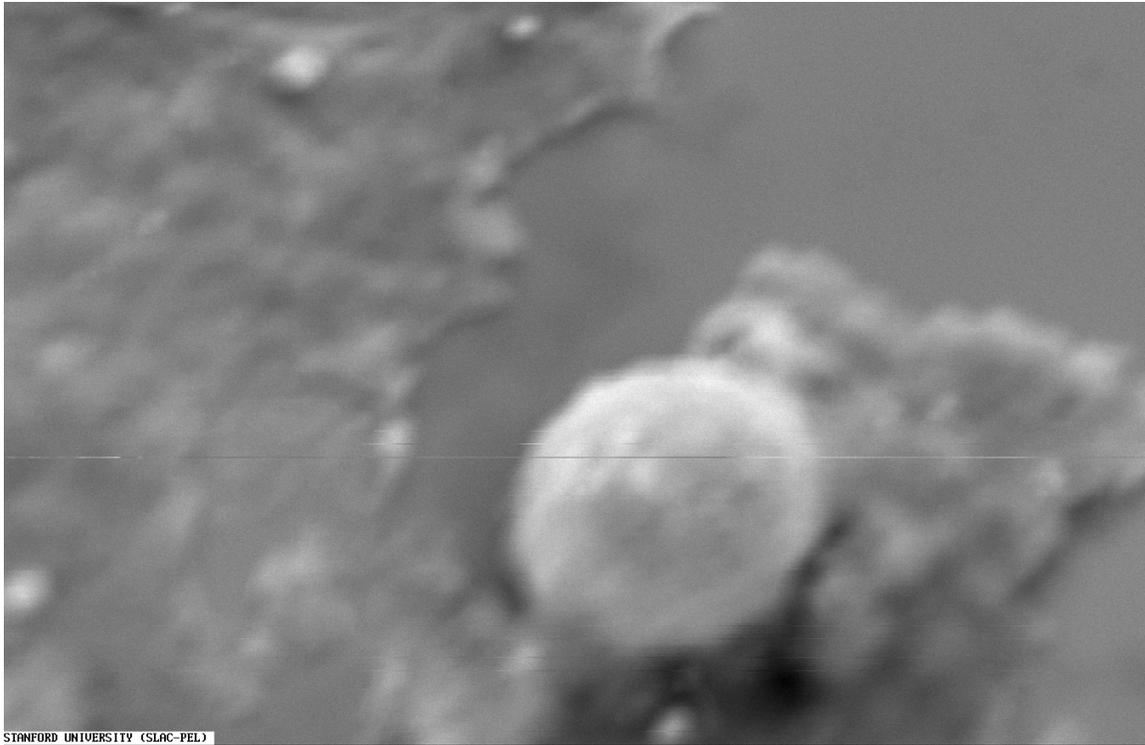
FILE: 000000  
DATE: 7/23/98 TIME: 9:09  
BC19 bottom particles at end of gouge



STANFORD UNIVERSITY (SLAC-PEL)

15kV 0.18kx 56.0P 011

FILE: 000009  
DATE: 7/23/98 TIME: 9:30  
BC14 bottom "crack"



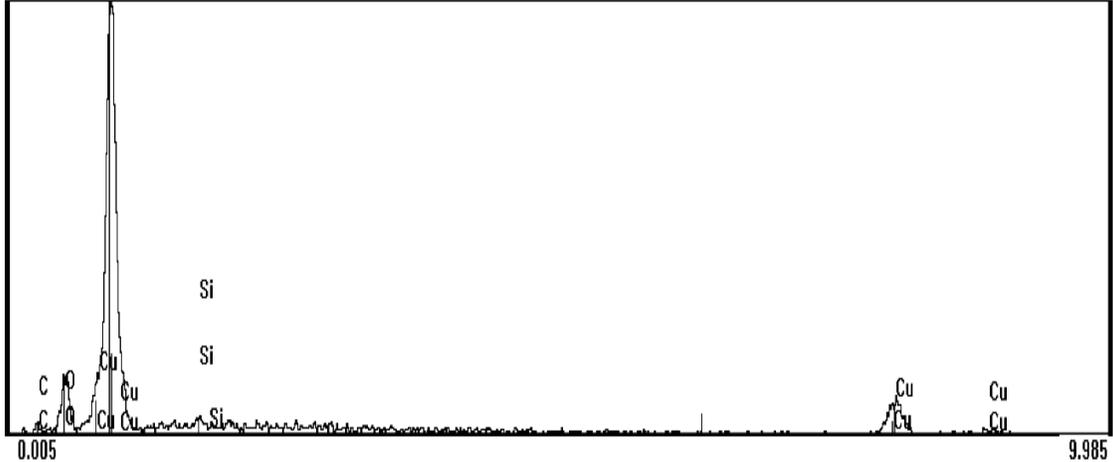
STANFORD UNIVERSITY (SLAC-PEL)

15kV 4.1kx 2.40µ 012

FILE: 000098  
DATE: 7/23/98 TIME: 9:47  
BC13 bottom sphere and blotch

Spectrum: 98072301 Range:20keV

Vert=345





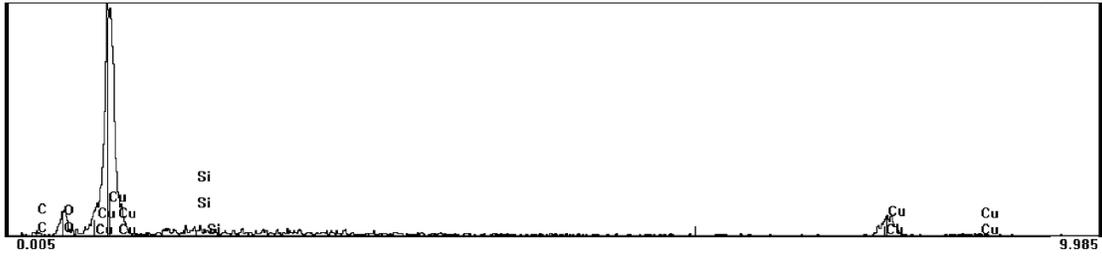
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15kV .139kx 73P 813

FILE: 98091  
DATE: 7/23/98 TIME: 10:07  
BC10 bottom blotch

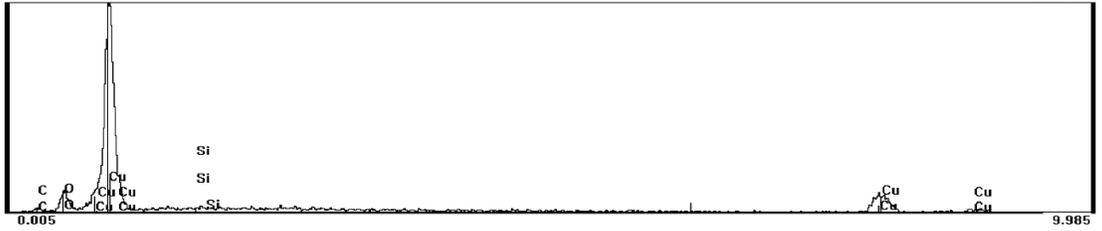
Spectrum: 98072302 Range:20keV

Vert=178



Spectrum: 98072303 Range:20keV

Vert=452

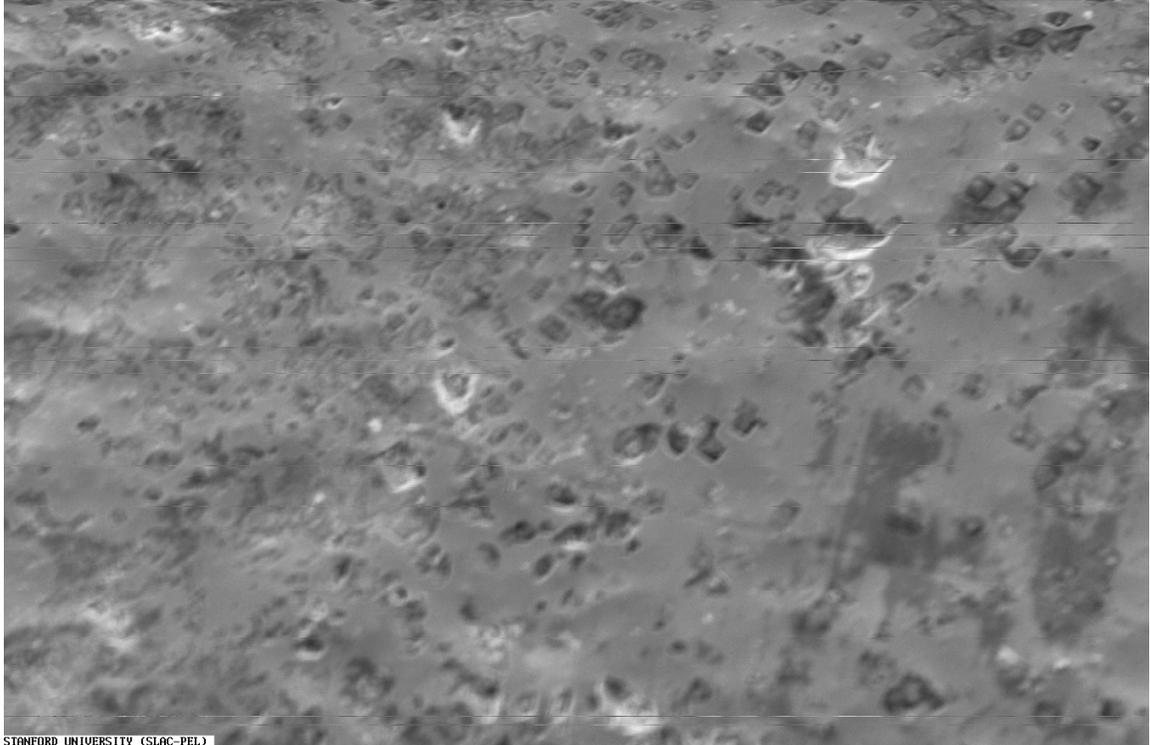




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15kv 1.00kx 10.0P 014

FILE: 000092  
DATE: 7/23/98 TIME: 11:28  
BC2 botton lotch



STANFORD UNIVERSITY (SLAC-PEL)

15kV 0.99kx 10.0µ 016

FILE: 000093  
DATE: 7/23/98 TIME: 11:39  
B13-4 EDM surface