EA05-005
STEPTOE & JOHNSON
FOR TEXAS INSTRUMENTS
2/23/2006
ATTACHMENT PART 1 OF 3

REPORT OF ANALYSIS

98-343

TO: Steve Proia

FR: Al Hopkins

SUBJECT: TSL # 148997: 77FS FORD/BOSCH TERMINAL PROBLEMS:
- UPDATE TO MEMO 98-330

DATE: 7/1/98

RAW TERMINALS FOUND AT SUPPLIER:
SEM-EDAX analysis of stains on raw terminals showed that oxidation was the cause of the staining on all the samples even though there were three different visual appearances to the stains. These stains-corrosion products are substantially different from the corrosion that had been previously found (and reported on in 98-330) on the terminals found at Ford/Bosch in the following ways:

- These stains showed chlorine in virtually all areas, this is a major contrast with the previous corrosion deposits on the terminals. Since chlorine is a corrosion accelerator, there is no need to search for another mechanism to explain the corrosion.

- These stains didn't have the previous characteristic decrease in corrosion from the tip toward the base. Instead, there was a random distribution, many times within the area that would have been within the electronics cavity.

- This corrosion product is more heavily colored than the previous products.

Another difference, which might or might not be significant is that we didn't see the "dried riverbed pattern" on any of these samples, and we had always seen it on the previous samples returned from Ford/Bosch (with the exception of the two samples from Gallatin which I described in 98-330).

These stains will not develop into the same exact type of contaminant that caused the original failures at the customer because of the differences enumerated above.

One of the stains had the appearance of being due to droplets being splashed on the surface. This type typically showed detectable chlorine, silicon and phosphorous in addition to the bulk elements of copper, zinc, carbon and oxygen. An optical photo is shown below:

I have described another type of stain as being associated with liquid wicking. We found the same elements in this type of stain as we had seen in the "Droplet Splash" type described above with the exception that we didn't find any phosphorous. A representative photo is shown below:

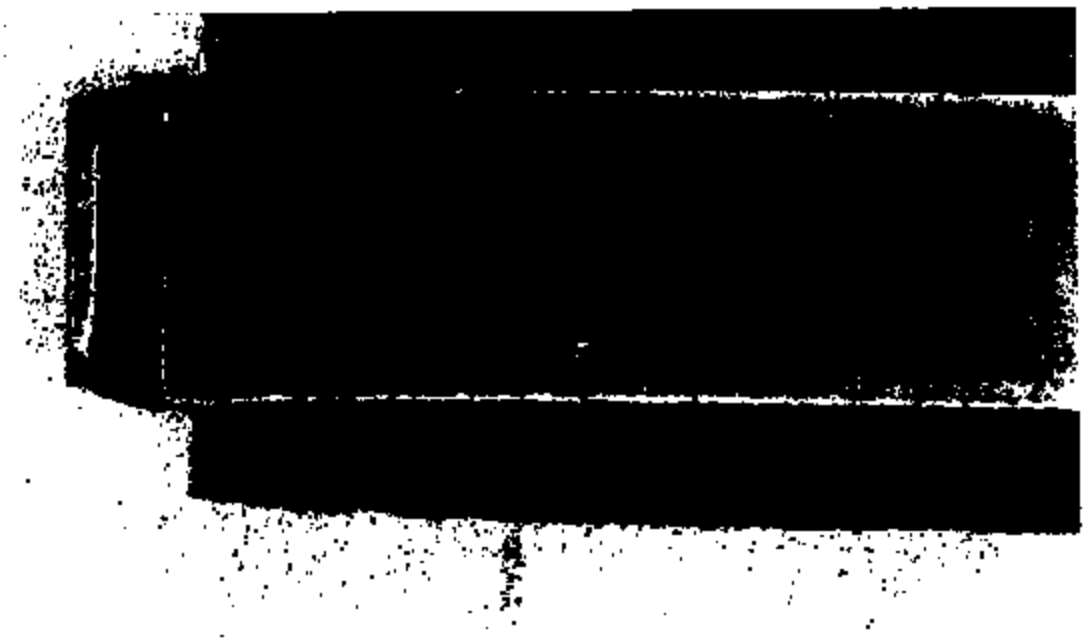
The final type of stain had the appearance of having been caused by a fingerprint although I can't be completely sure that this was the case. We typically found chlorine, silicon, potassium and iron in addition to the bulk elements of copper, zinc, carbon and oxygen. A representative photo is shown below:

DEVICES BROUGHT BACK BY BOB GILDEN FROM SUMTER

It is my understanding that all devices had been tested with a multimeter with point probes and passed. Additionally, the #3 device had been tested and found good by your device with a mating connector. None-the-less, this device had the same exact pattern as the previous devices returned from Ford/Bosch. In other words, we found the following:

- Heavy corrosion initiating from the tip of the terminal and decreasing as one goes back towards the plastic base.
- No chlorine in the corrosion deposit; we only found the bulk products of copper, zinc, carbon and oxygen.
- "Dried riverbed" pattern to the corrosion deposit.
- Similar attack on both terminals.
- Not strongly colored considering the amount of corrosion product that is present.

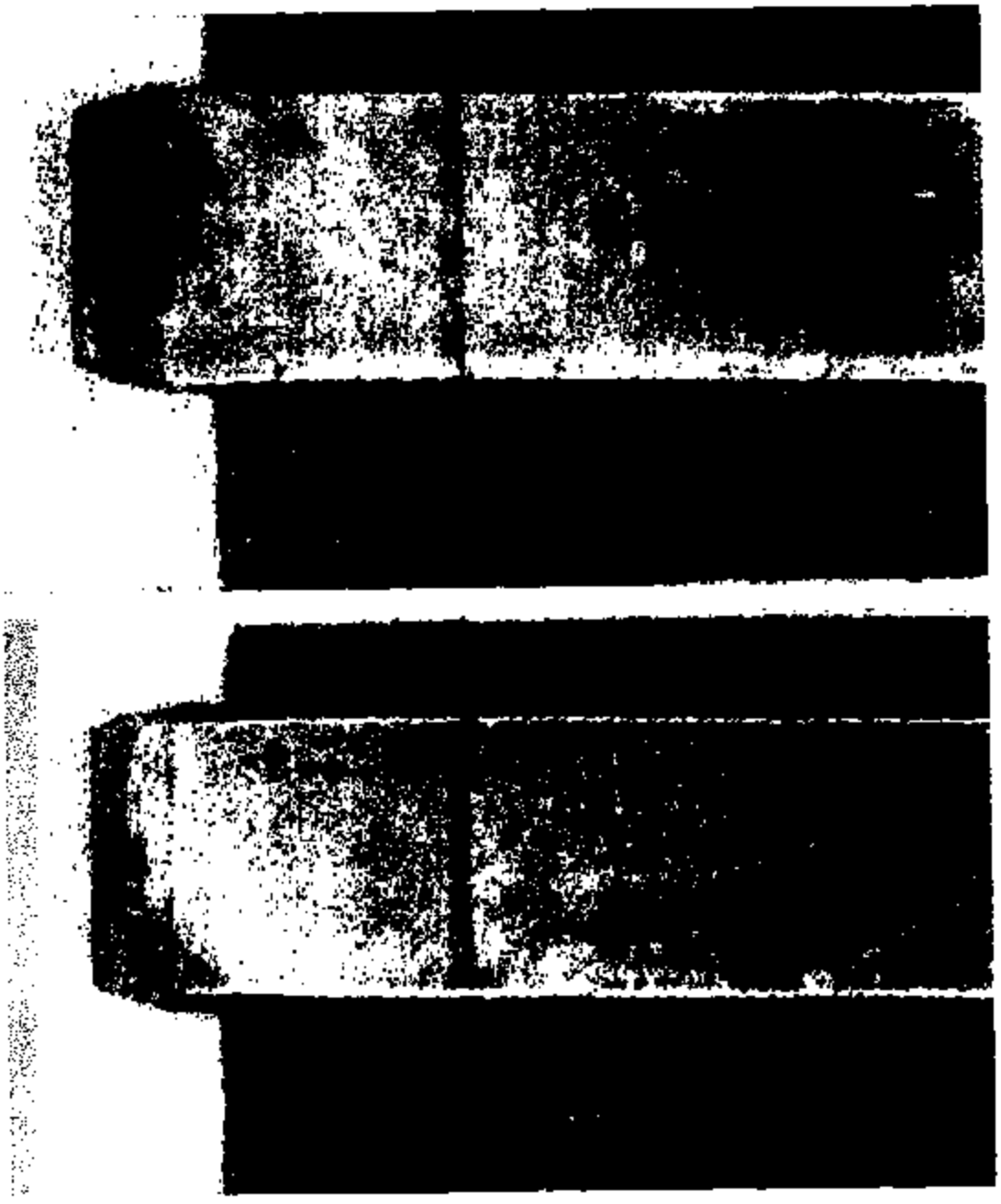
A photo of this terminal is shown below:



The other two devices had a much different pattern of corrosion. They are different from the typical Bosch/Ford problem and the Gallatin problem in the following ways:

- Both devices had one bad terminal and one pristine terminal.
- The bad terminal had a "Splash" type stain that extended up the leg and into the electronics cavity. This had to occur before the terminals were molded into the plastic. This defect is similar to the "splash" type stain found on the raw terminals.
- In addition to the splash stain there was a corrosion zone on the ultimate tip of the bad terminal of both these devices. We found the same elements in both these end type stains and the splash type of stains so they are probably were exposed to the same liquid although by a different mode.
- We found chlorine, potassium, calcium, iron, sulfur and silicon in addition to the bulk species of copper, zinc, carbon and oxygen.
- We didn't find the "dried riverbed" pattern on either sample.

Photos of terminals from these two devices are shown below:



DEVICES RETURNED WITH CONNECTORS

The terminals on these devices (#12 and 13) had the same problem as the original three samples but to an even worse extent. We also found the same deposit (copper, zinc, oxygen, and carbon) on the mating areas of the mating connector of the #12 device. So far, I haven't found any indications that the corrosion had occurred while the terminal was

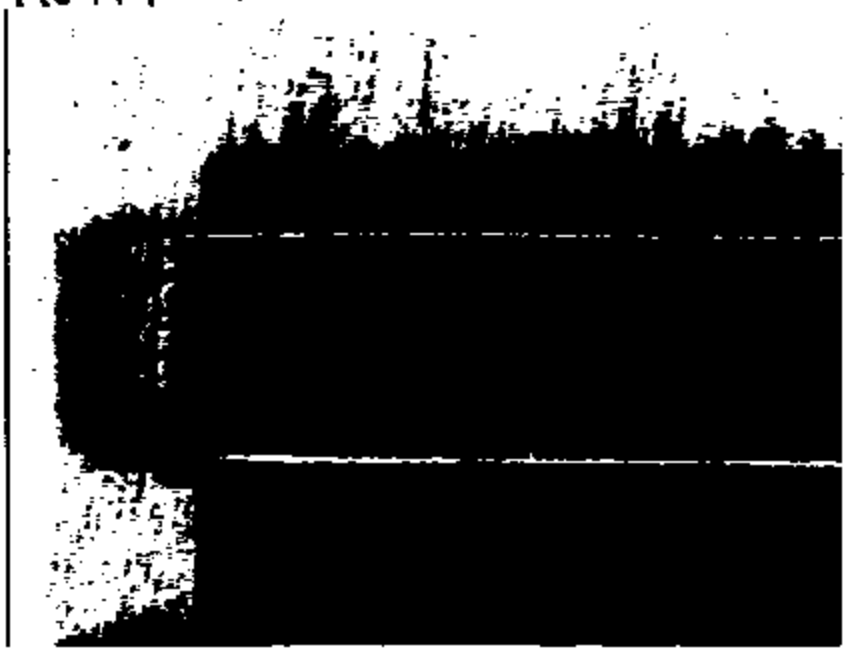
mated to the connector. So far it looks as though the connector had this species present only because it had scrapped the deposit from the terminal. I want to alert you, however, to the fact that there is an inherent difficulty in determining if liquid was present because solder doesn't have the same staining propensity that copper does. Work continues on these samples.

Ahmed Amin performed X-ray diffraction analysis on this heavily discolored #12 terminal sample. He found a quite good match with the lines of Cu2O although there were significant peak position shifts. I think that we can conclude that Cu2O is the major species even though other species are probably there.

LIQUID SAMPLE RETURNED BY BOB GILDEA
The sample has been given to Beth. I have advised her to wait until you get the MSDS before doing an analysis; let us know if you would rather that she proceed anyway.

AL HOPKINS MSG ID: AHOP PHONE: 508/236-3040

148997 = 1



Ex 1

#3 after Disassembly of Base

PW A PW B

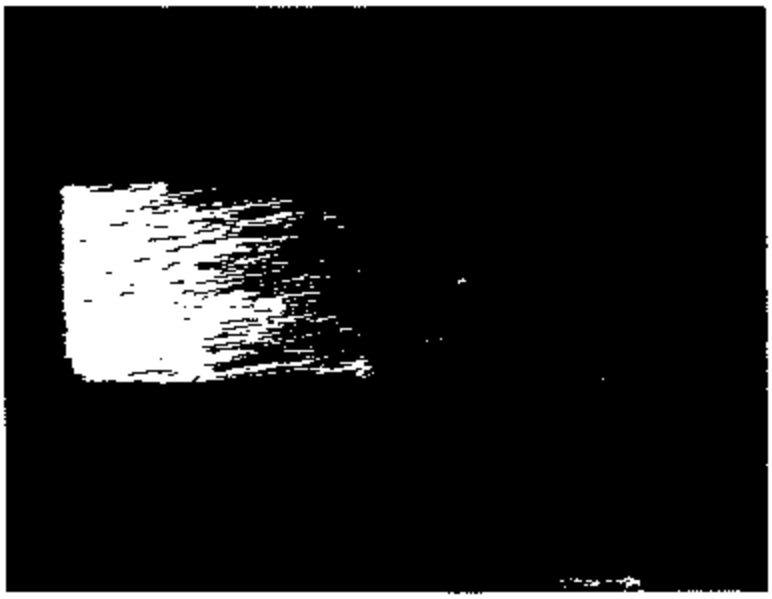
S206/1 1#

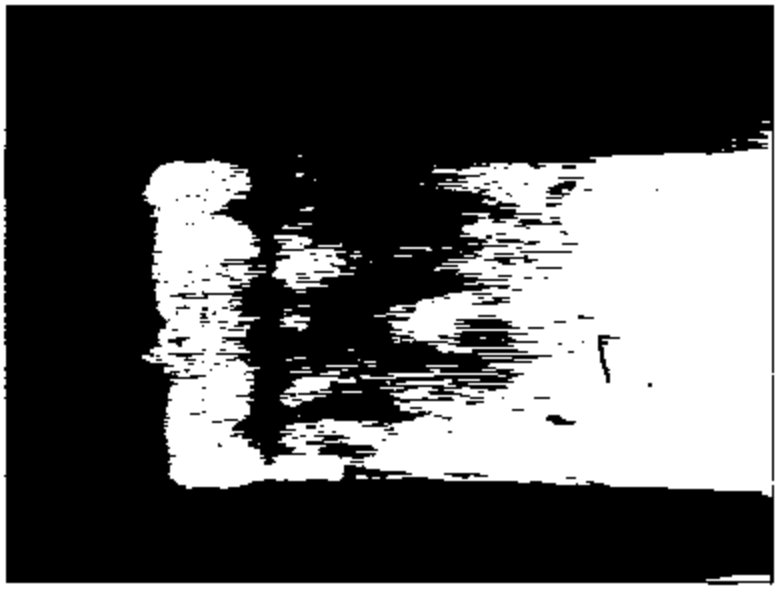
ΣH

EH

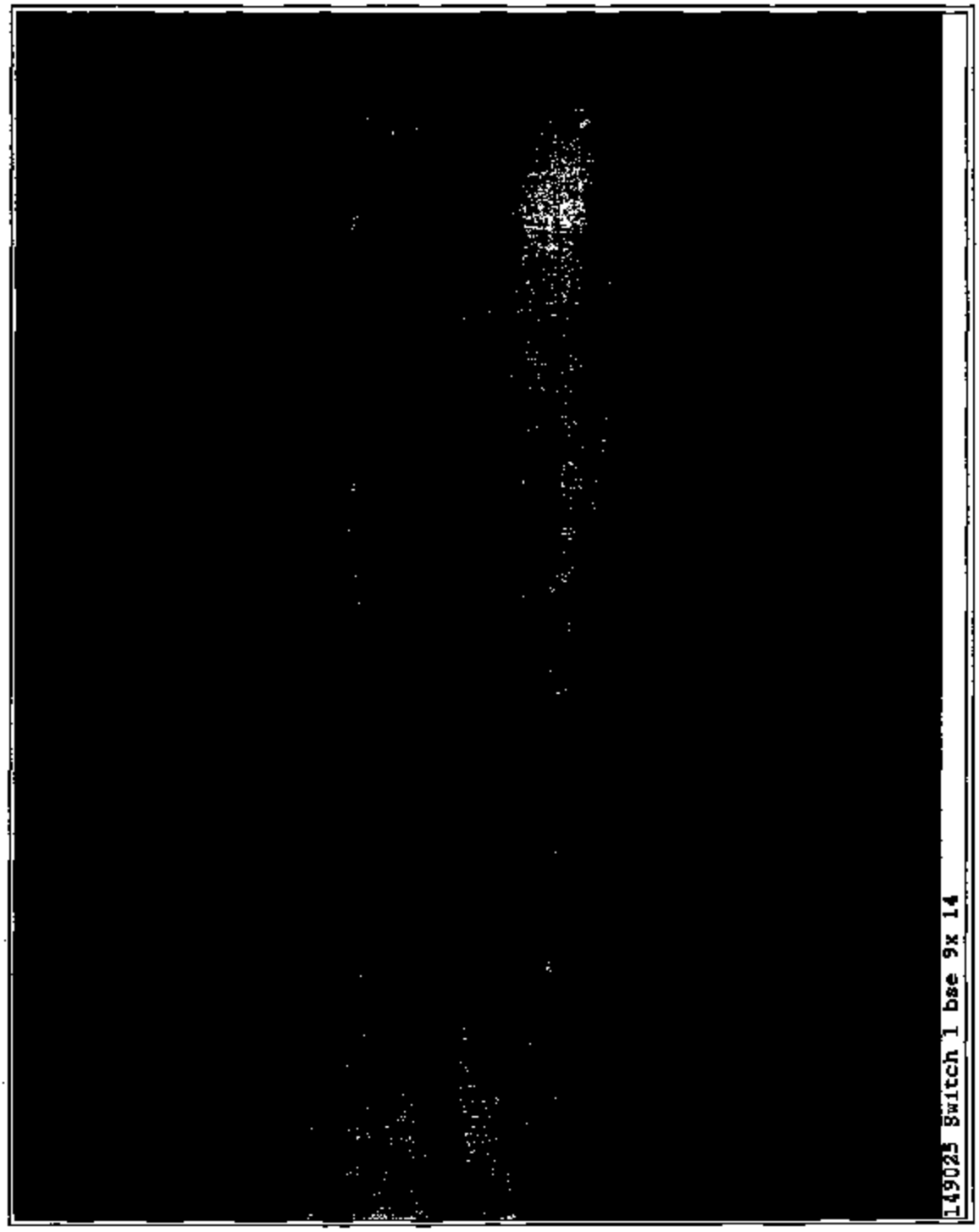
#2 149025

#3





#3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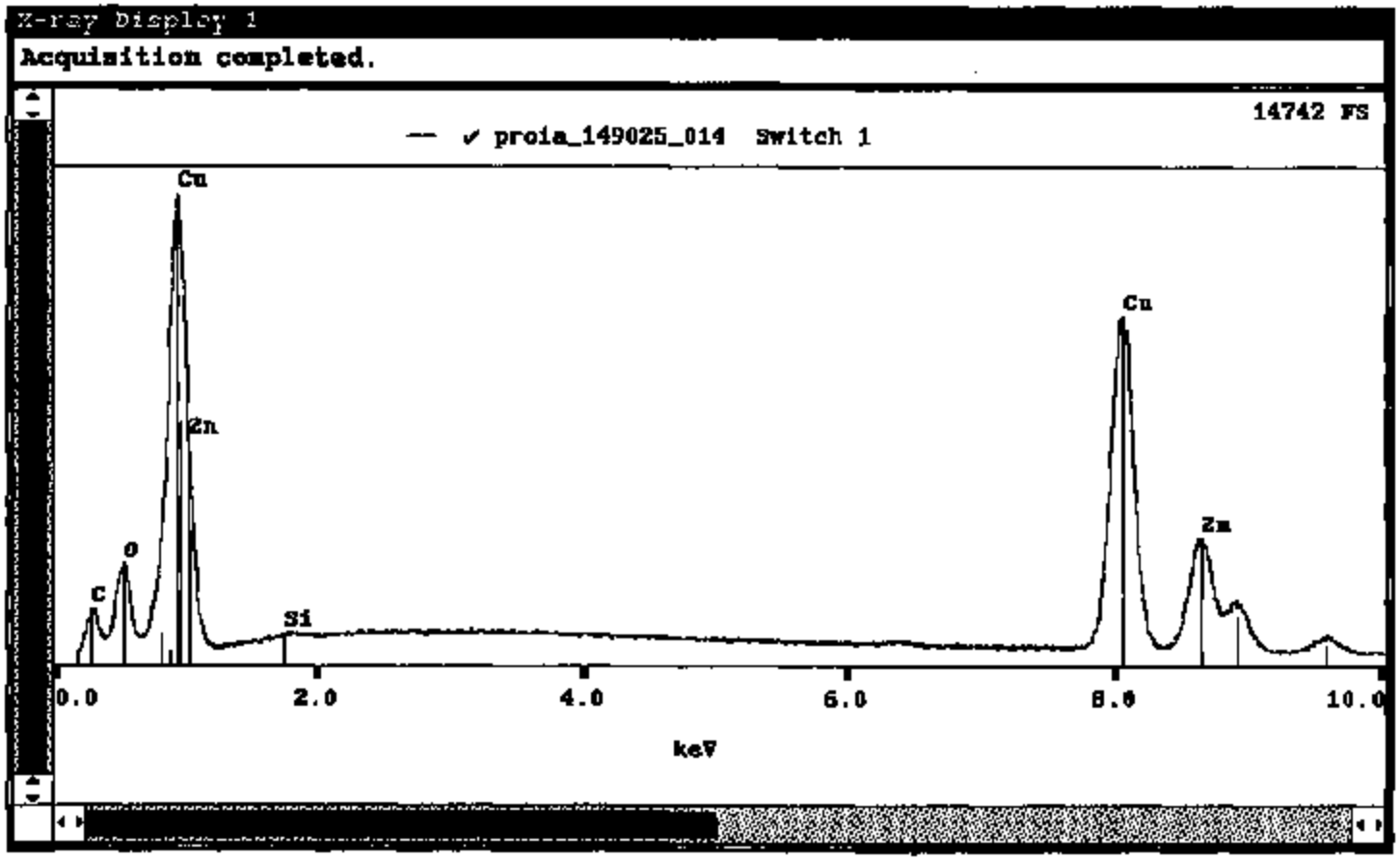
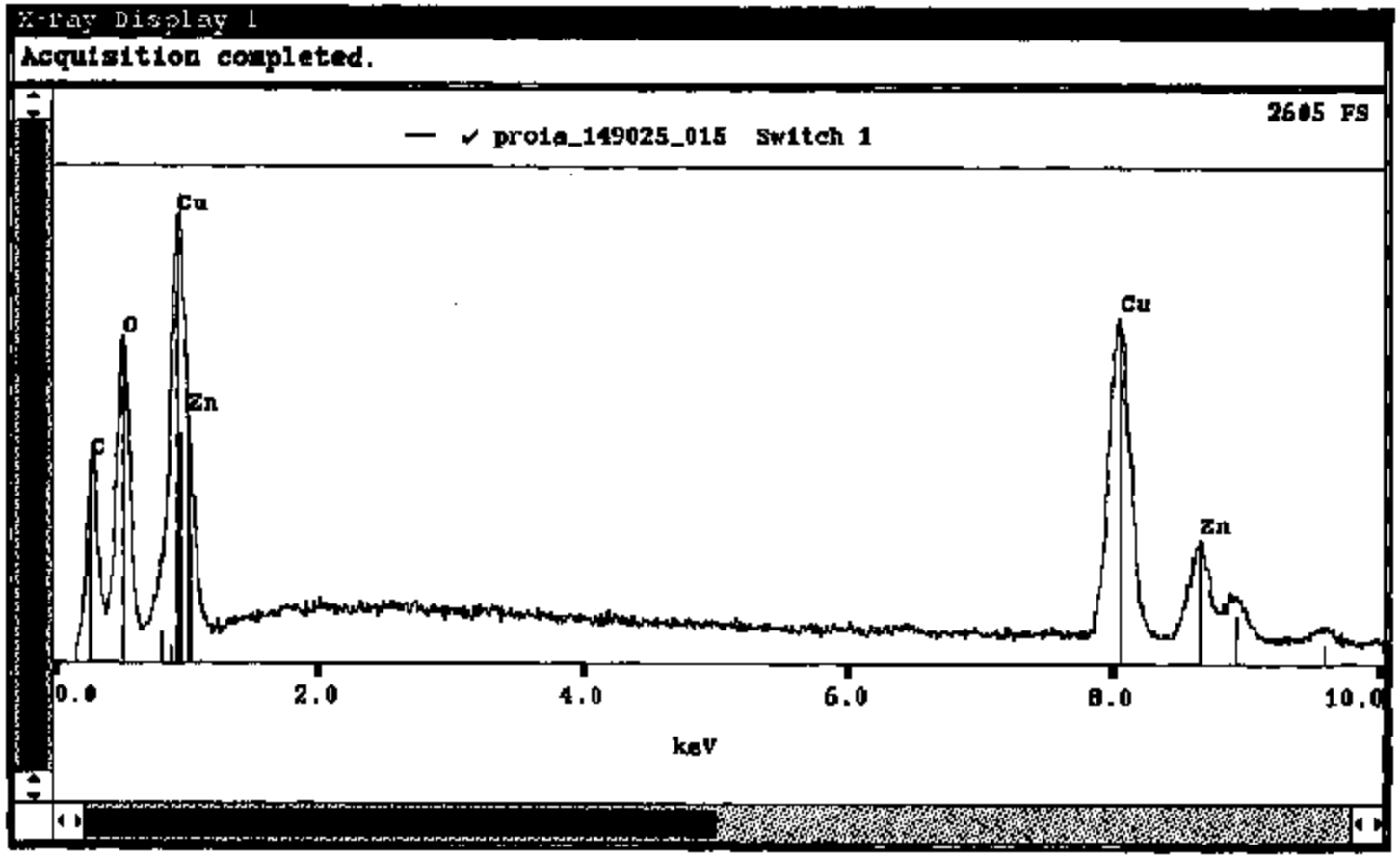

X-ray Display 1
Acquisition completed.
14742 FS
— ✔ proia_149025_014 Switch 1
Cu
Zn
O
C
Si
Cu
Zn
0.0
2.0
4.0
6.0
8.0
10.0
keV



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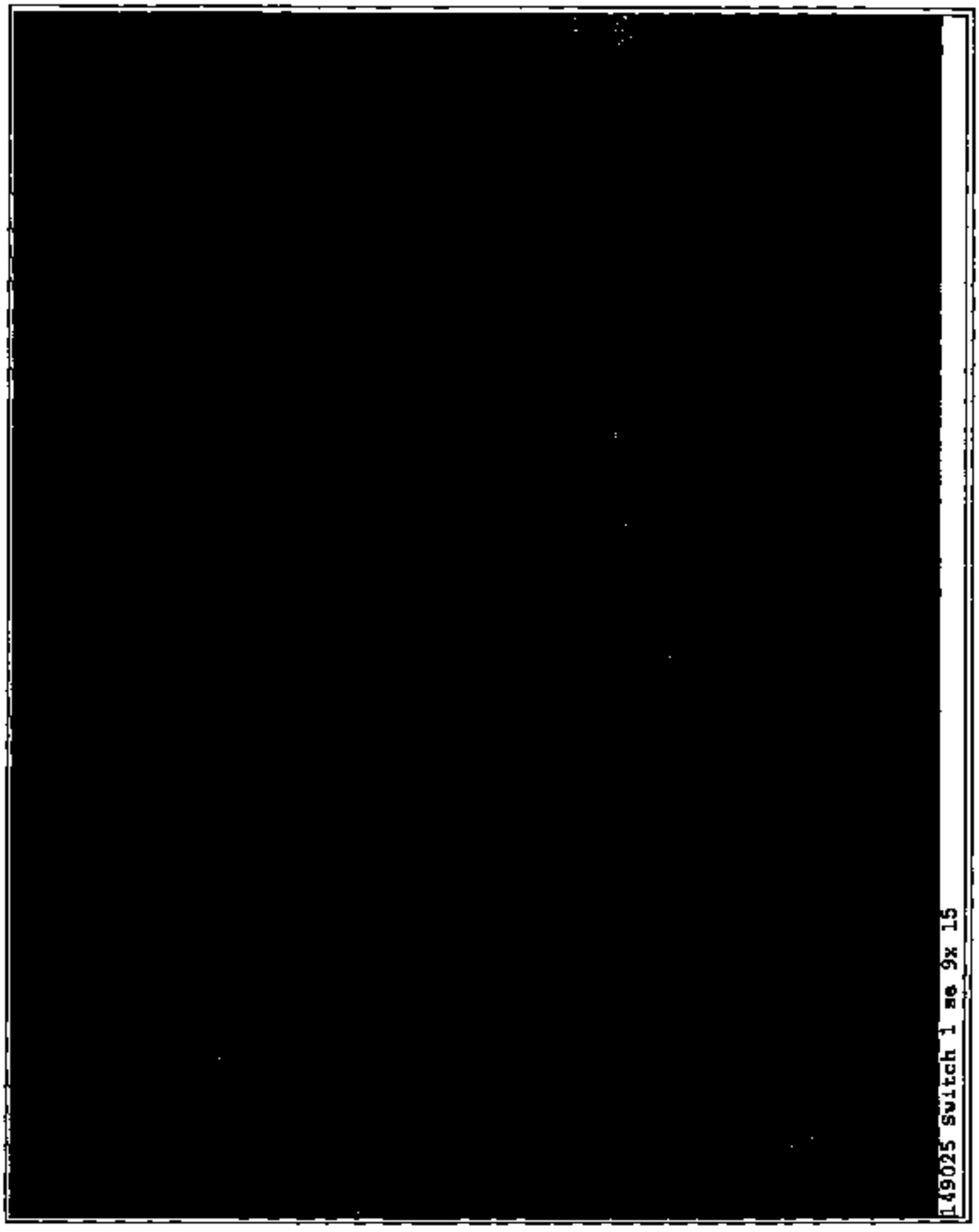
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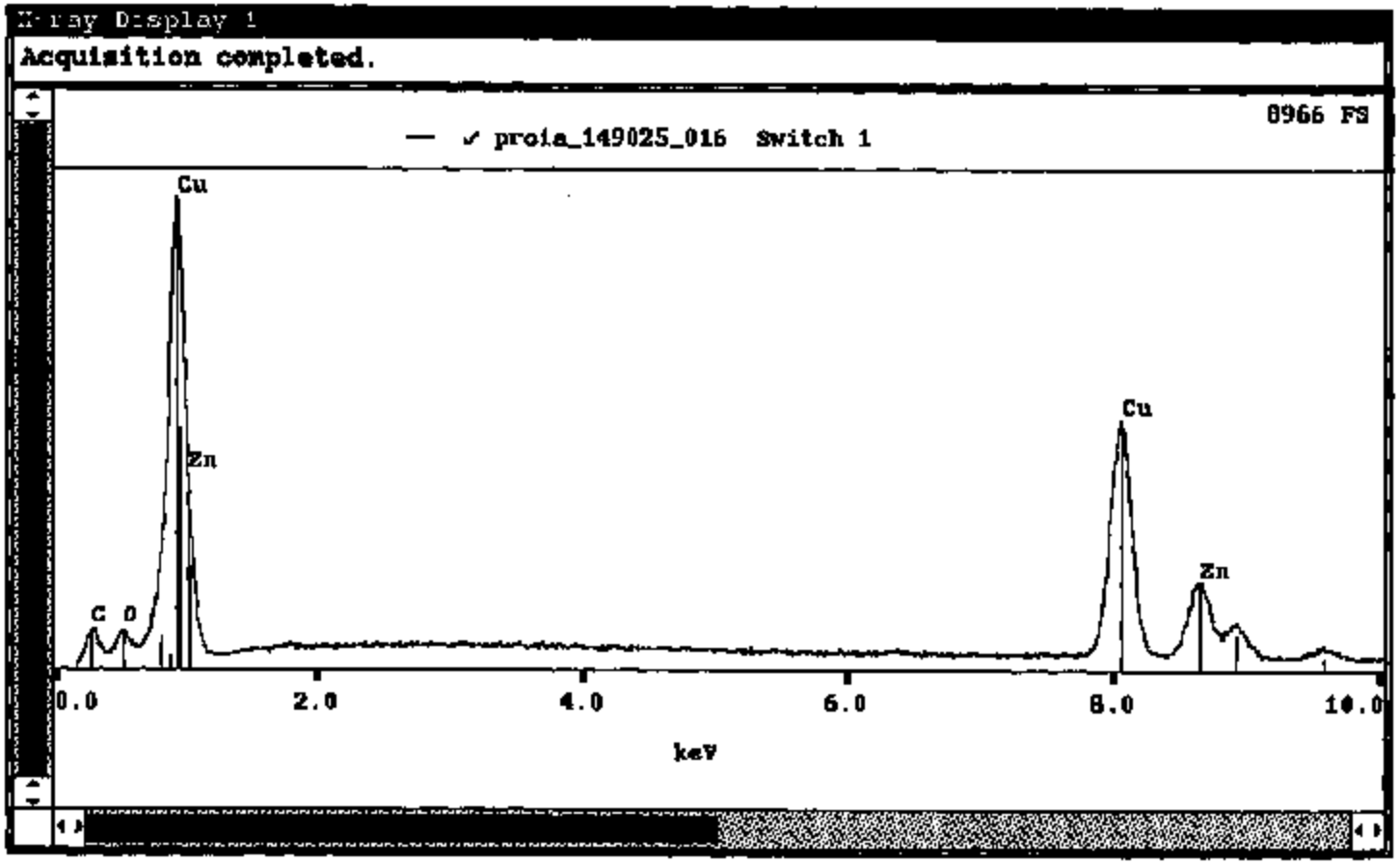
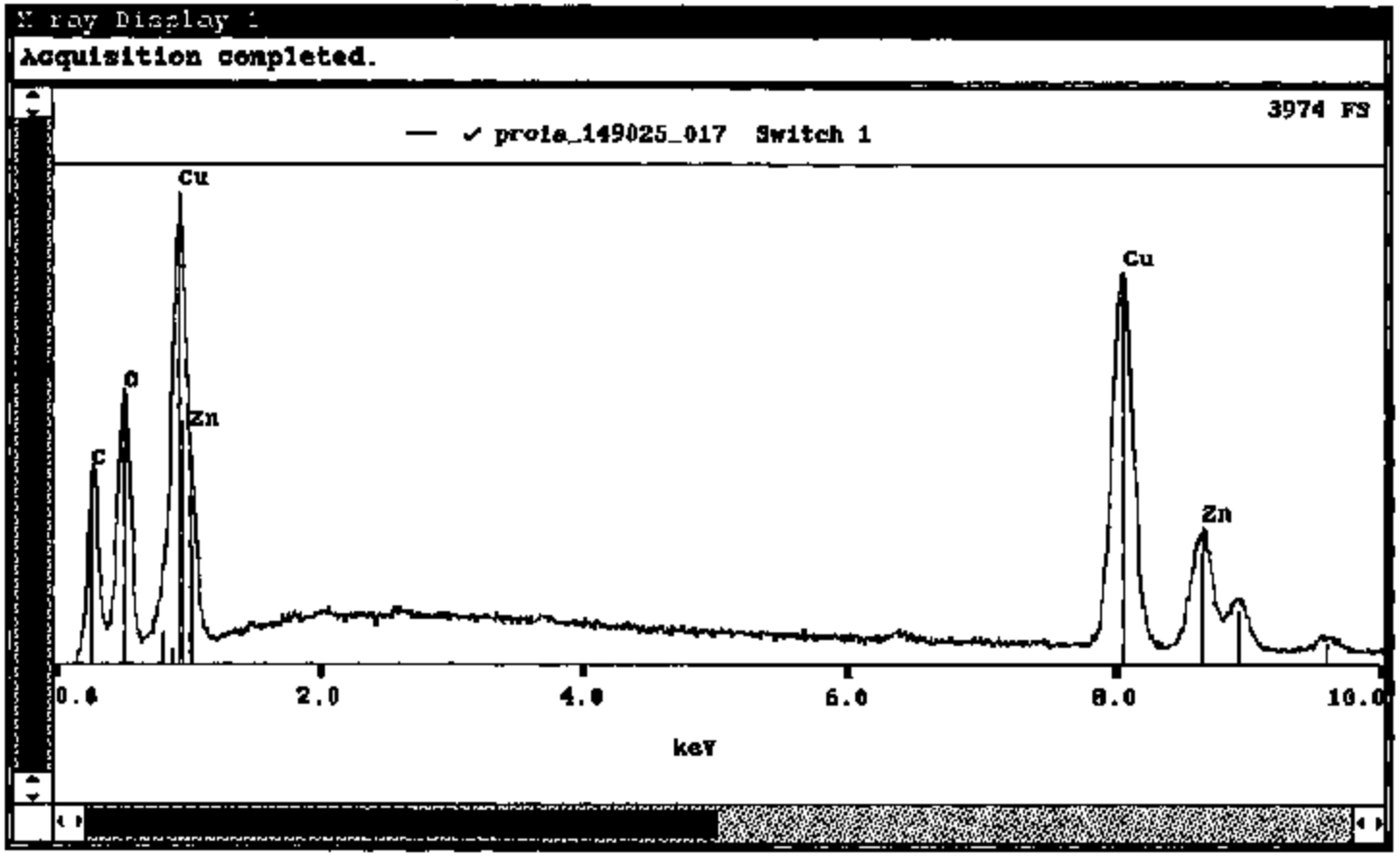
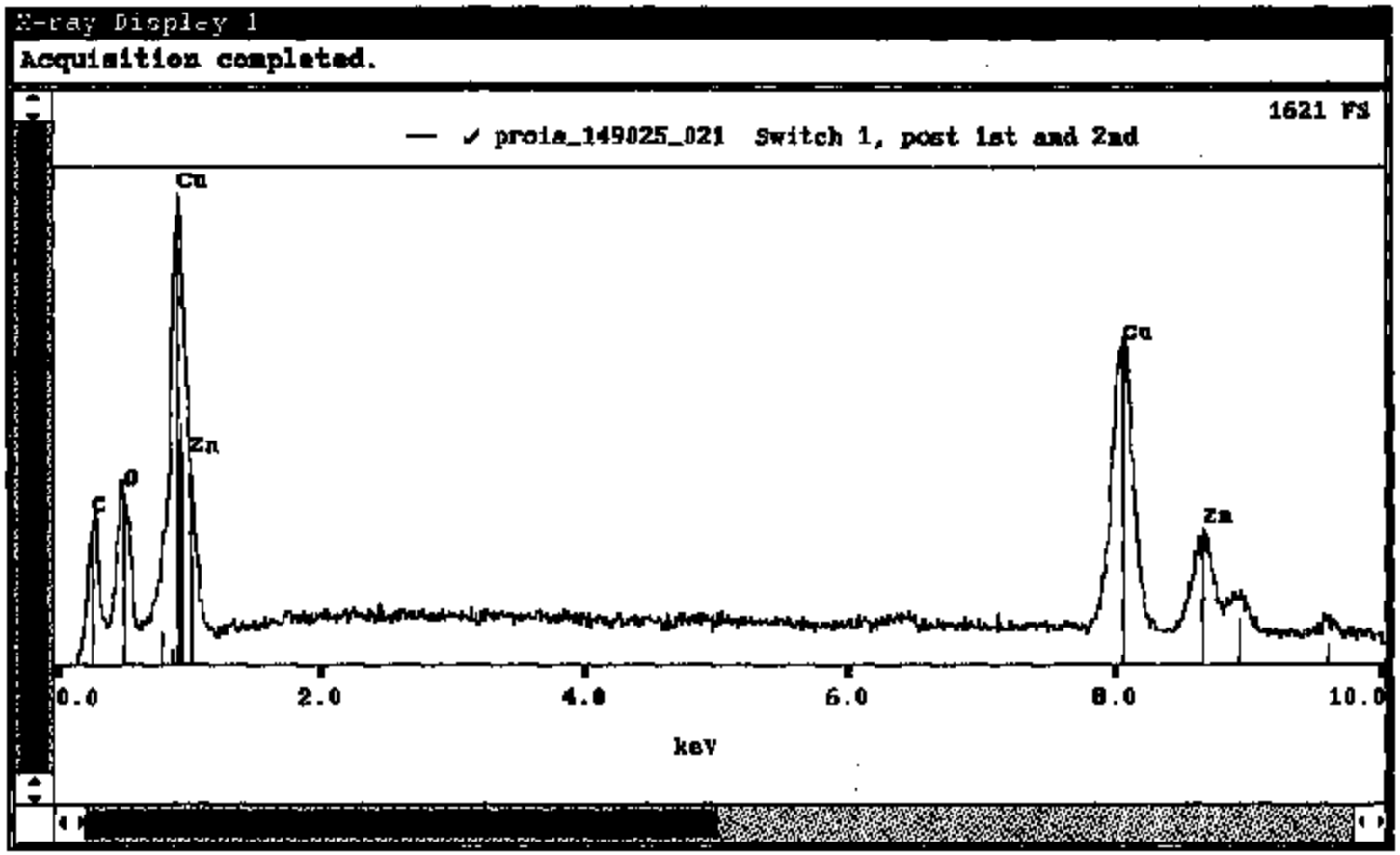
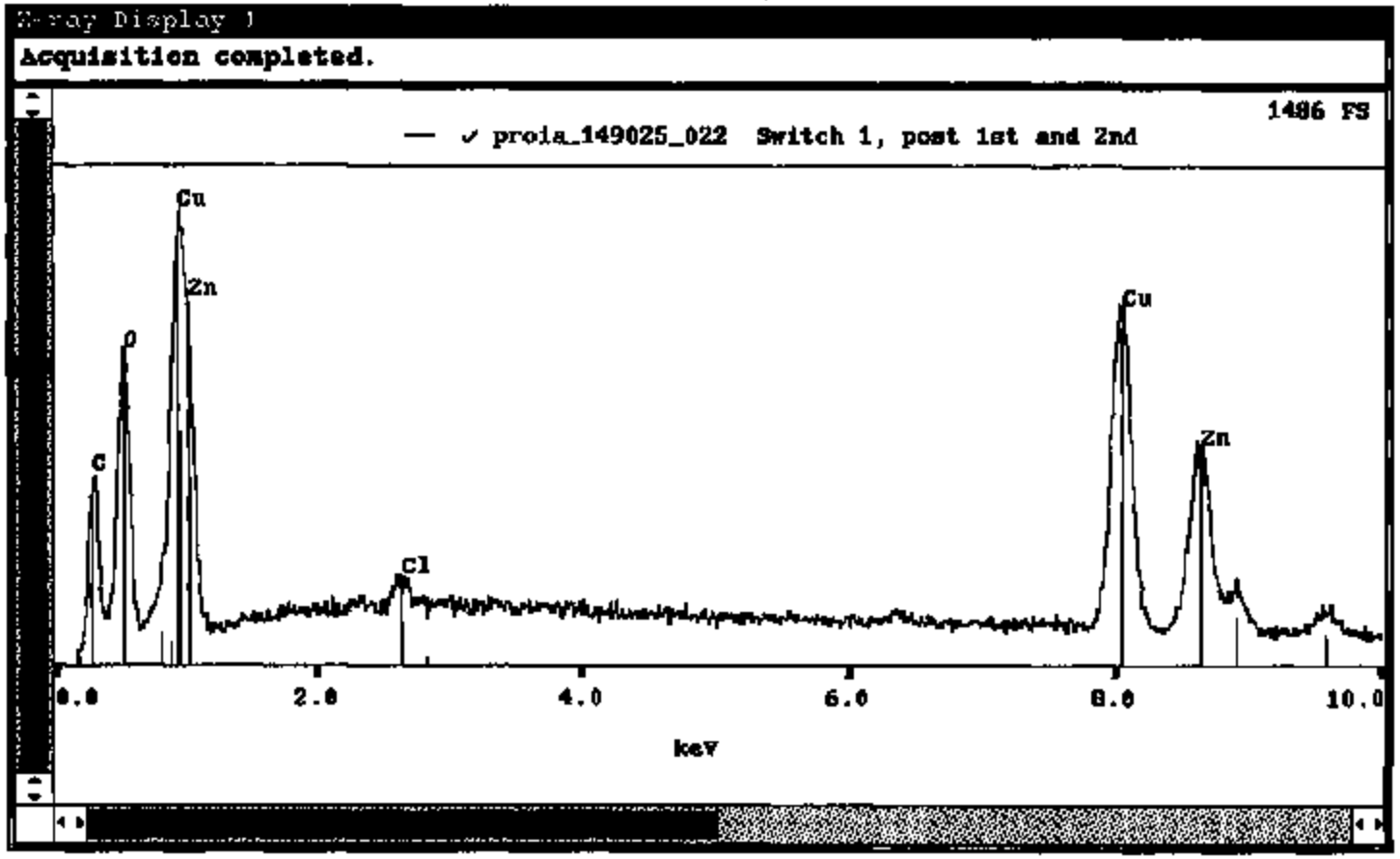
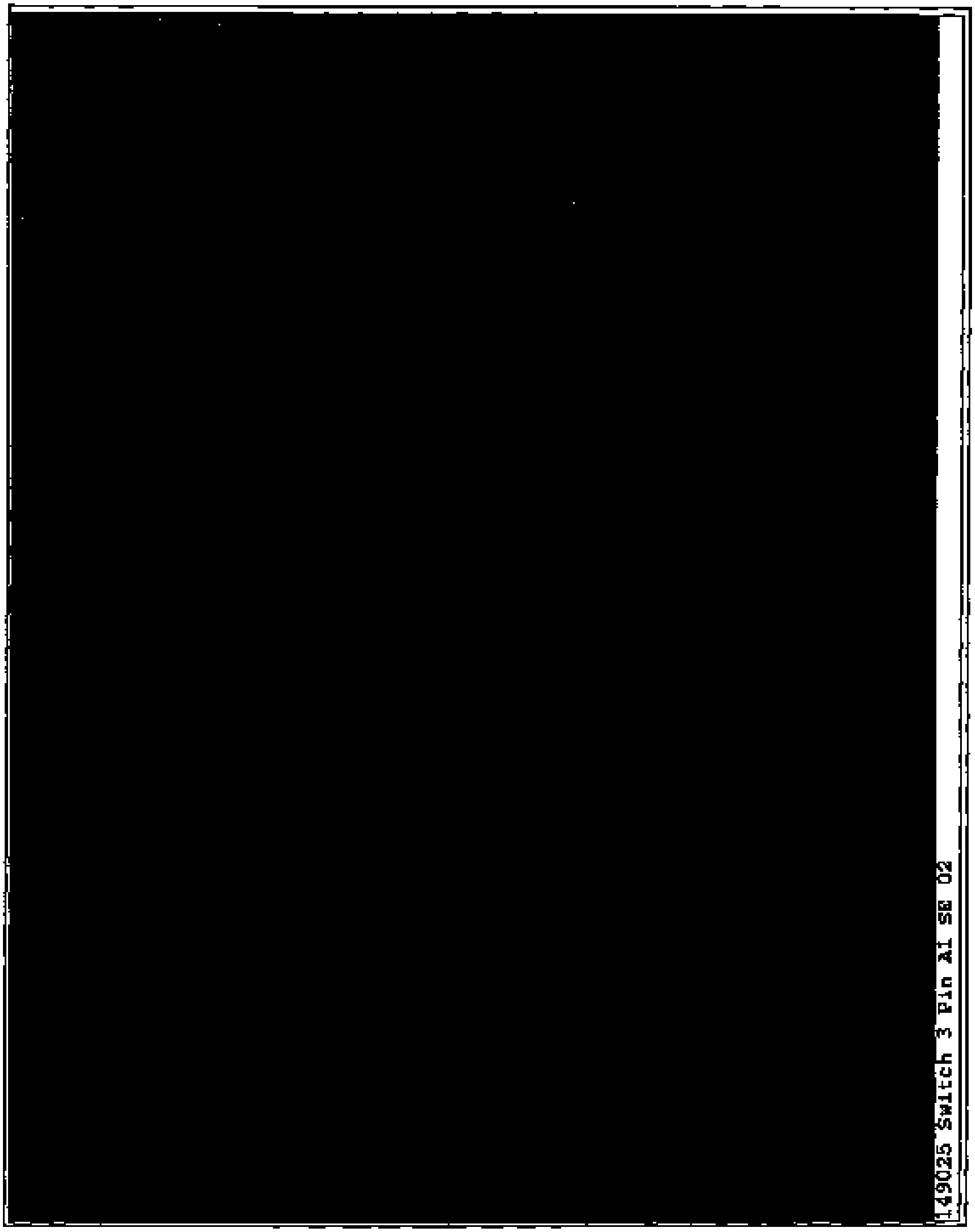




149025 Switch 1 bse 90x 20 post ipa/acetone & cychex/ace/ipa us clean



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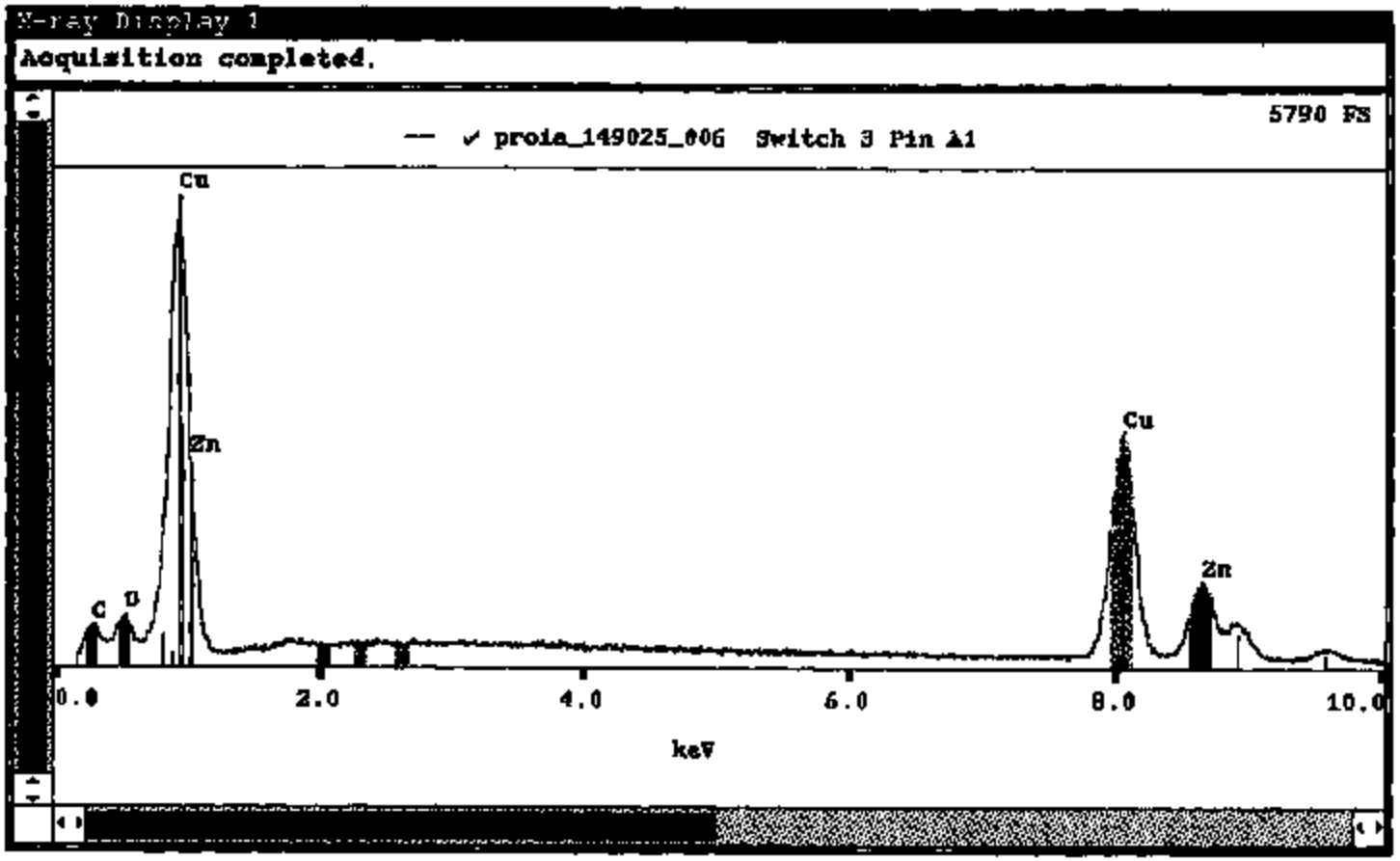

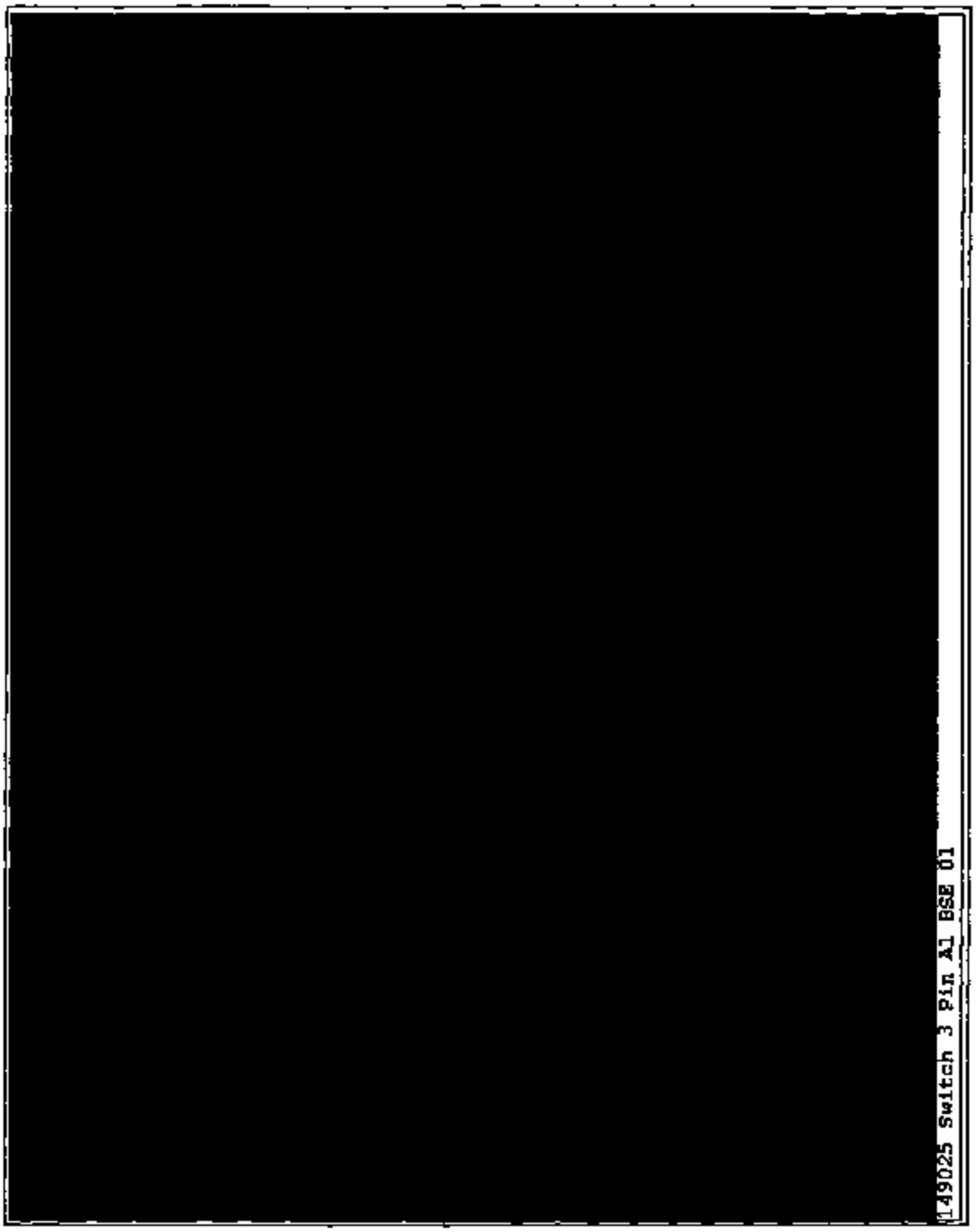
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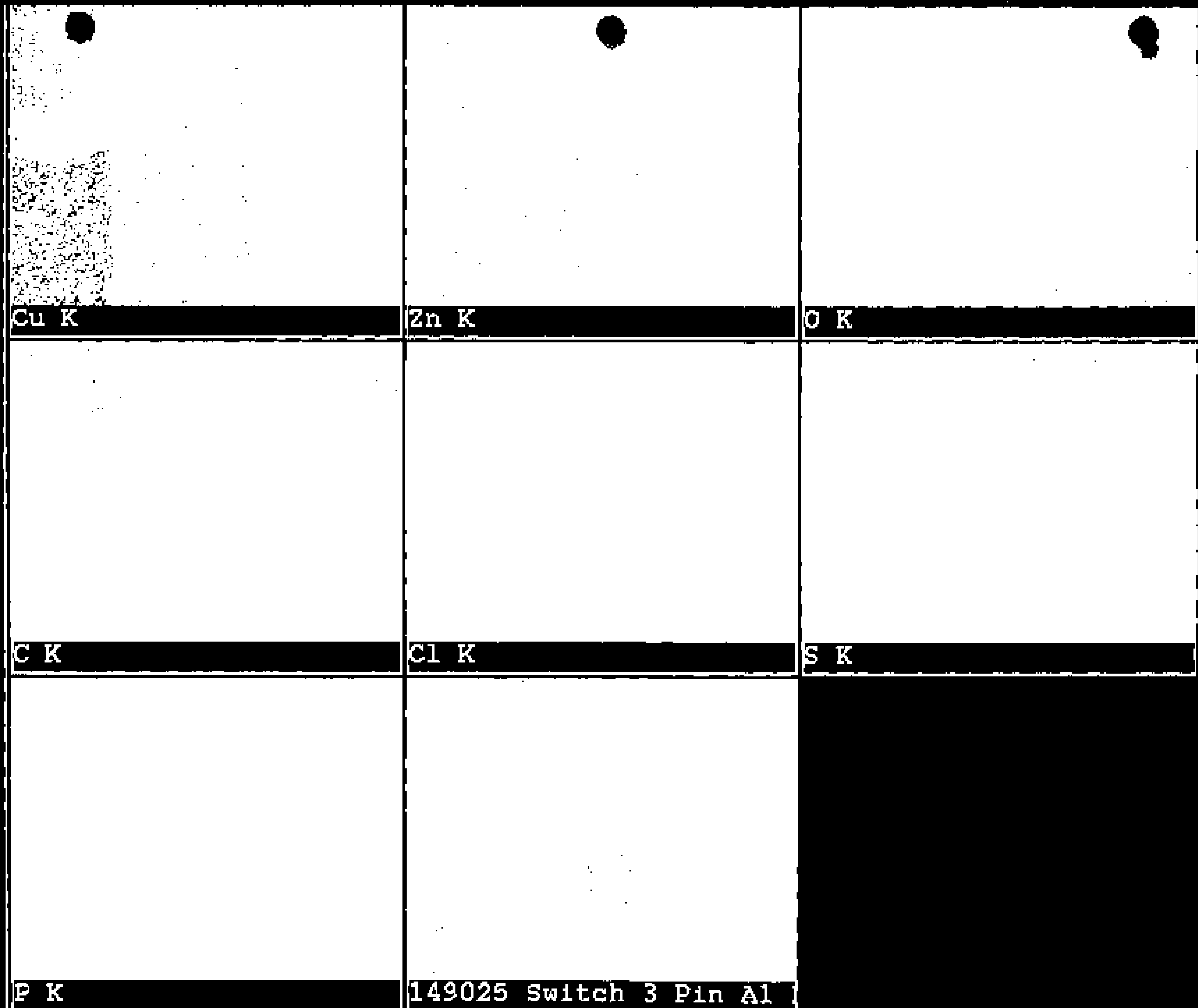

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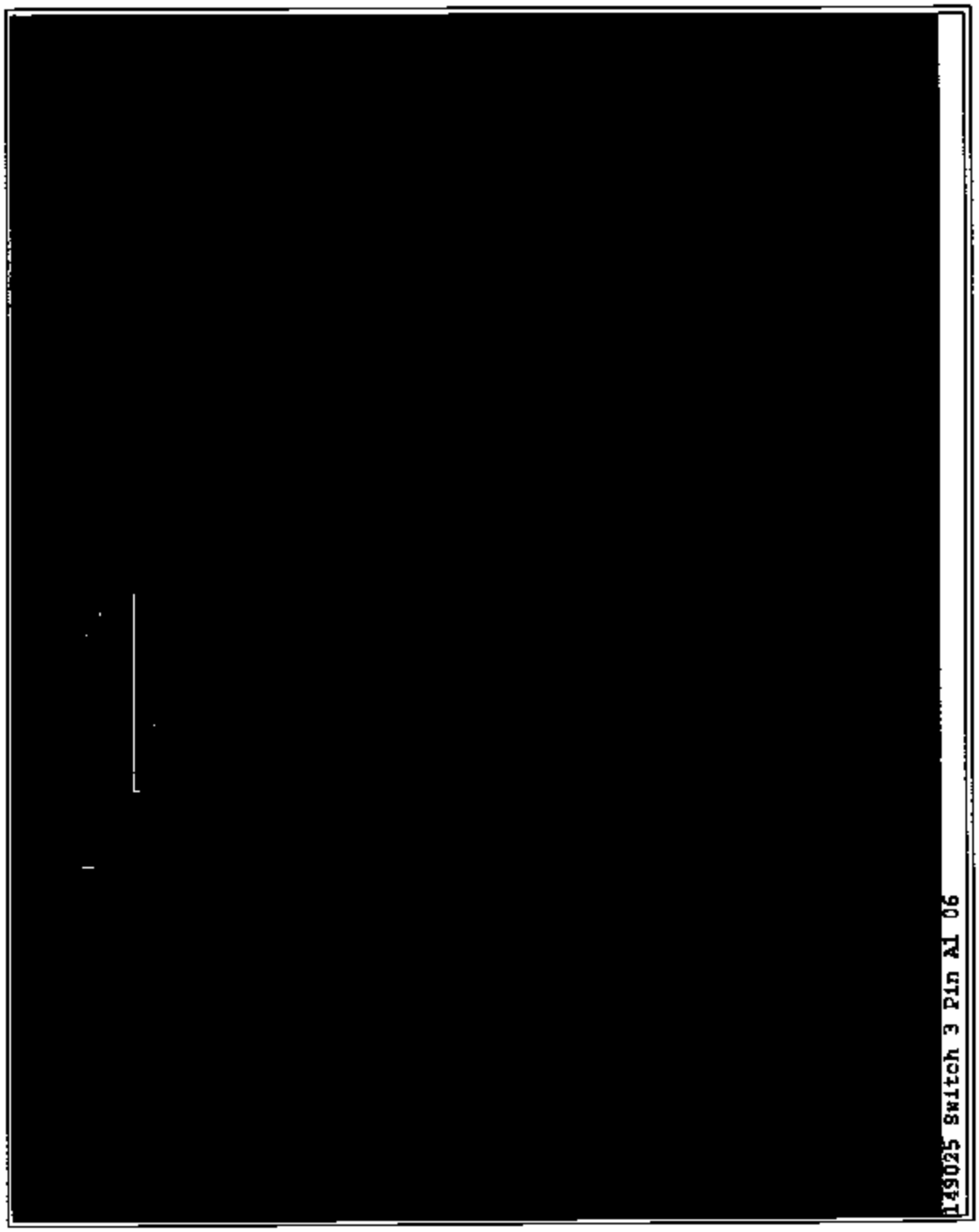
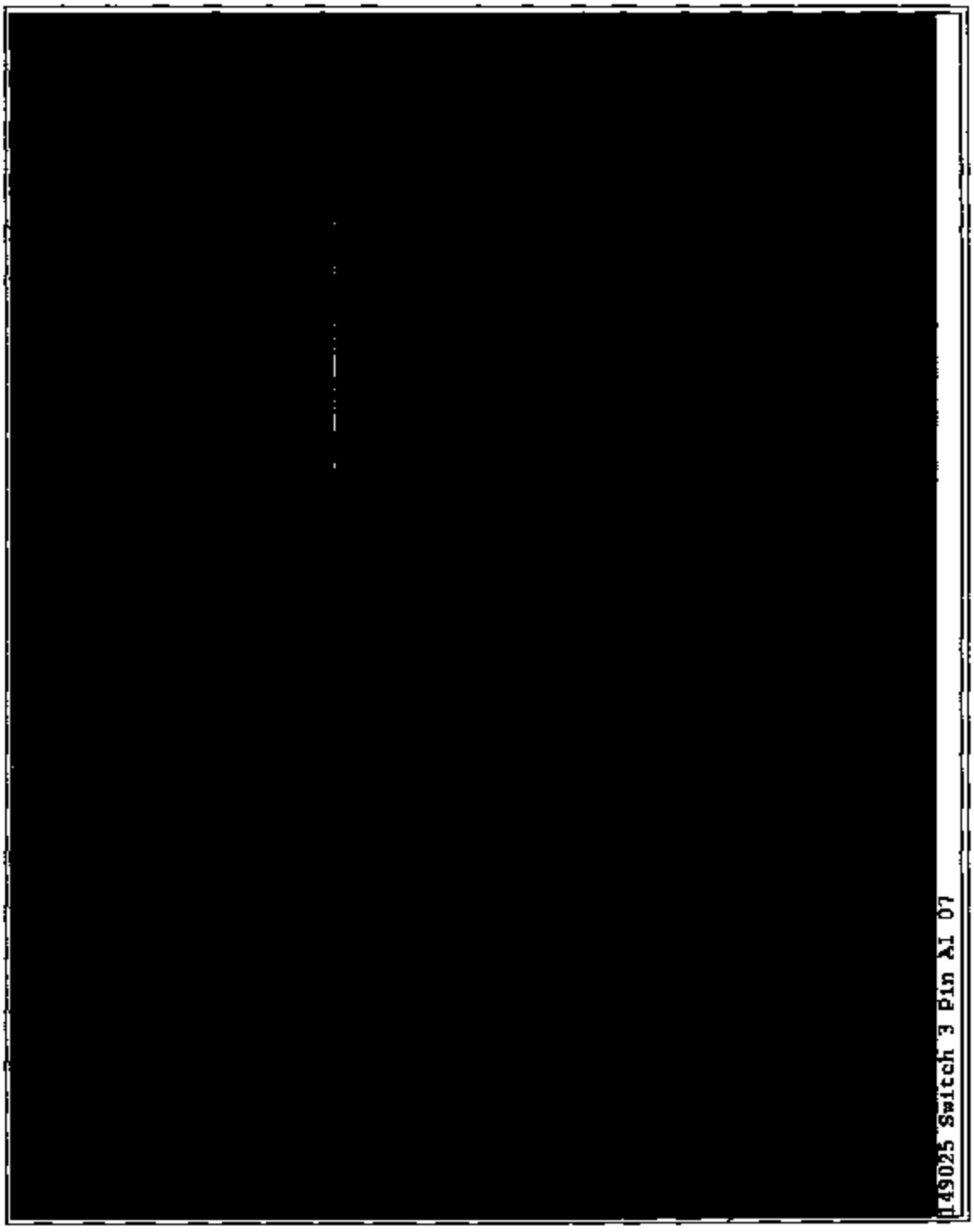

149025 Switch 3 Pin A1 06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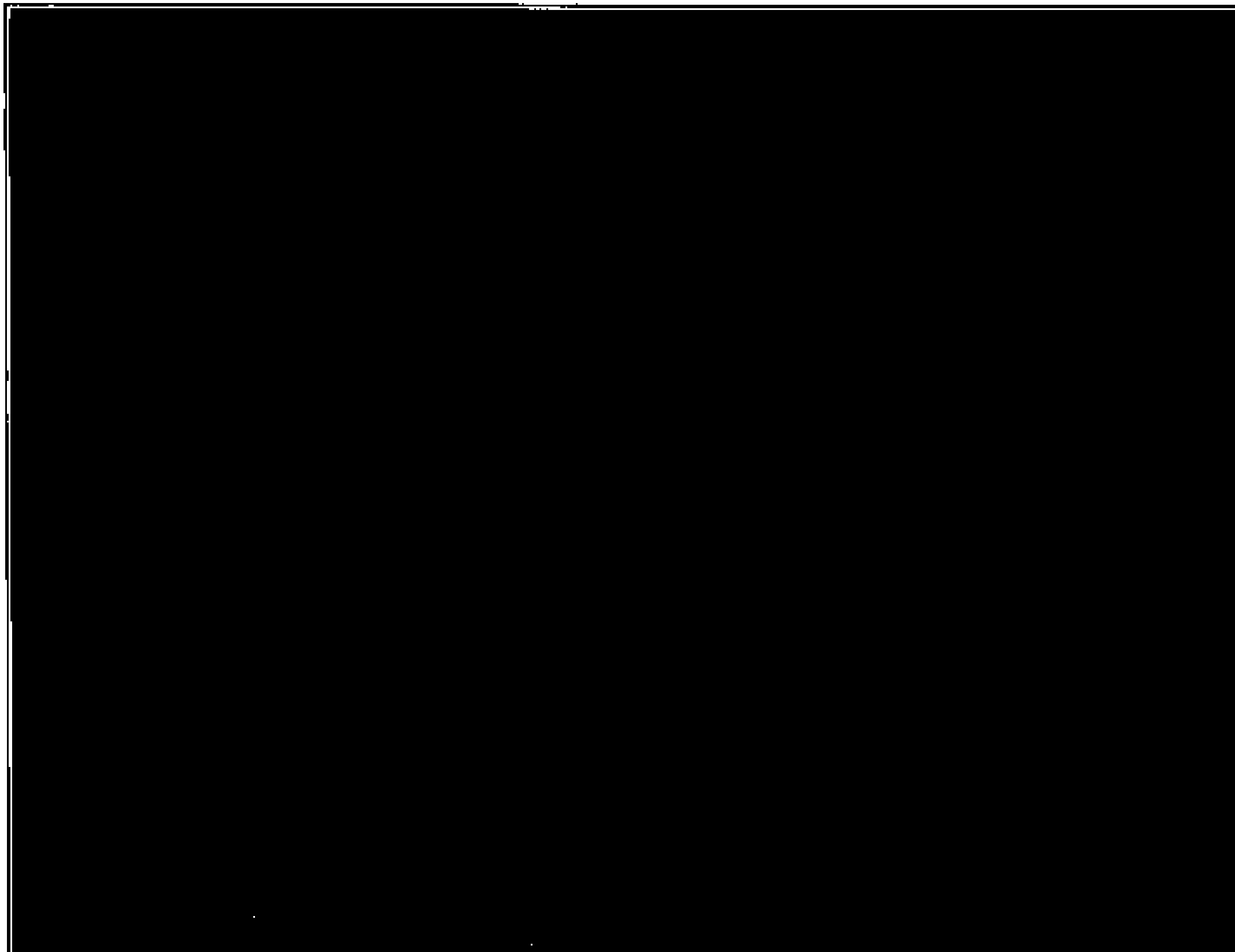

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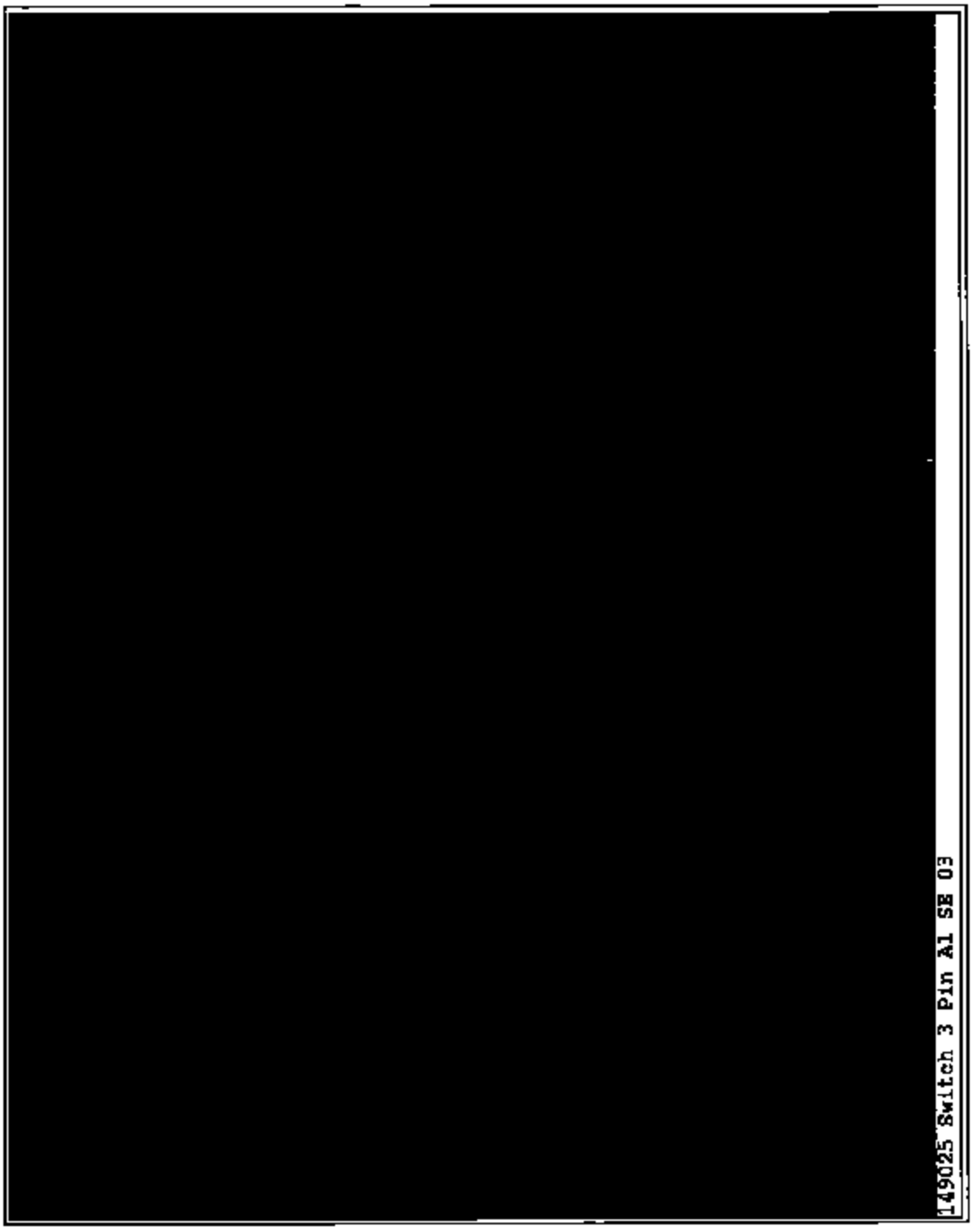
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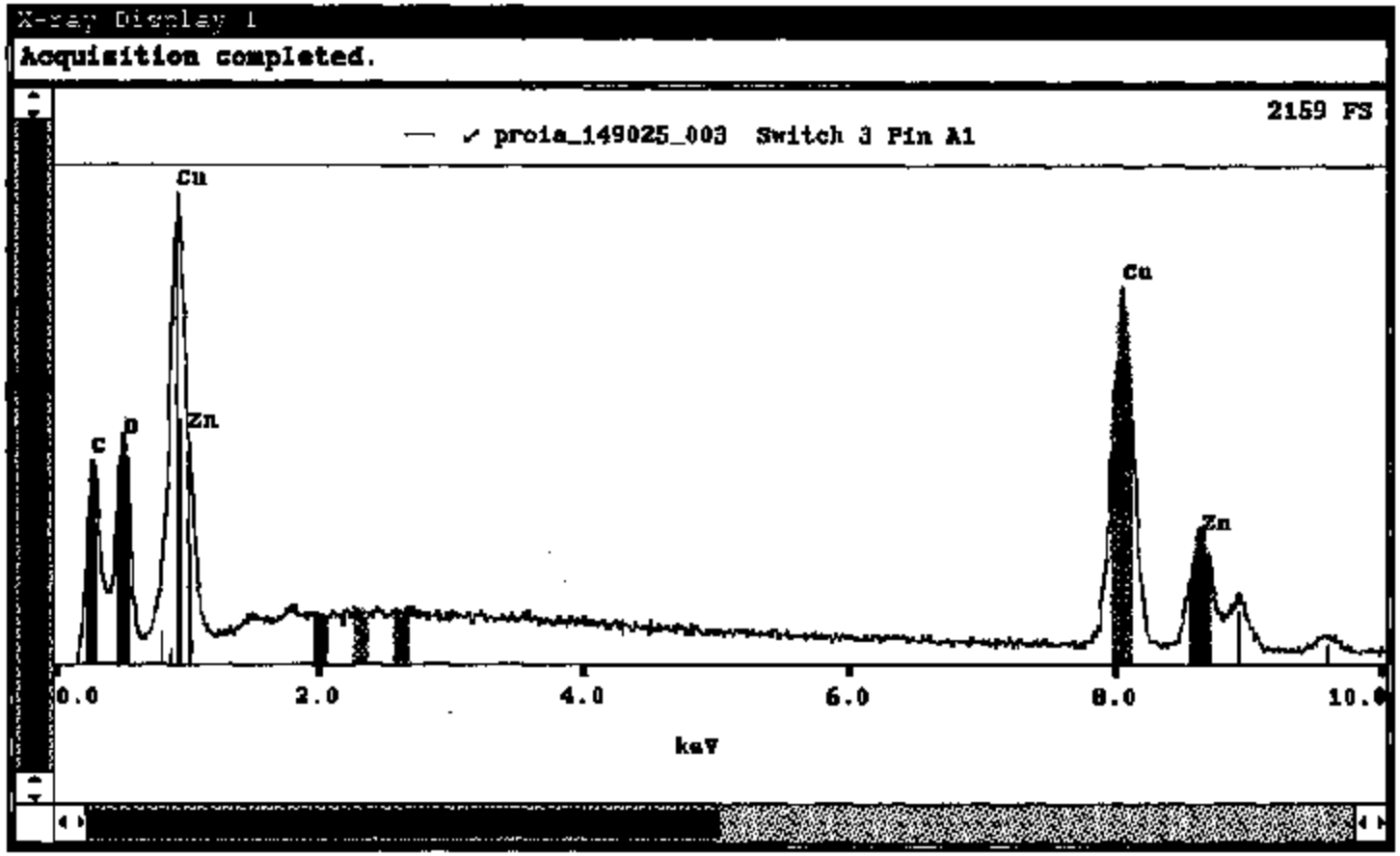

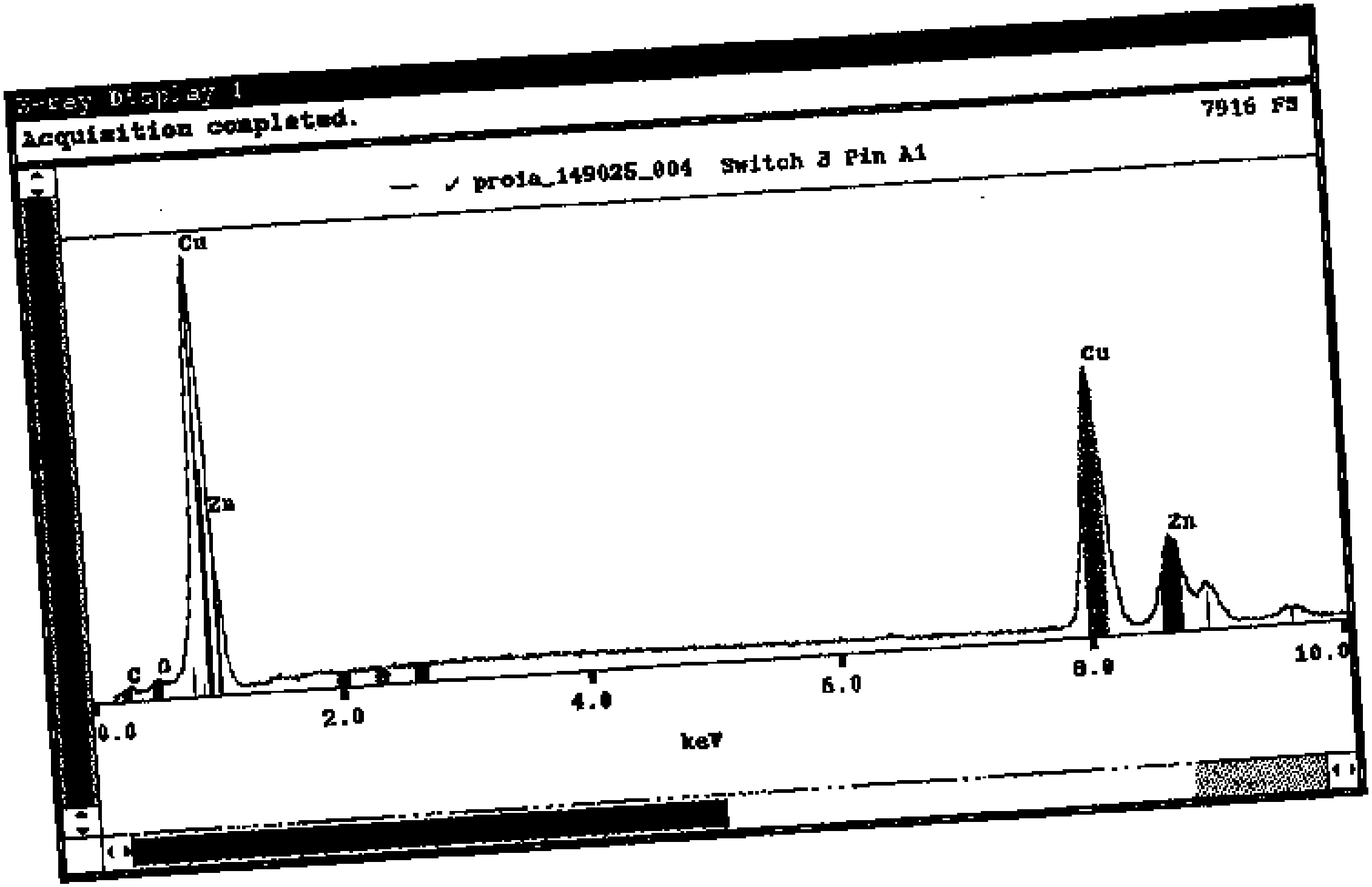

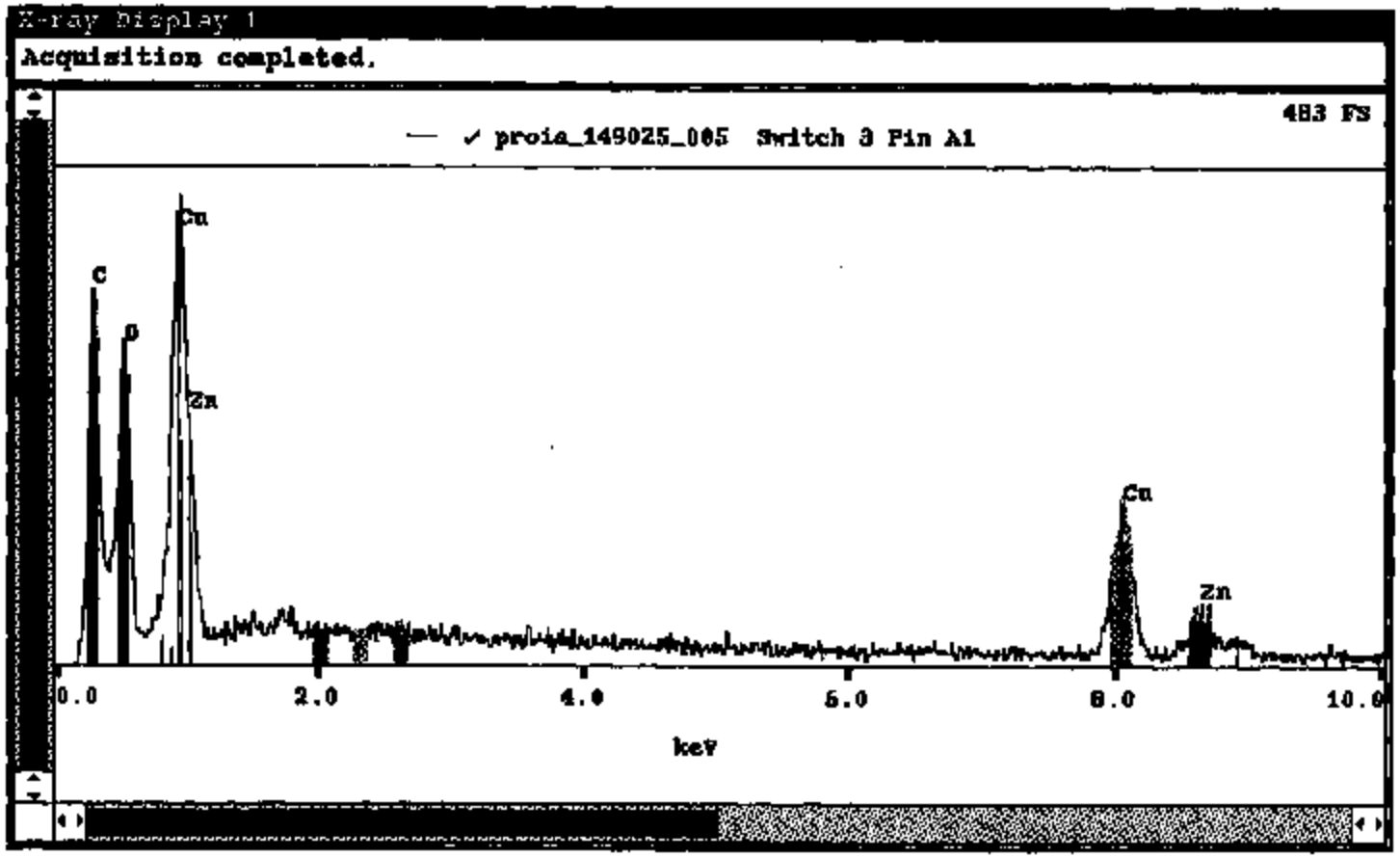

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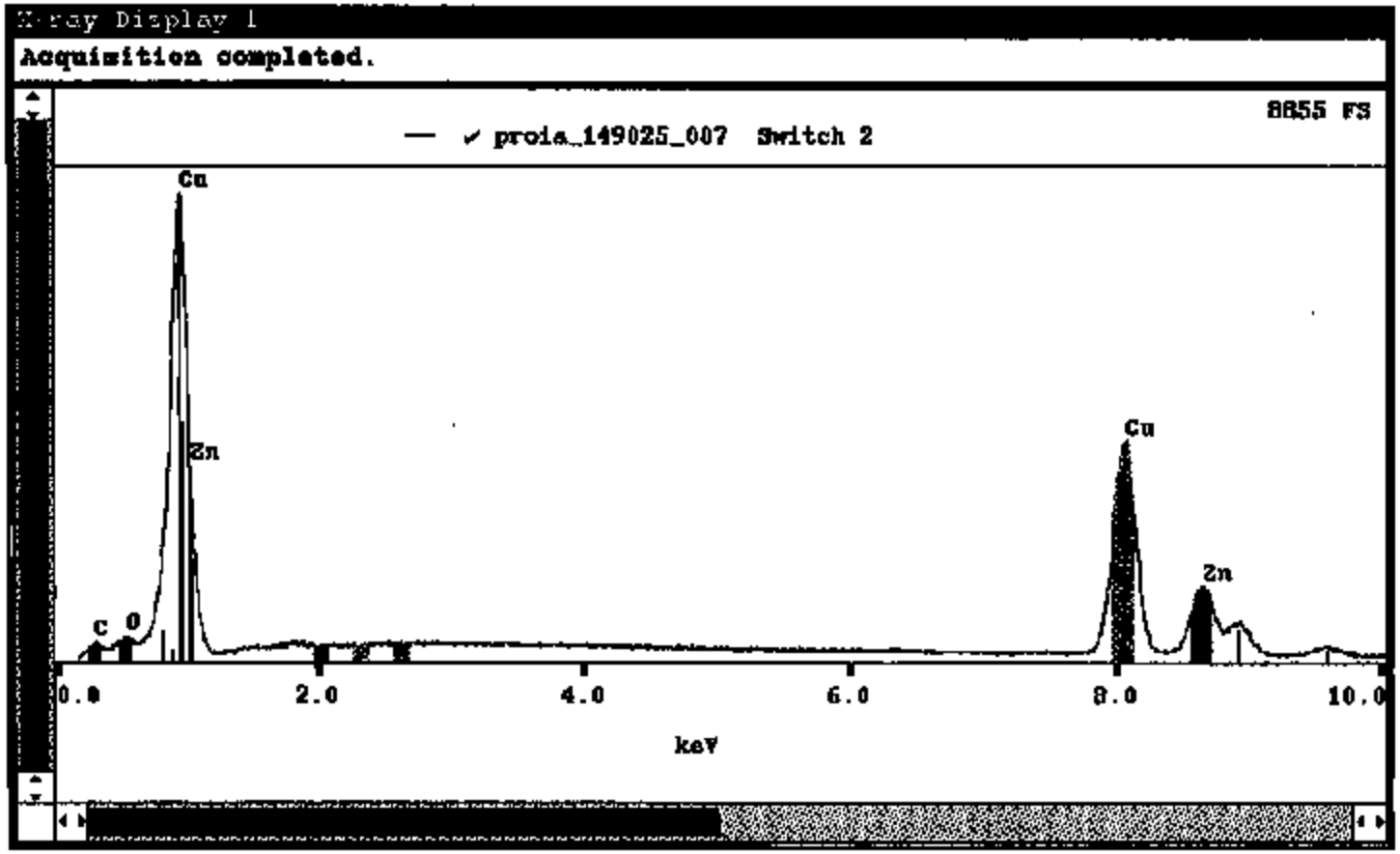

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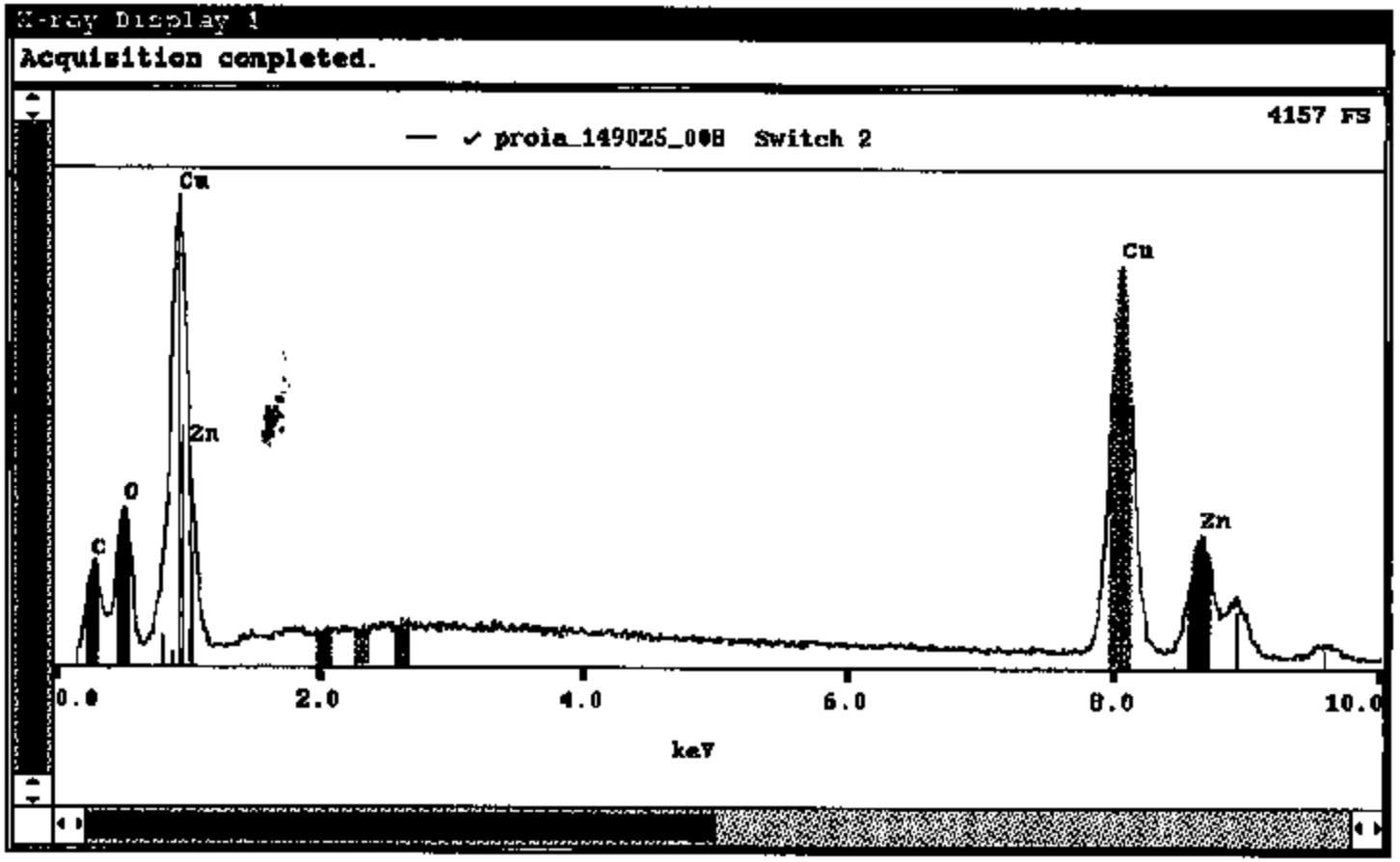

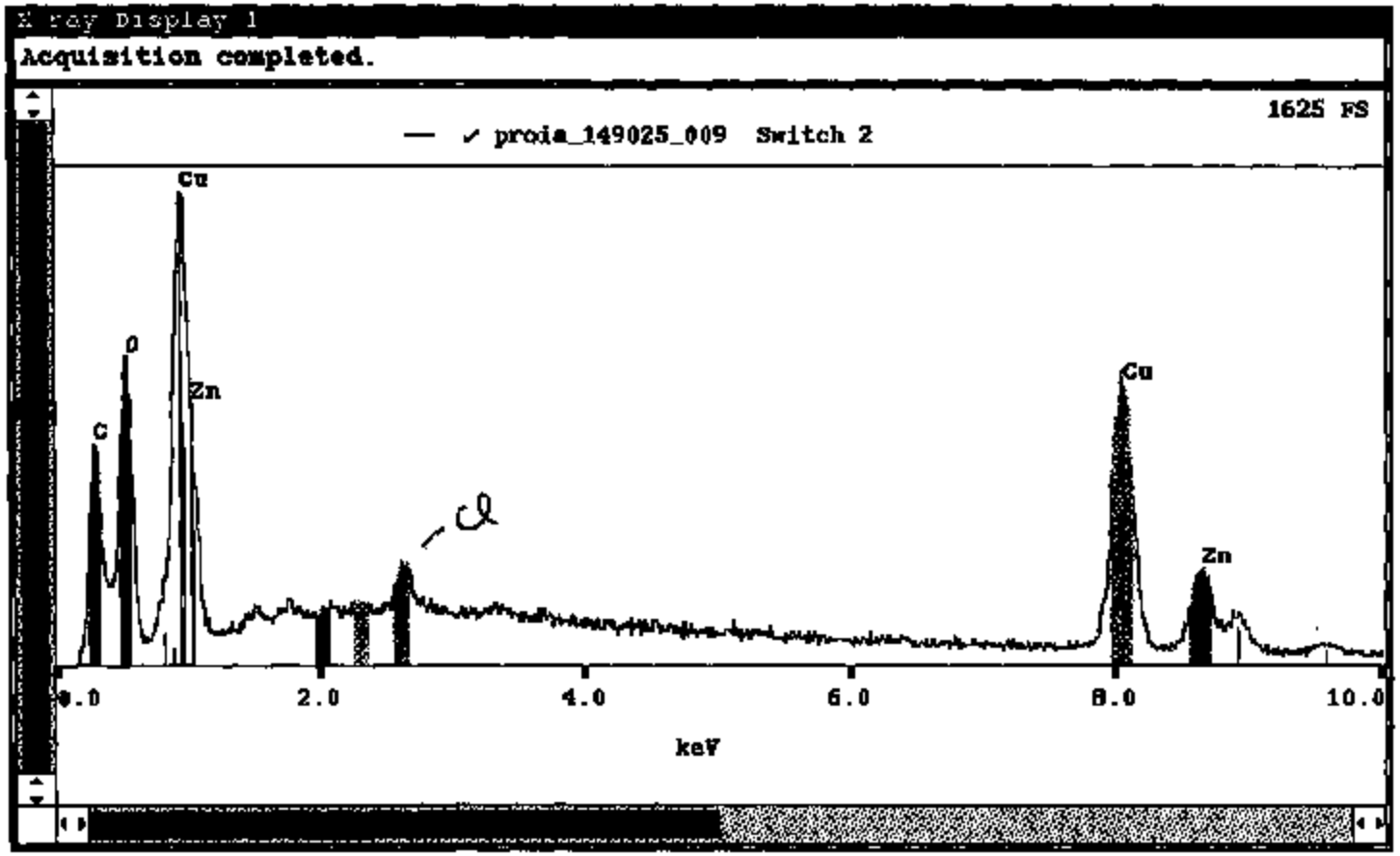

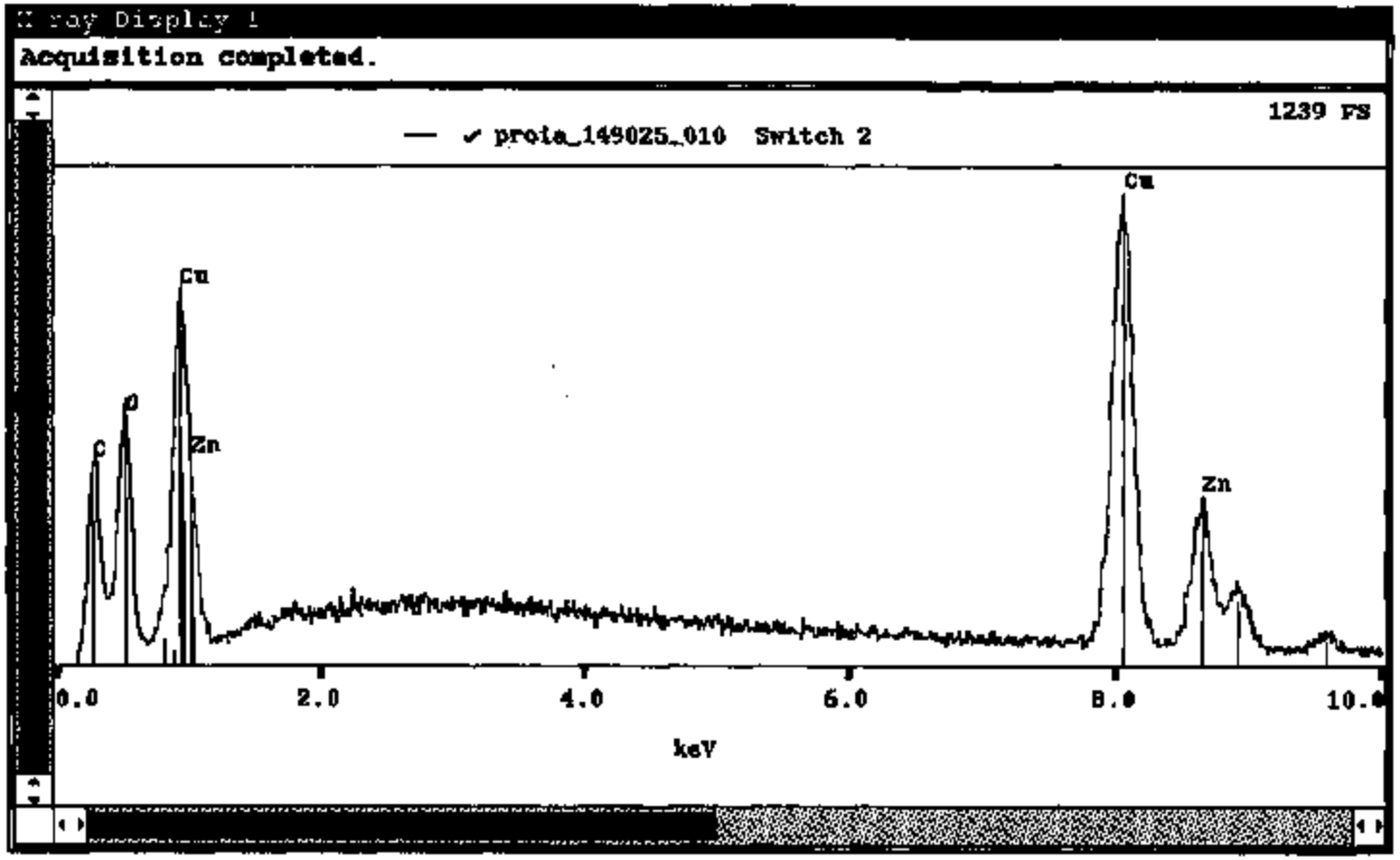

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149025 Switch 2 10

149025 Switch 2 BSE 12