



# Contribution to the Characterization, Identification and Comparison of Polyurethane Foam Particles

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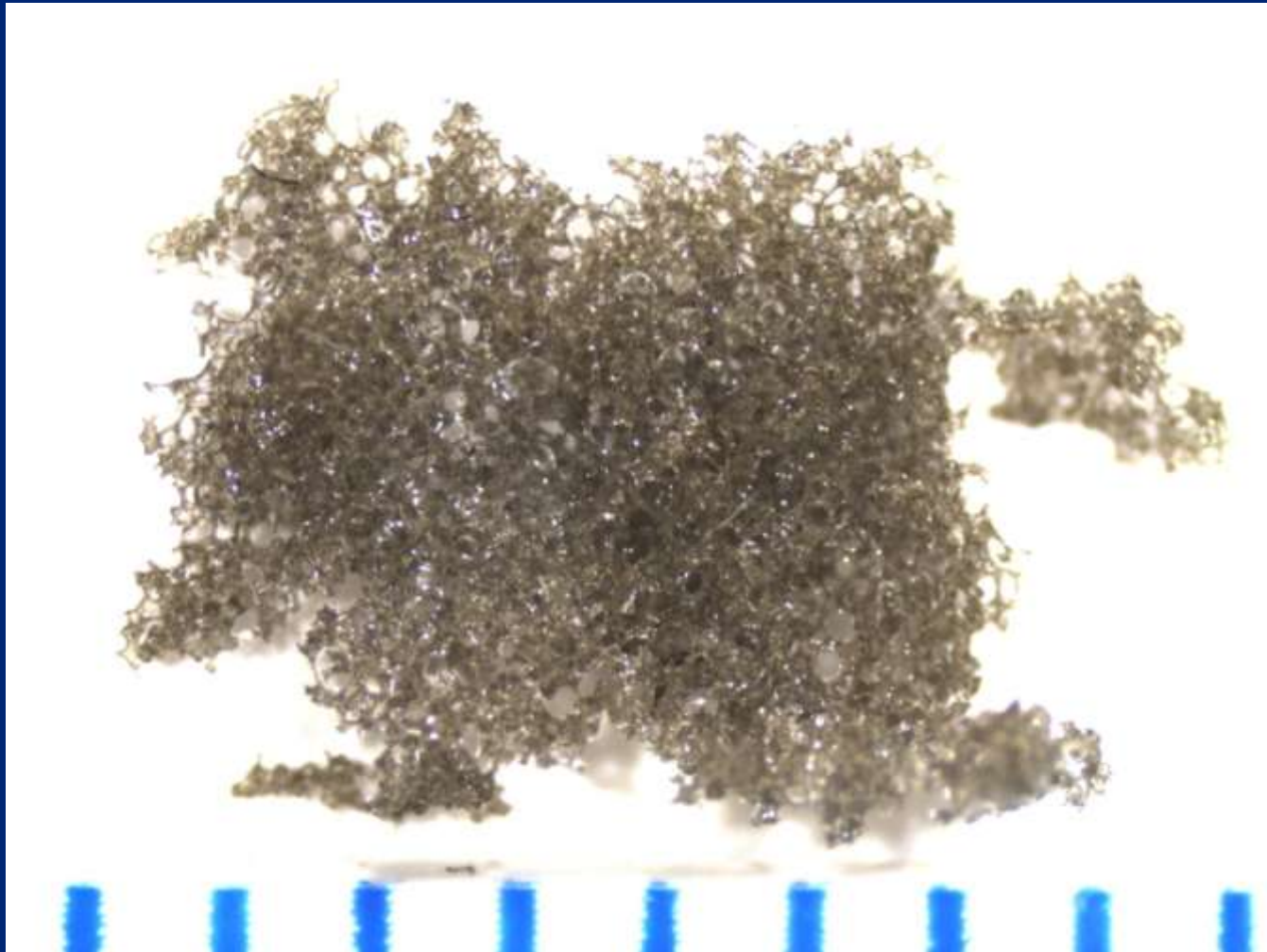
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Elgin, IL USA

[www.microtracescientific.com](http://www.microtracescientific.com)



# Particles of plastic foam are occasionally encountered during the examination of microscopic trace evidence





**The fact that they are usually observed as small particles (and thus easily transferable) is typically an indication that the source object has degraded**



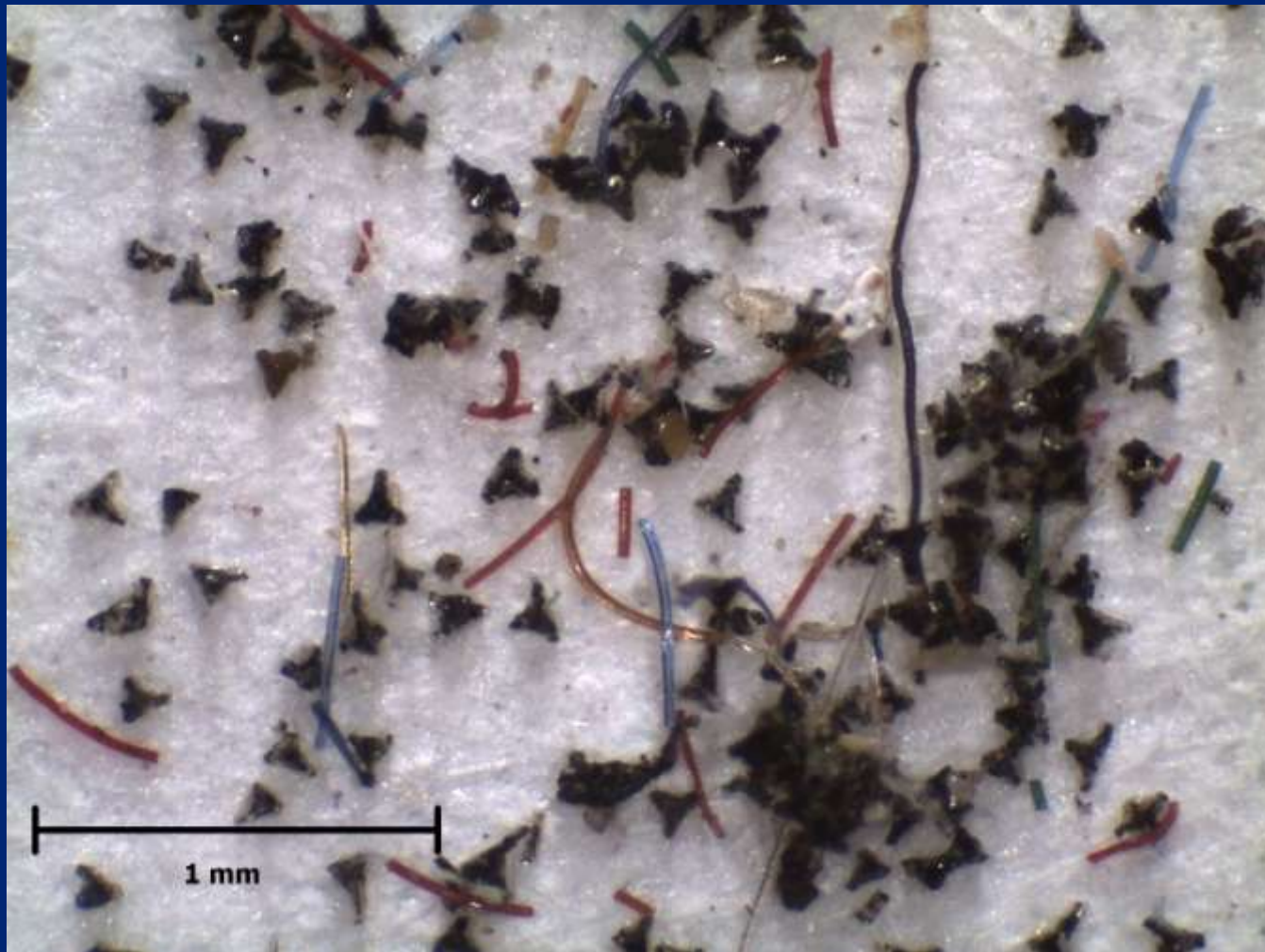


**In cases where the source can be determined these particles can provide significant evidence of contact**





**Microscopical and microchemical methods are complimentary and have both proven of value in this type of analysis**





# Microscopy

- **Stereomicroscopy**
- **Polarized light microscopy**
- **Phase contrast microscopy**
- **Color/MSP**
- **Fluorescence/MSF**
- **SEM-EDS / Micro-XRF**



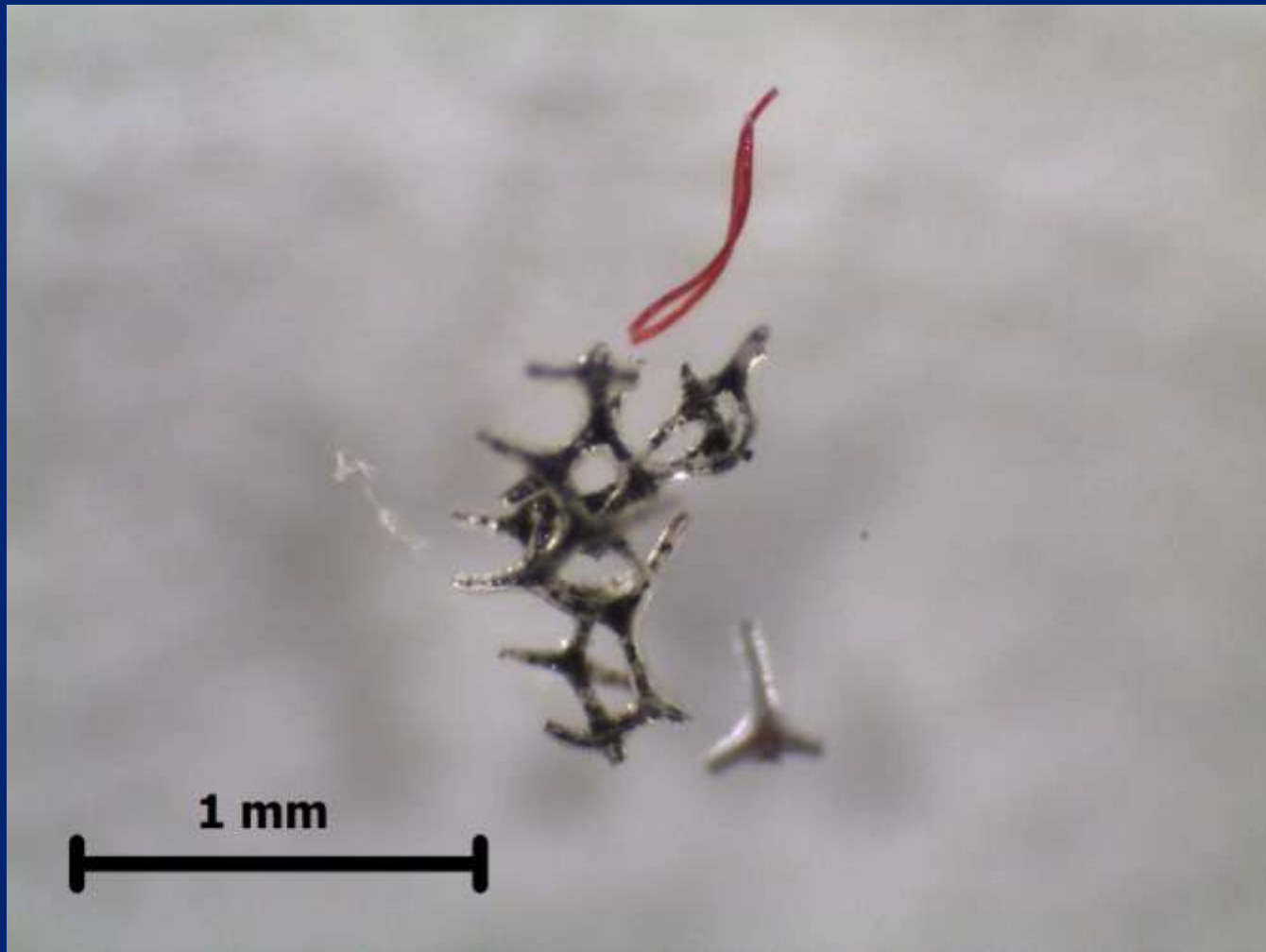
# Stereomicroscopy

Shape  
Color





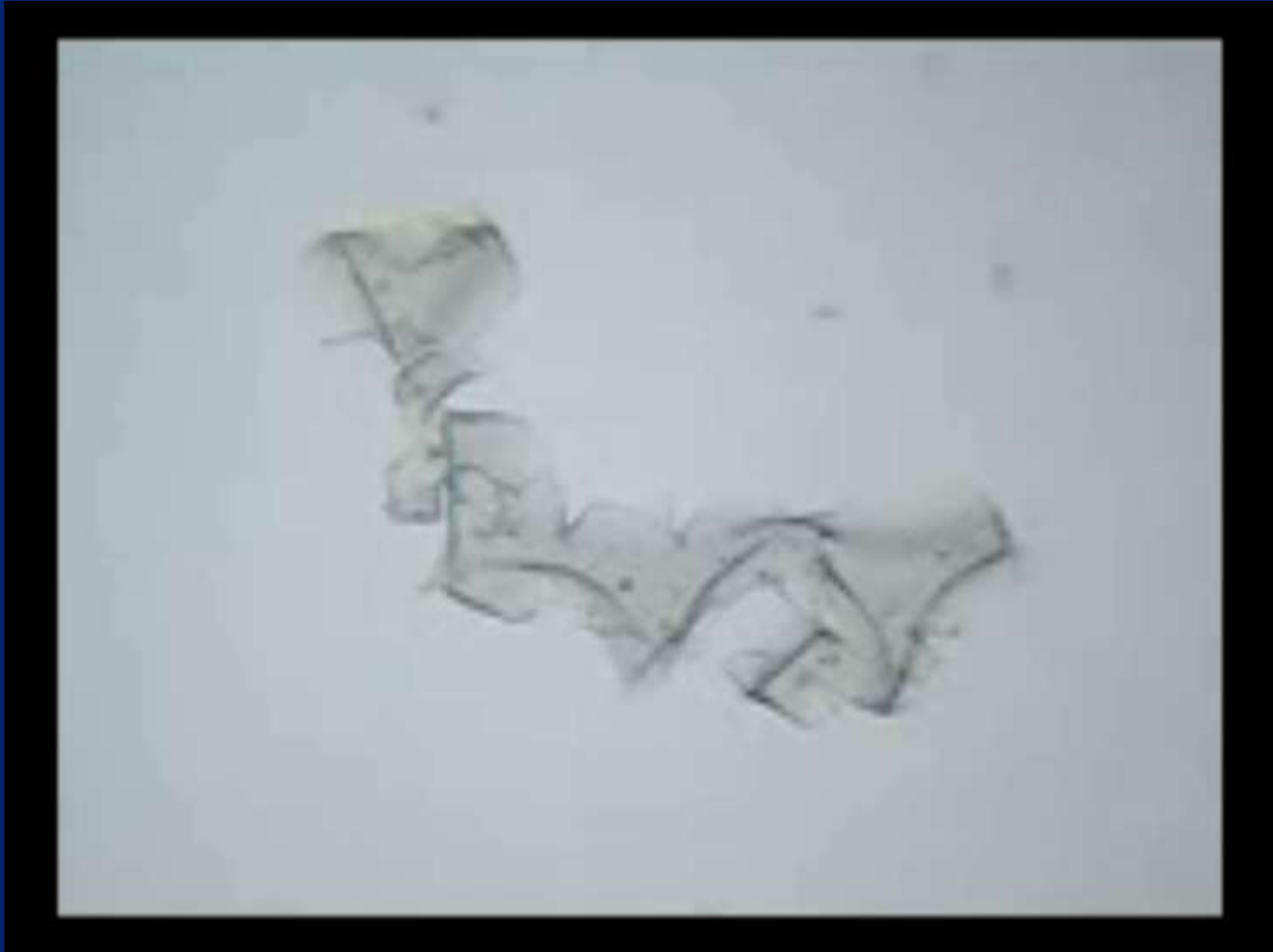
**Some details of internal structure can often be observed even before mounting for PLM**







# Testing for elastomerism





# Polarized light microscopy

(Mounted in 1.660)





# Birefringence



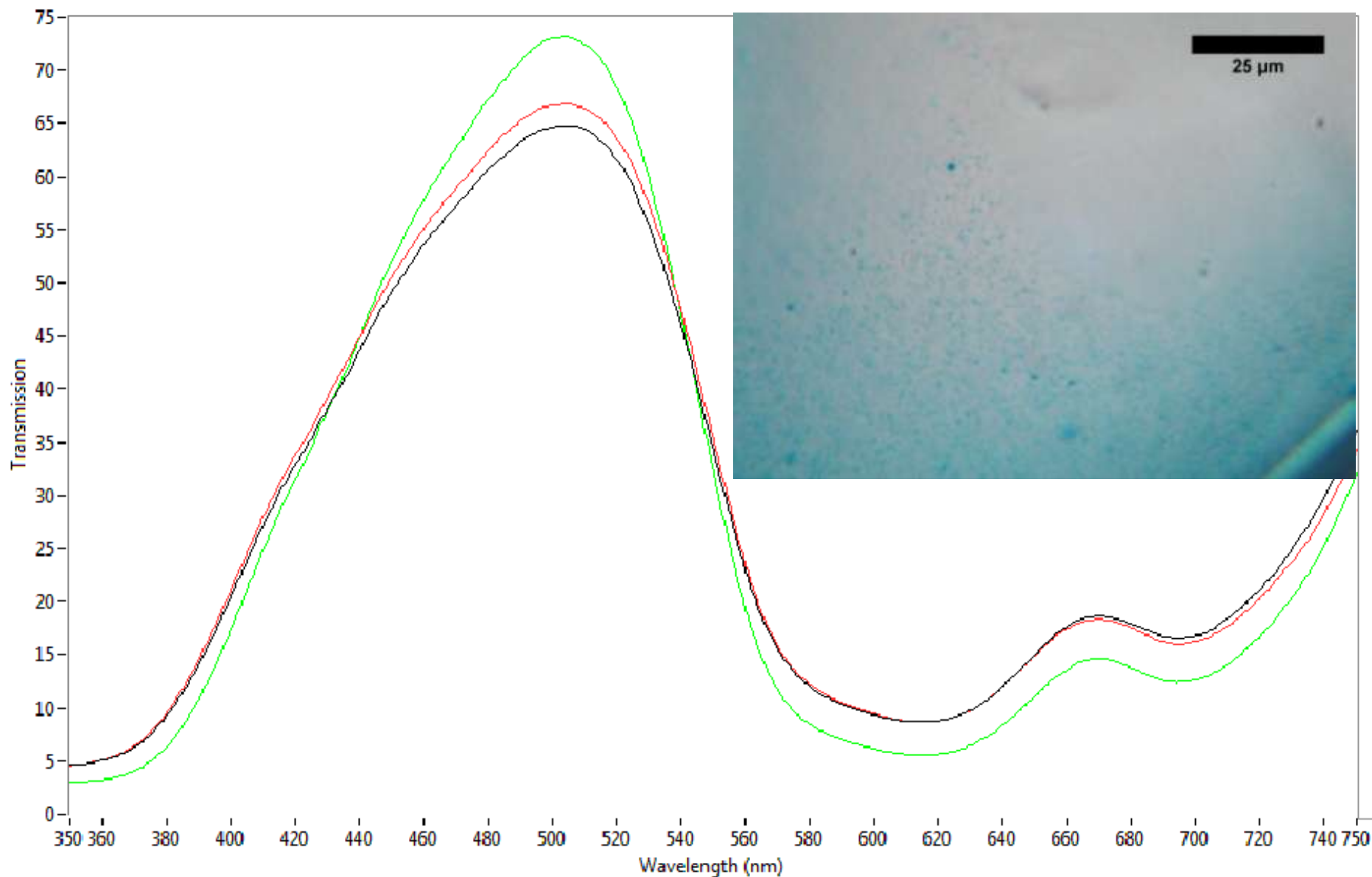


# Phase contrast microscopy

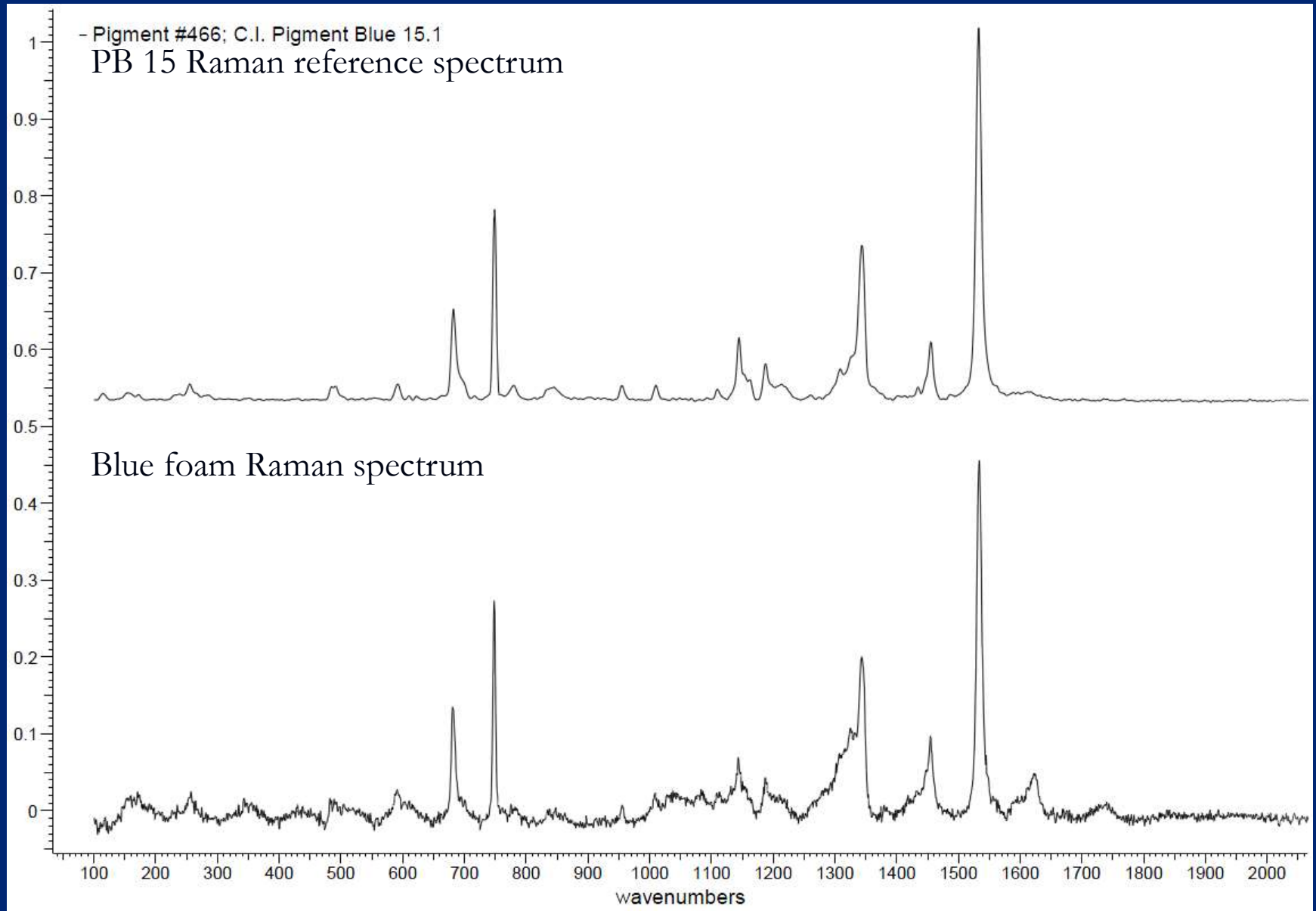




# Microspectrophotometry

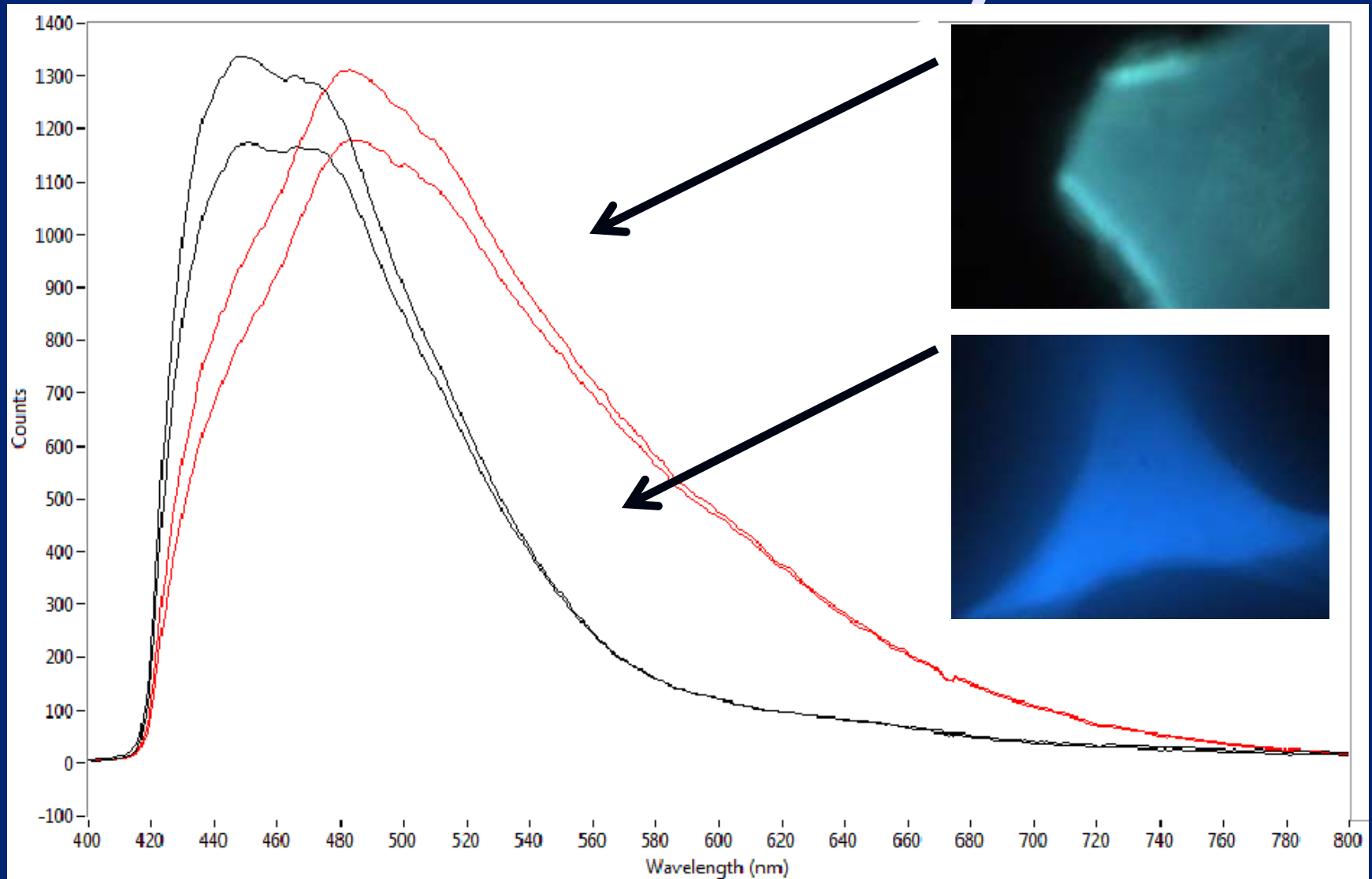


# Raman microspectroscopy



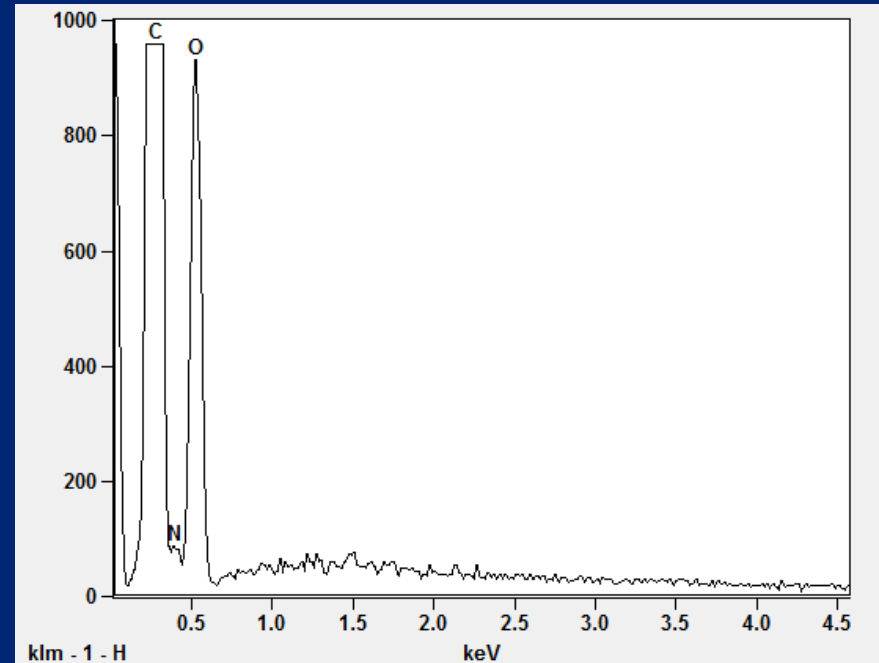
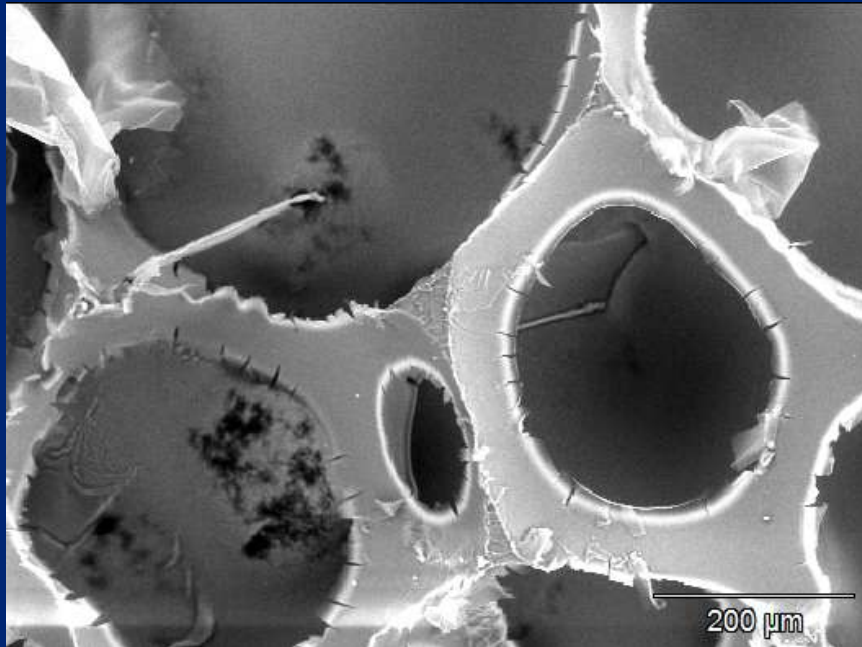


# Fluorescence microscopy and Microfluorimetry





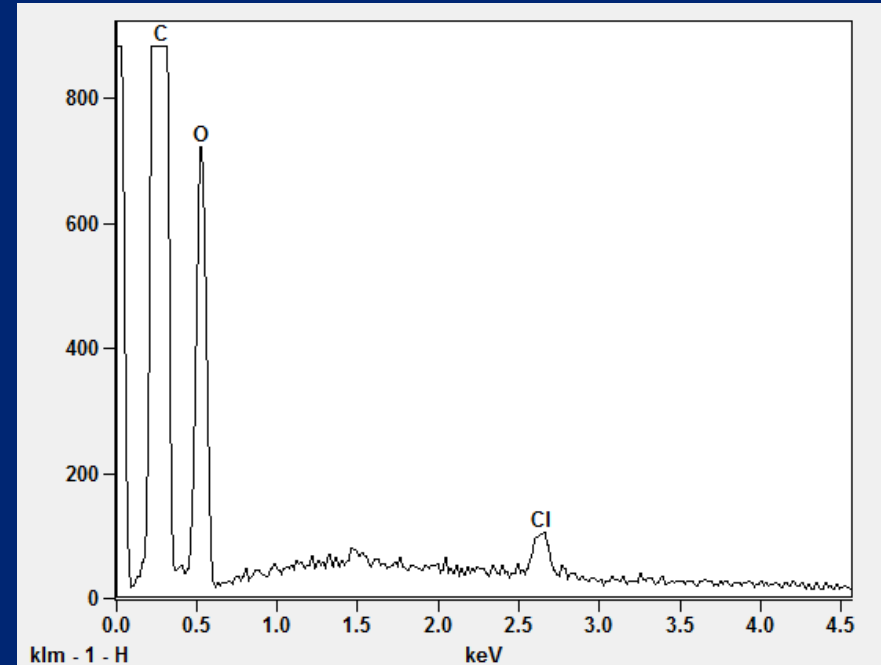
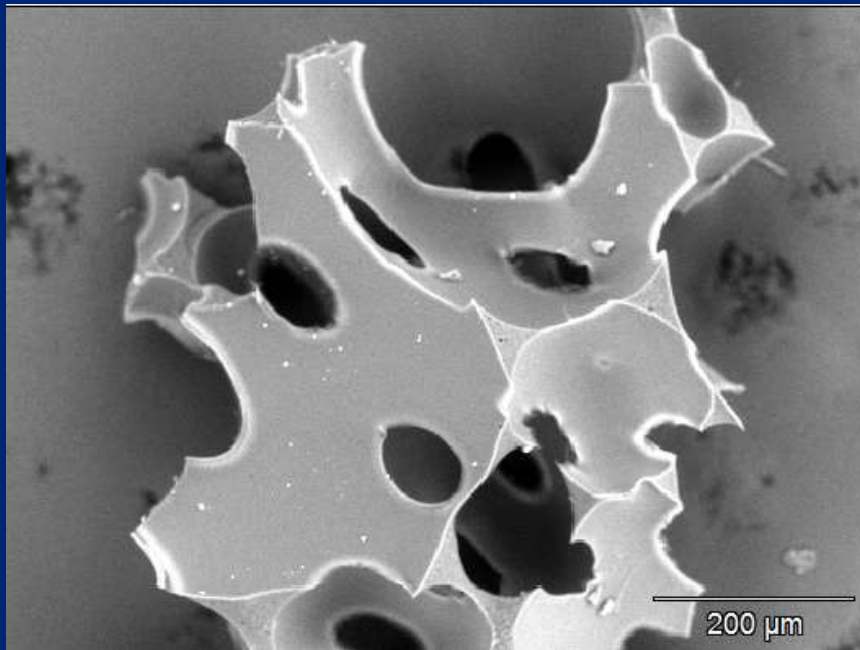
# SEM-EDS Analysis





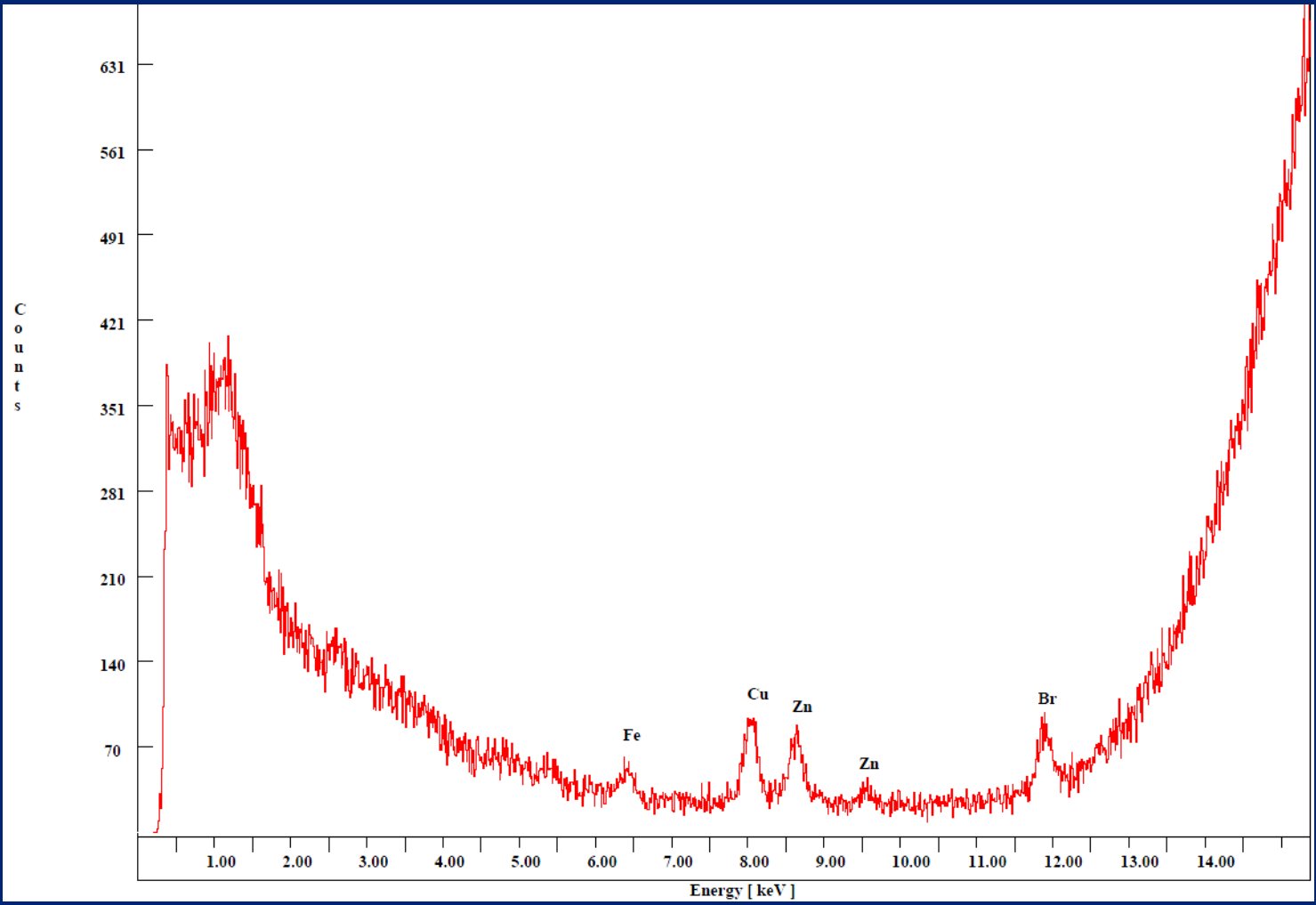


# SEM-EDS Analysis





# Micro-XRF spectrum showing bromine from flame retardant





# Microchemical Methods – primarily instrumental

- Infrared microspectroscopy as neat particle in compression cell (if necessary)
- Infrared microspectroscopy after solvent extraction
- Raman microspectroscopy
- GC/MS
  - Solvent extraction
  - Pyrolysis

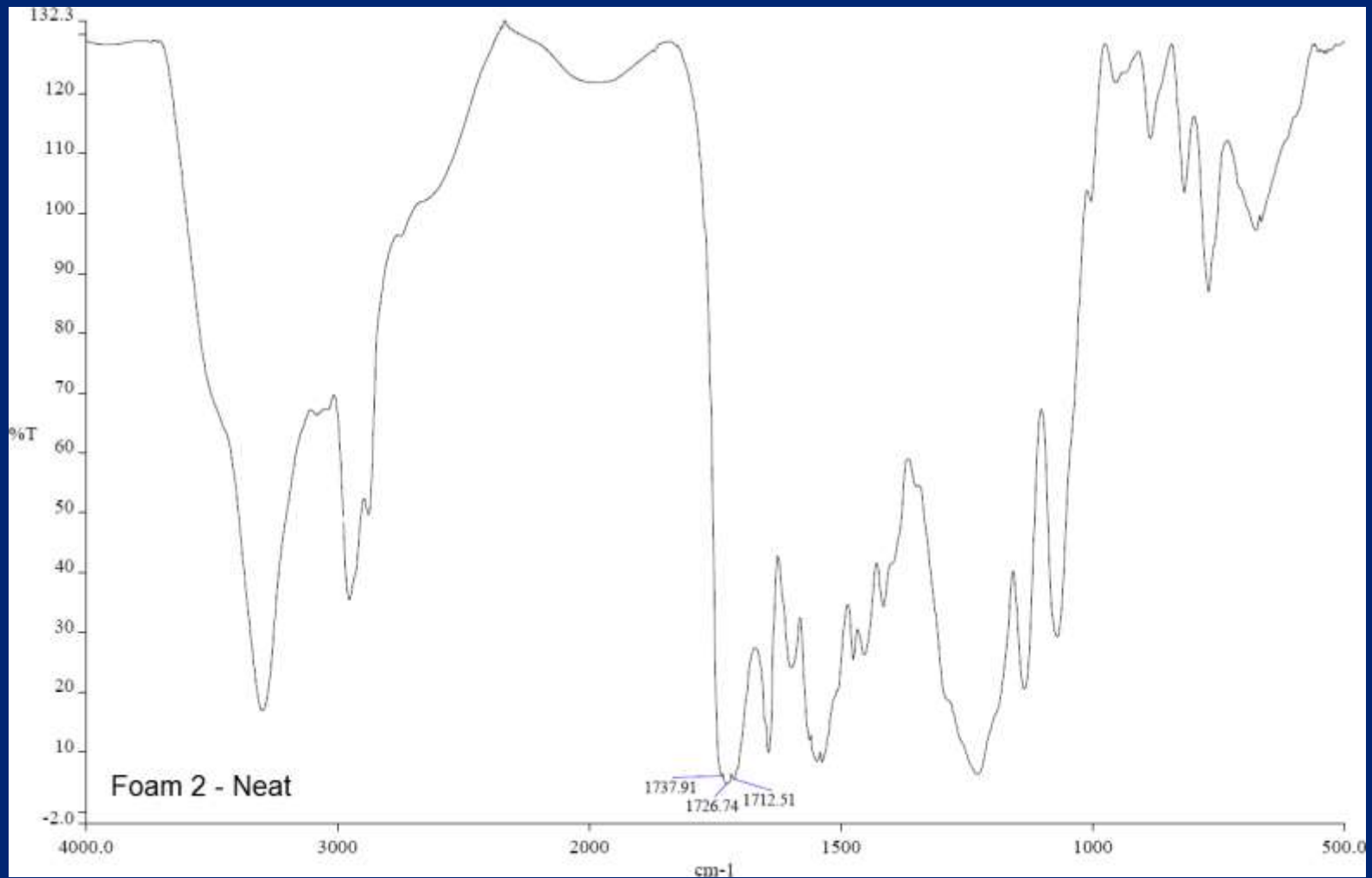


# Micro-FTIR

- Identify as polyurethane or other.
- Classify as polyether or polyester.
- After extraction identify plasticizers (e.g. phthalates) and obtain spectrum of the neat polyurethane
- Compare infrared spectra

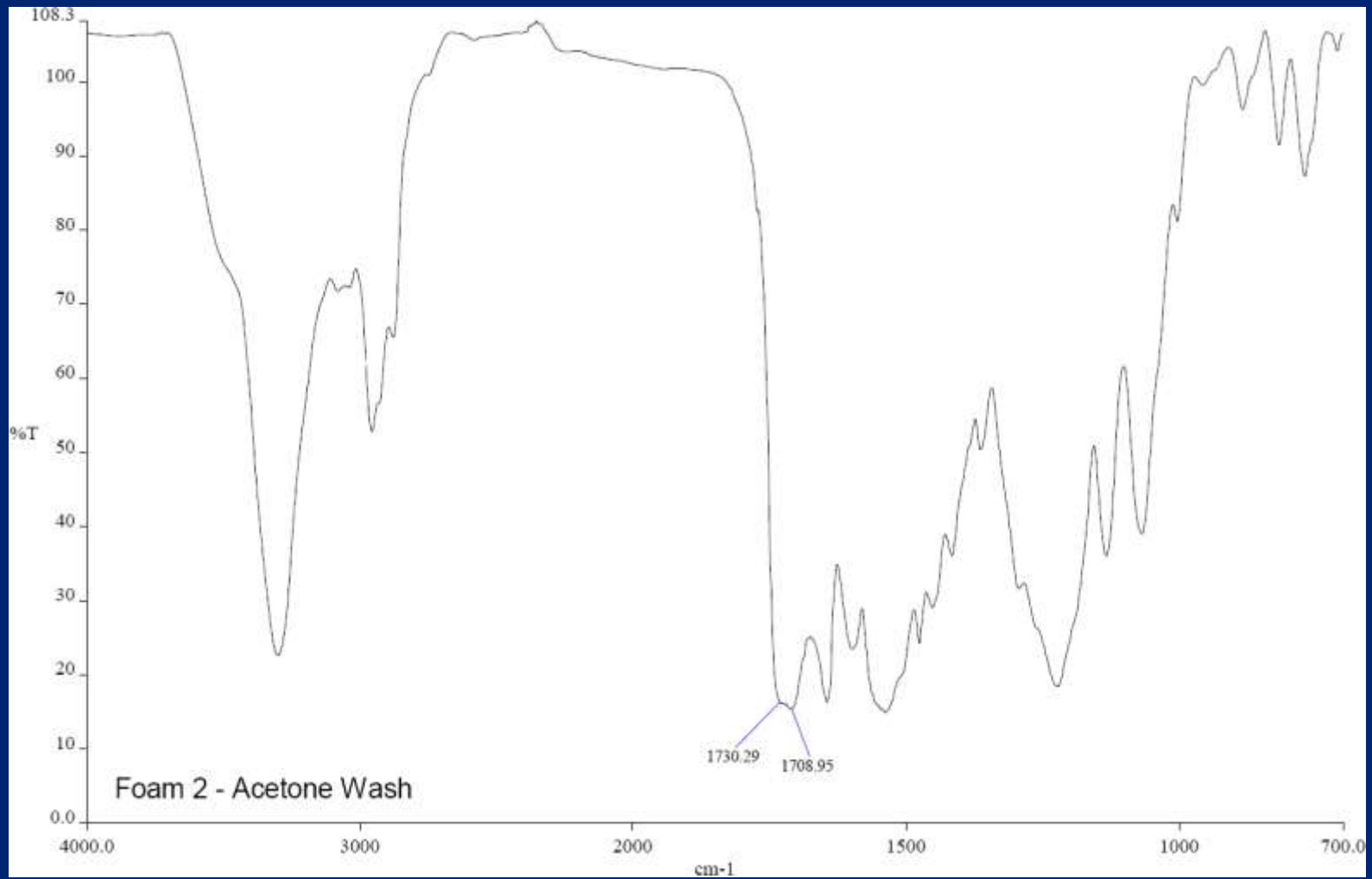


# Polyester type urethane - neat



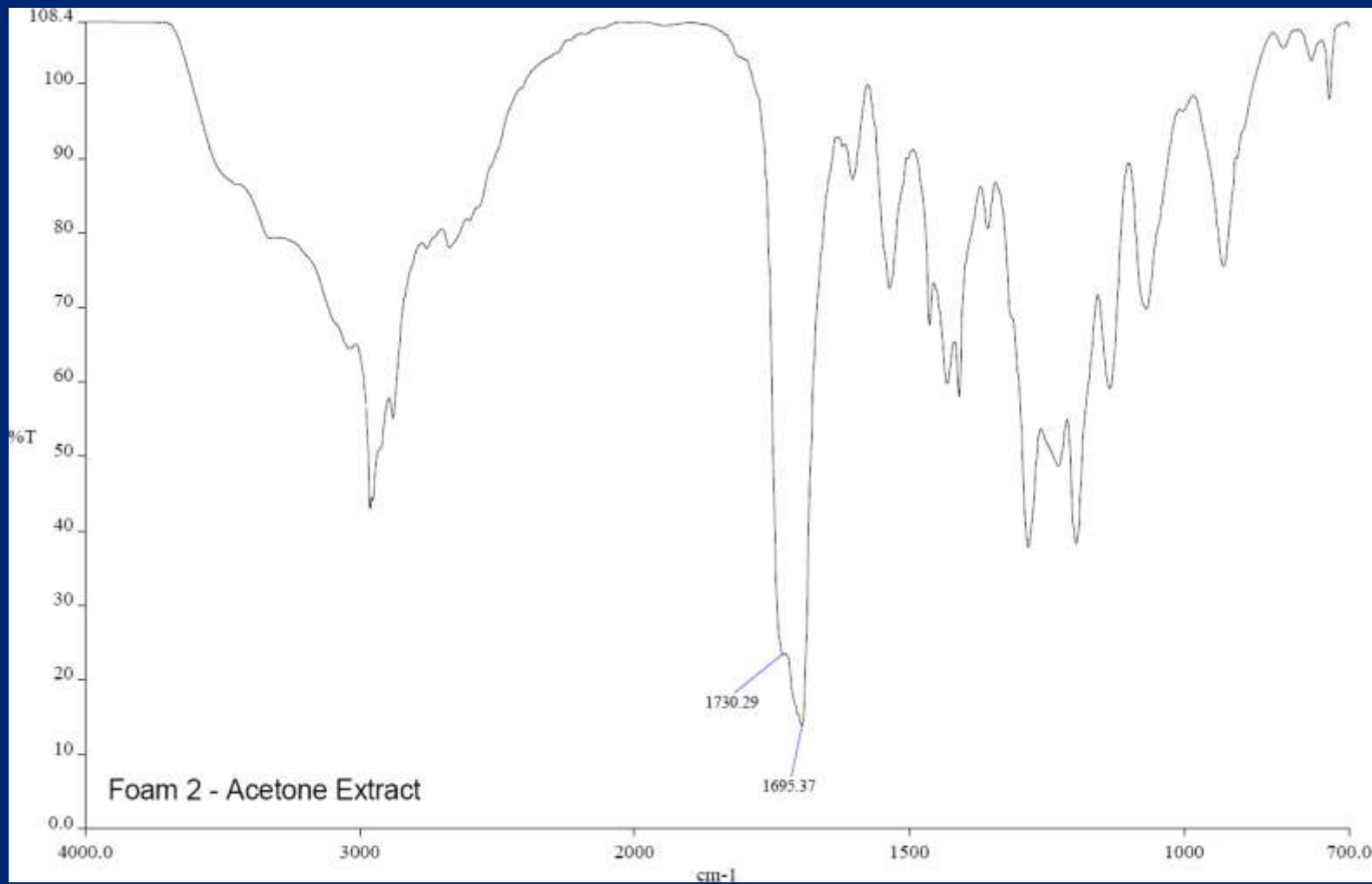


# Polyester urethane after acetone wash



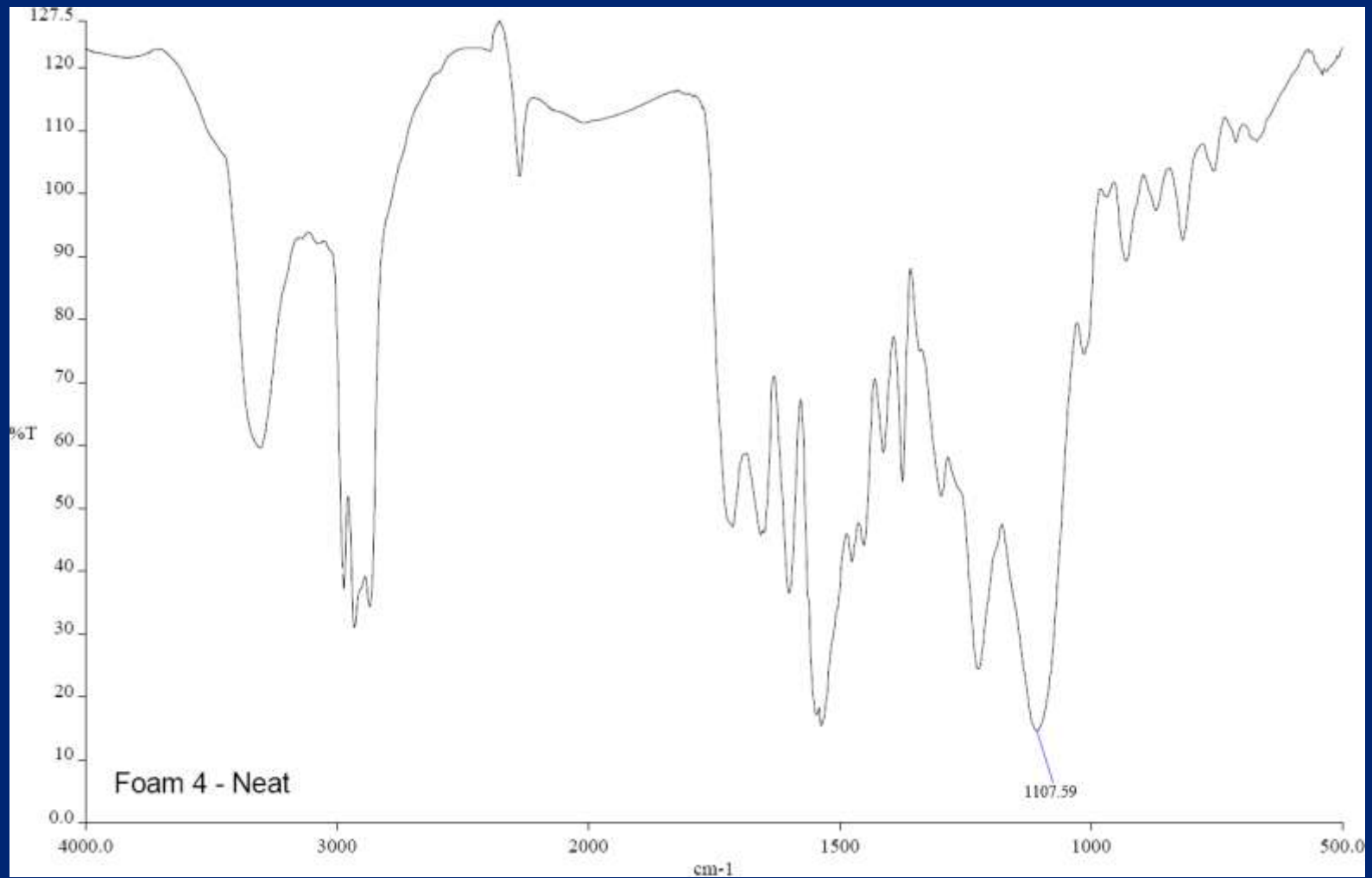


# Acetone extract from Foam 2





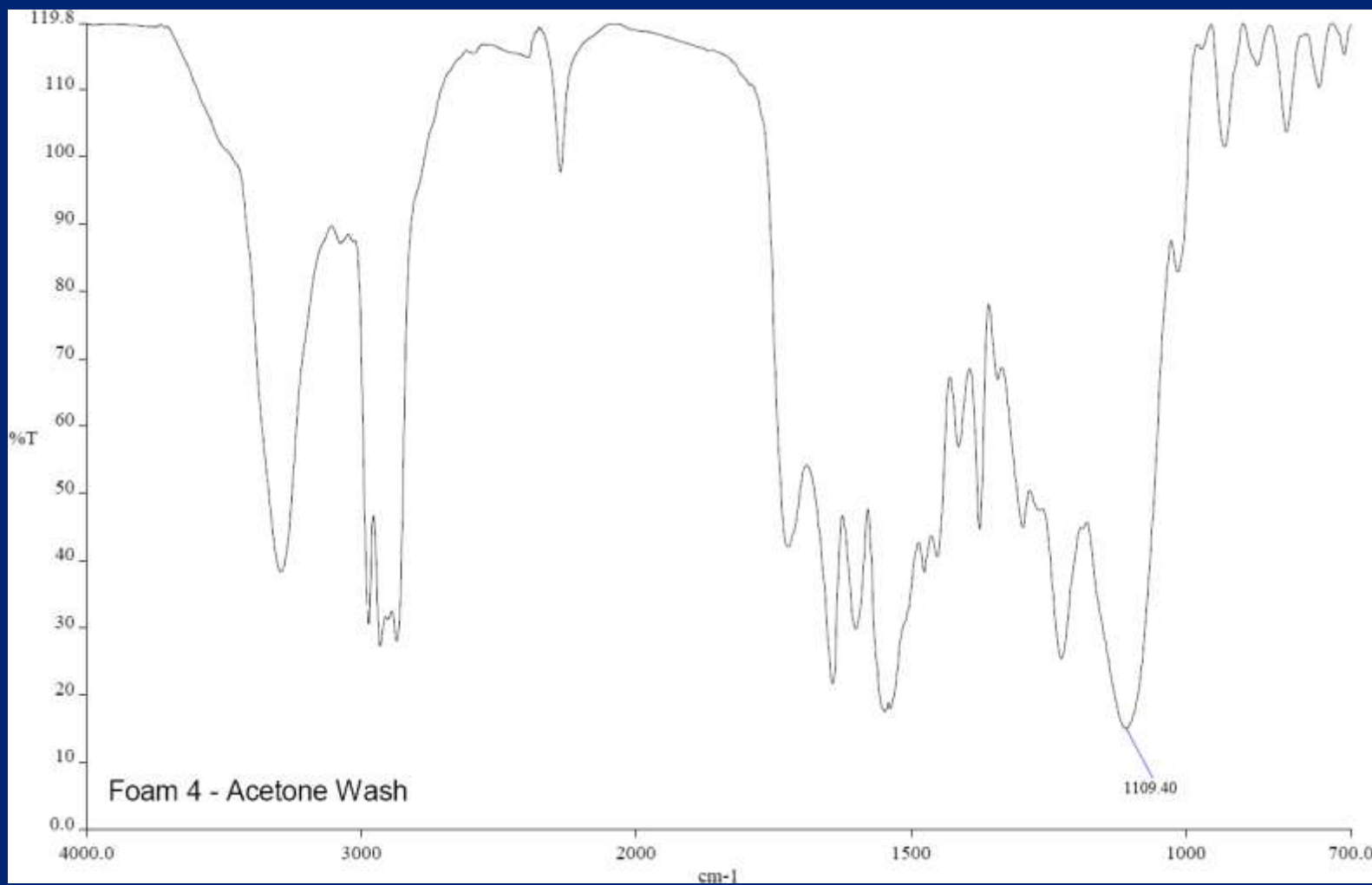
# Polyether type urethane foam - neat





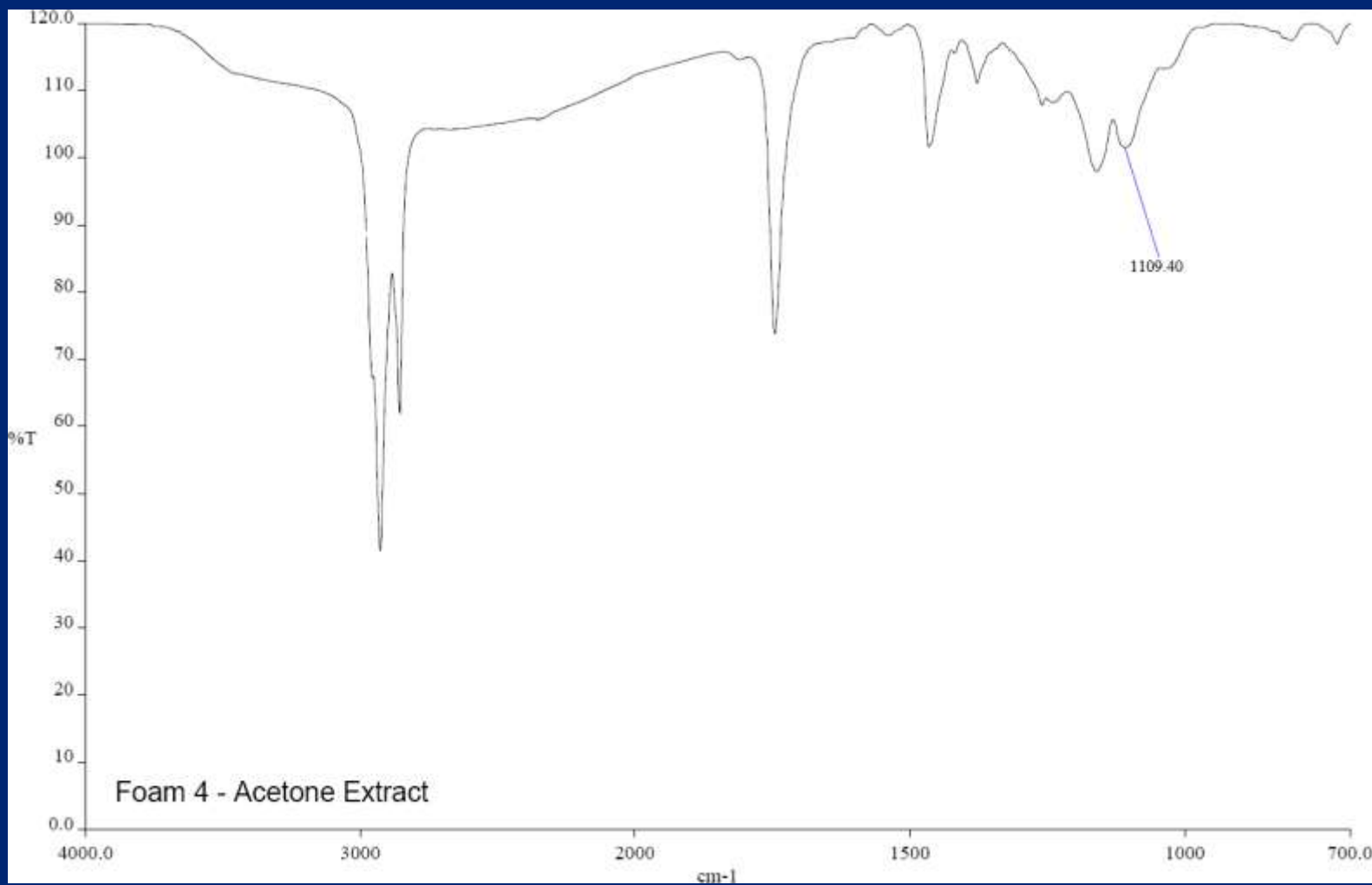


# Polyether urethane after acetone wash





# Acetone extract from foam 4





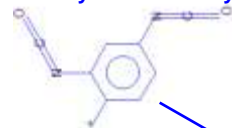
# GC-MS

- Information from both extraction and pyrolysis. Extraction provides especially useful data on lower molecular weight compounds.
- Separation and identification of ingredients of the product (e.g. plasticizers, styrene, etc.)
- Study of breakdown products, which provide especially good points of comparison.

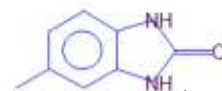
kCounts  
700

**Sample ID: Sample #1**  
**Pyrolysis**

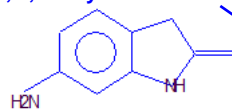
**Benzene, 2,4-diisocyanato-1-methyl-**



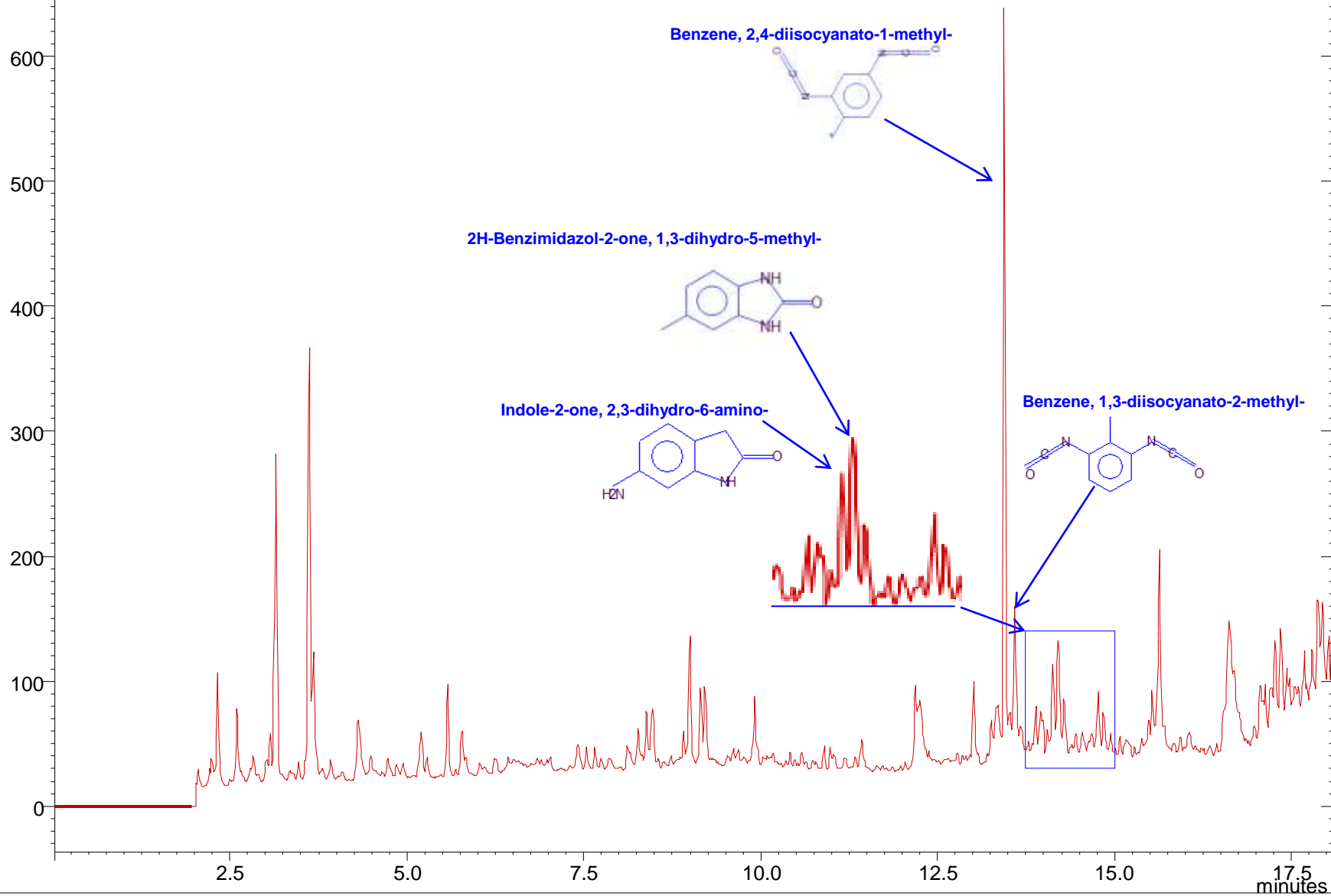
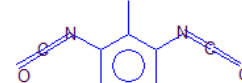
**2H-Benzimidazol-2-one, 1,3-dihydro-5-methyl-**



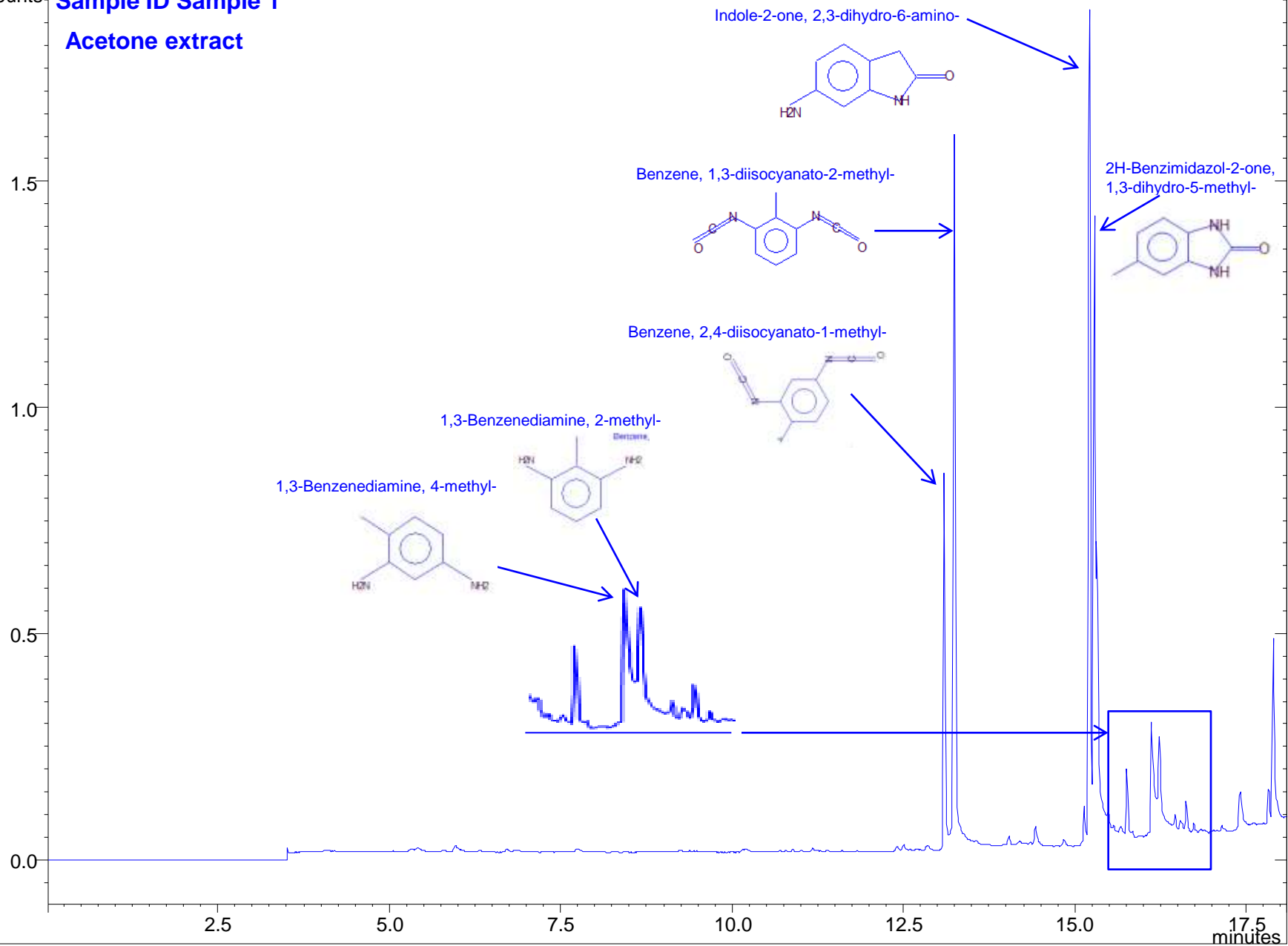
**Indole-2-one, 2,3-dihydro-6-amino-**



**Benzene, 1,3-diisocyanato-2-methyl-**

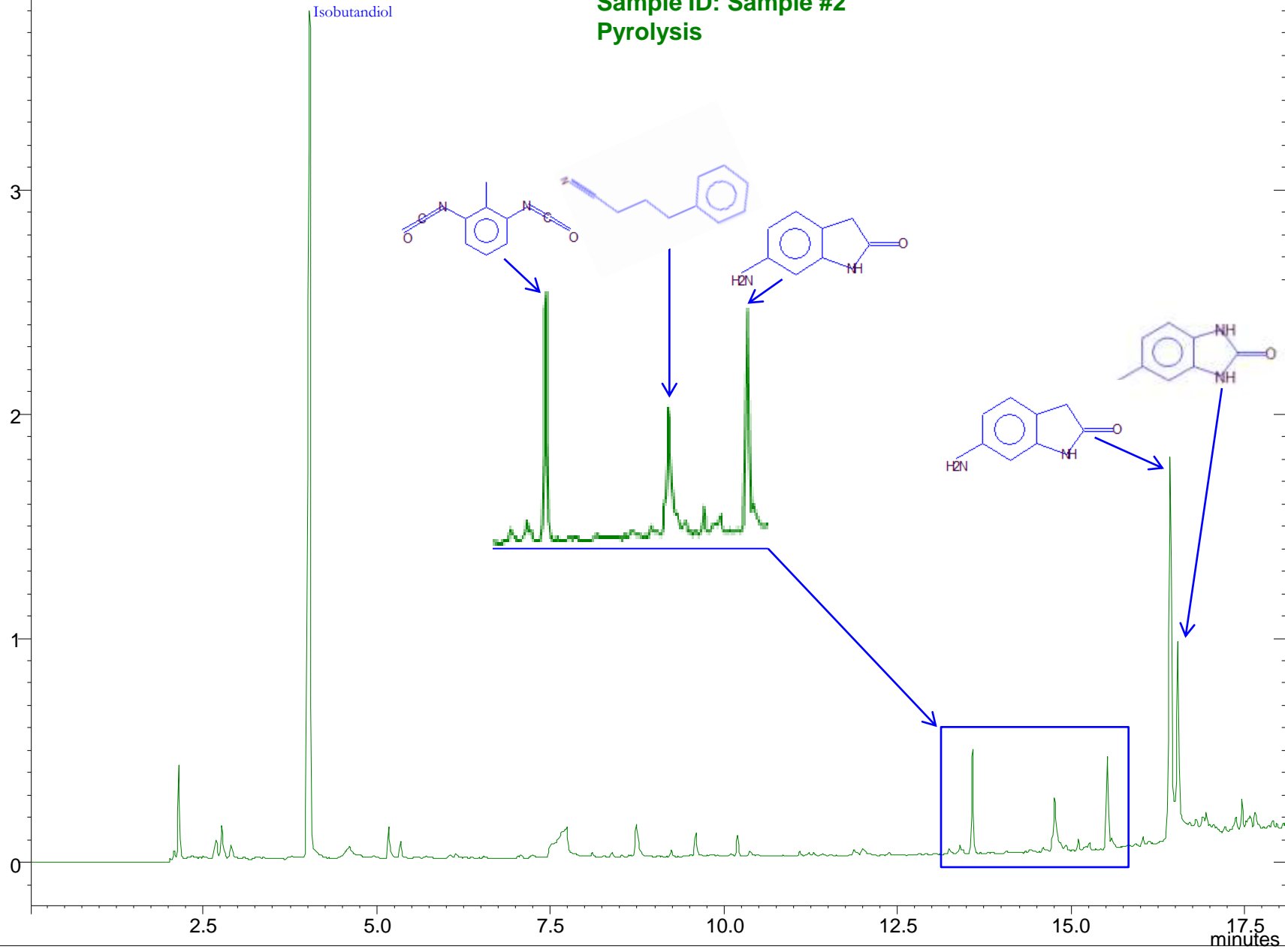


MCounts **Sample ID Sample 1**  
**Acetone extract**



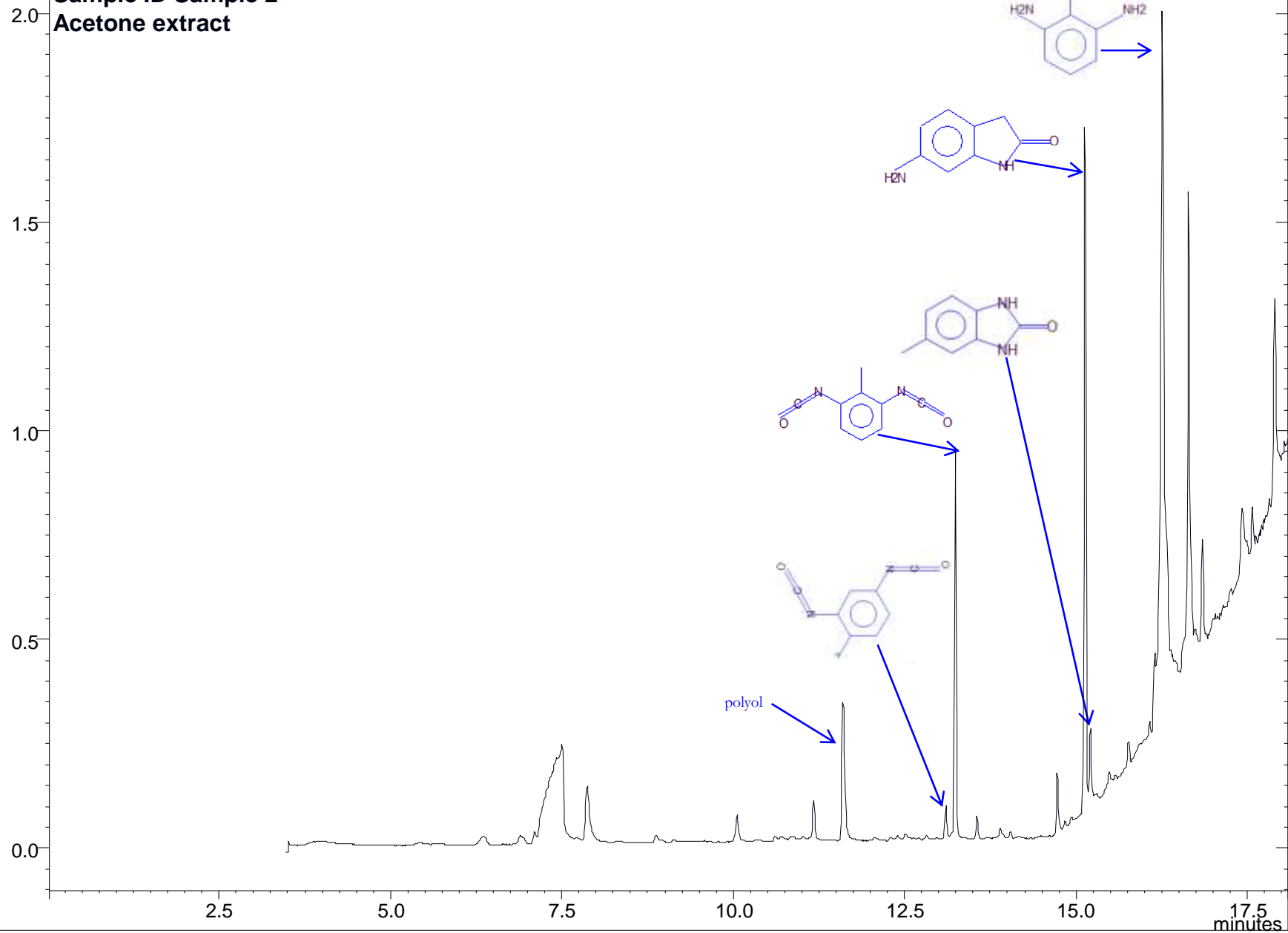
MCounts

Sample ID: Sample #2  
Pyrolysis



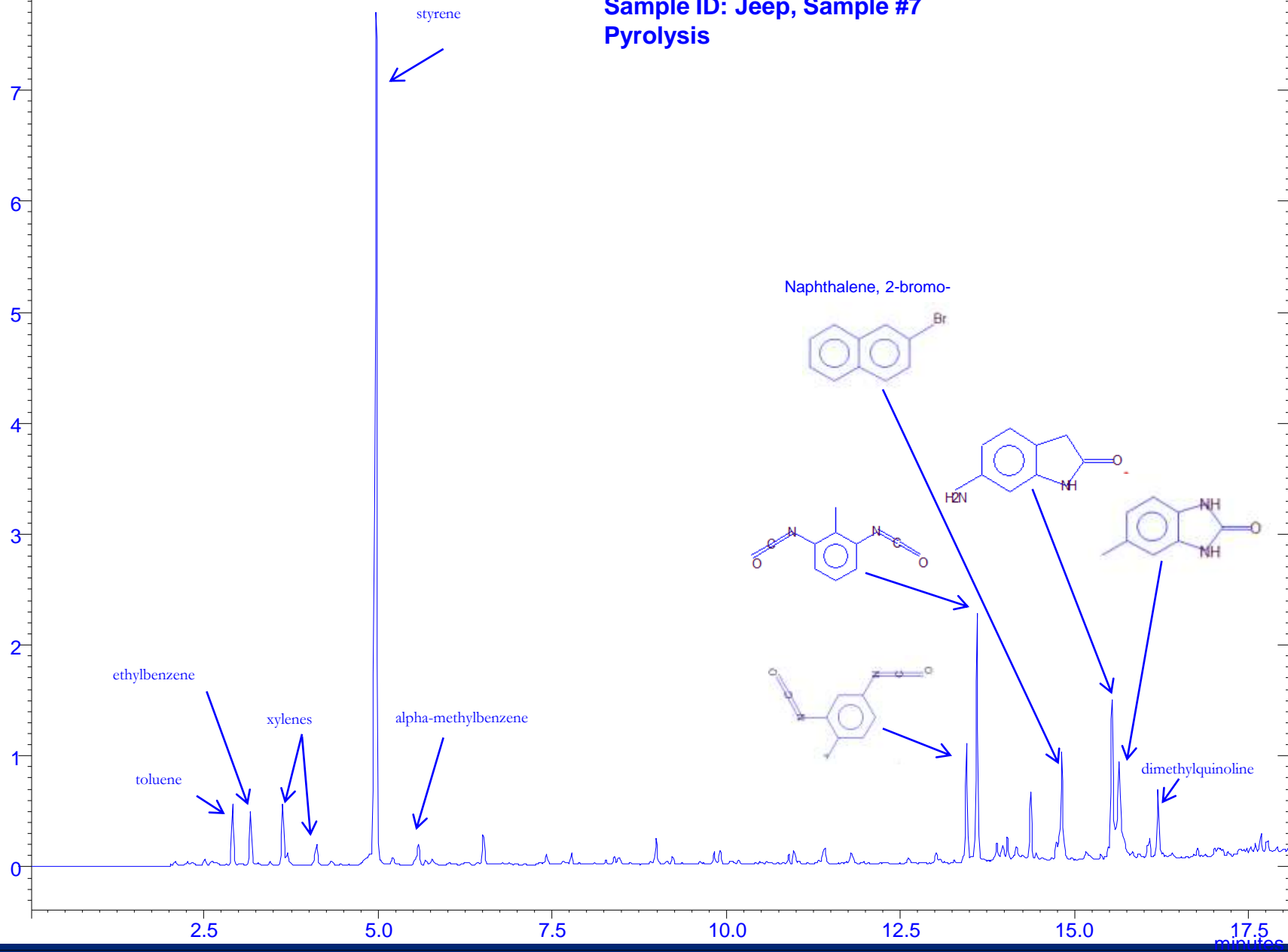
minutes

MCounts  
Sample ID Sample 2  
Acetone extract



Sample ID: Jeep, Sample #7  
Pyrolysis

MCOUNTS







# Summary

- By means of microscopical and microchemical techniques, it is possible to analyze and identify even single small polyurethane particles.
- By careful selection of techniques and their order of application, it is possible to characterize single polyurethane foam particles for purposes of comparison.
- Since these particles are typically degraded to some degree, GC-MS analysis of neat particles, their extracts or pyrolyzates provides a convenient and reliable means of comparison based on the degree of chemical alteration that the Q and K samples have undergone.



# Thanks and acknowledgement

- Mark Palenik
  - Katie White
  - Jay Beckert
- Chris Palenik

