# MIR Hyperspectral Imaging

Presentation of a laboratory measurement with Inno-Spec's **BlackEye**

*Black plastic sorting*

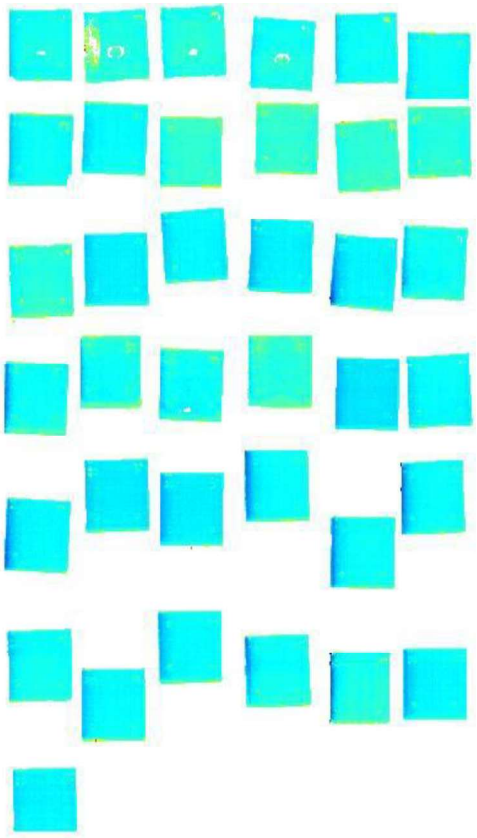
# Project Description:

Investigation on eight different black polymer types by medium infrared (MIR) hyperspectral imaging (HSI) using the inno-spec Black Eye and two different chemometric software tools

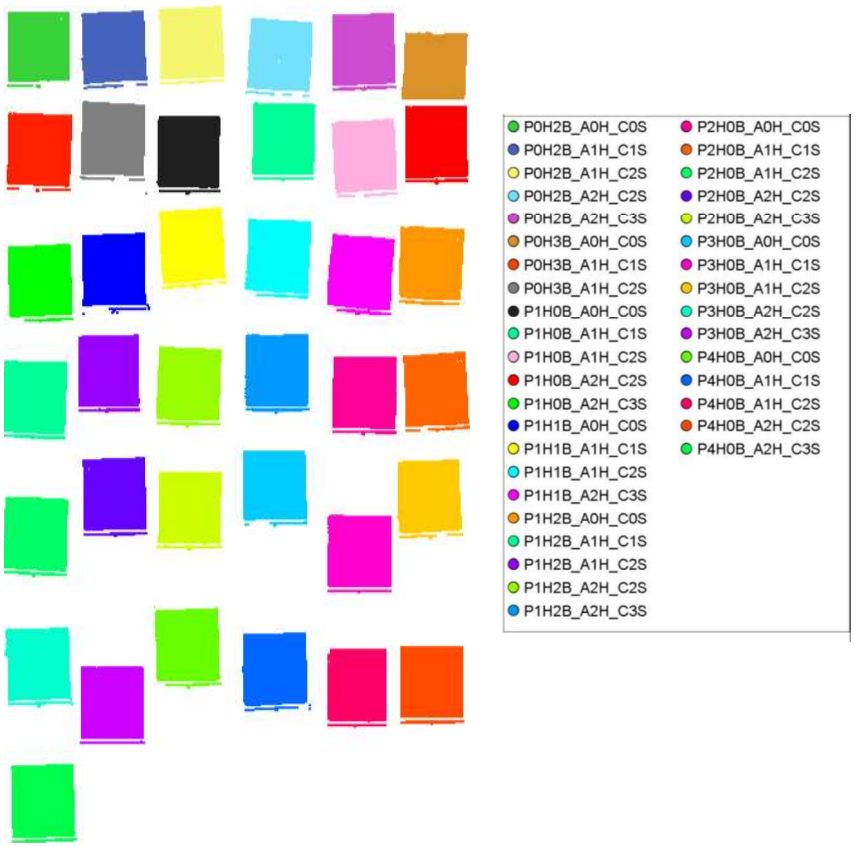
| | |
|---|---|
| **Measurement Devices:** | BlackEye HSI |
| **Spectral range** | 2800 nm - 4200 nm |
| **Sample Type:** | Eight different black polymer types |

Investigated samples – eight different black polymers were investigated. Several samples of each polymer were used, containing one of two possible black colour additives.

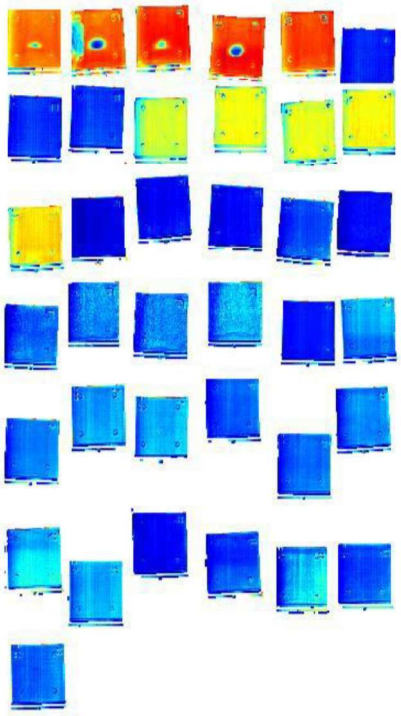
Contour 2D image (intensity)



2D image (colour coded by polymer type, additive, concentration)

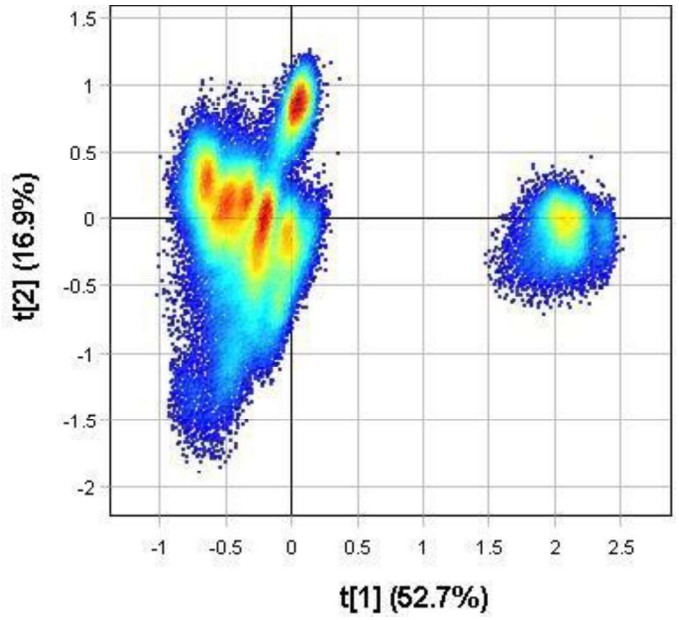


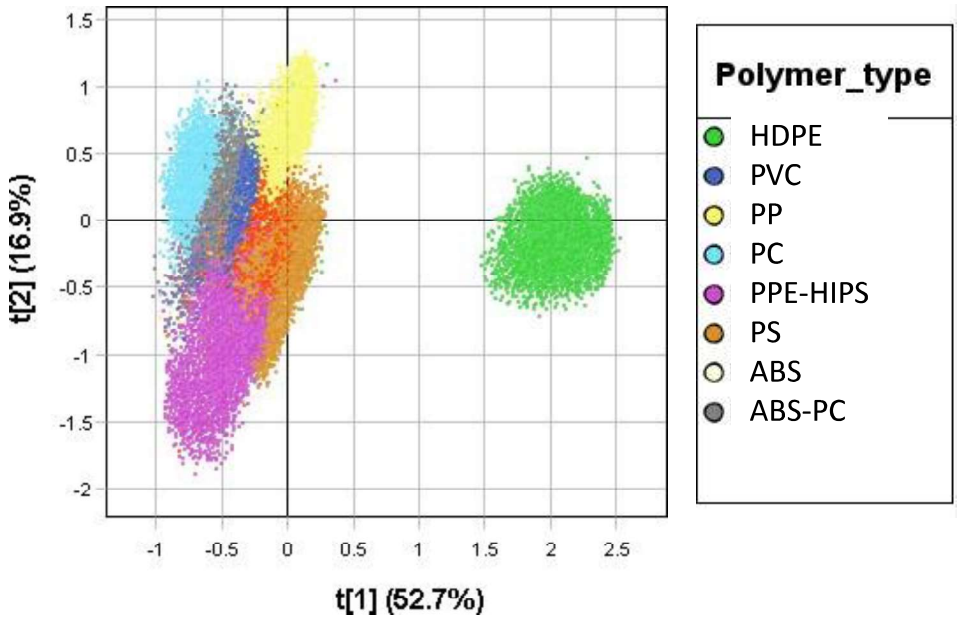

Contour 2D image PCA model



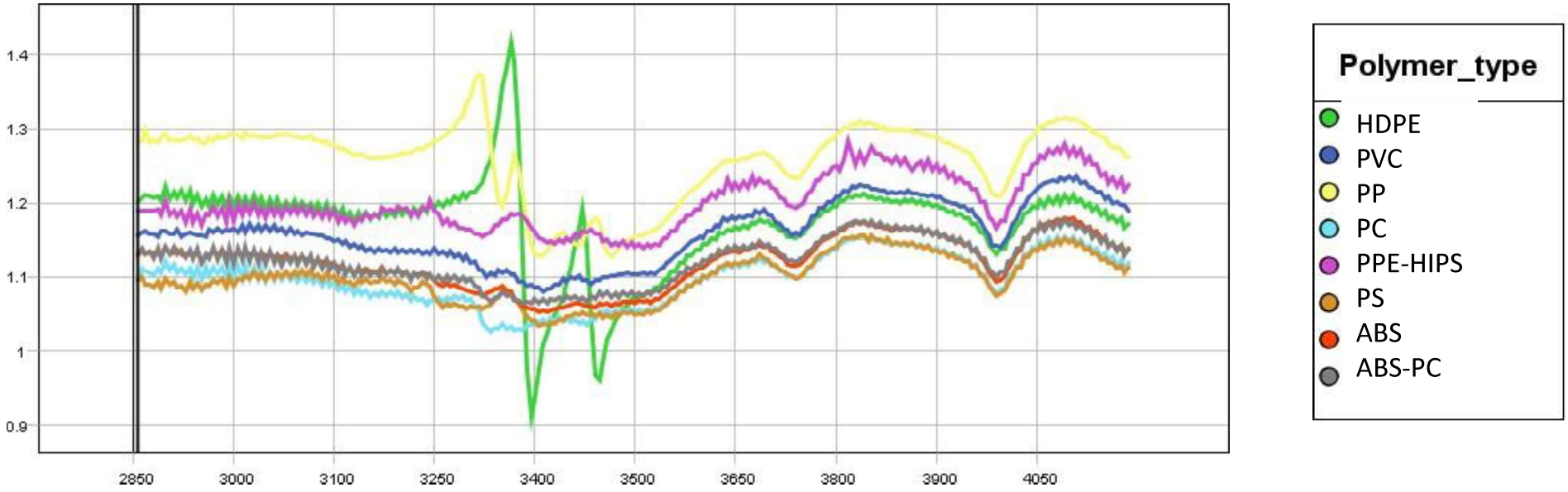
# PCA Model - rough first overview

The PCA model on baseline corrected, smoothed and differentiated data shows several clearly separable groups.
Colour codig them by polymer type shows that polymer type determines the separation.
HD-PE (green) is most clearly distinguishable. Also PP, PPE-HIPS and PS are distinguishable for the applied modifications.

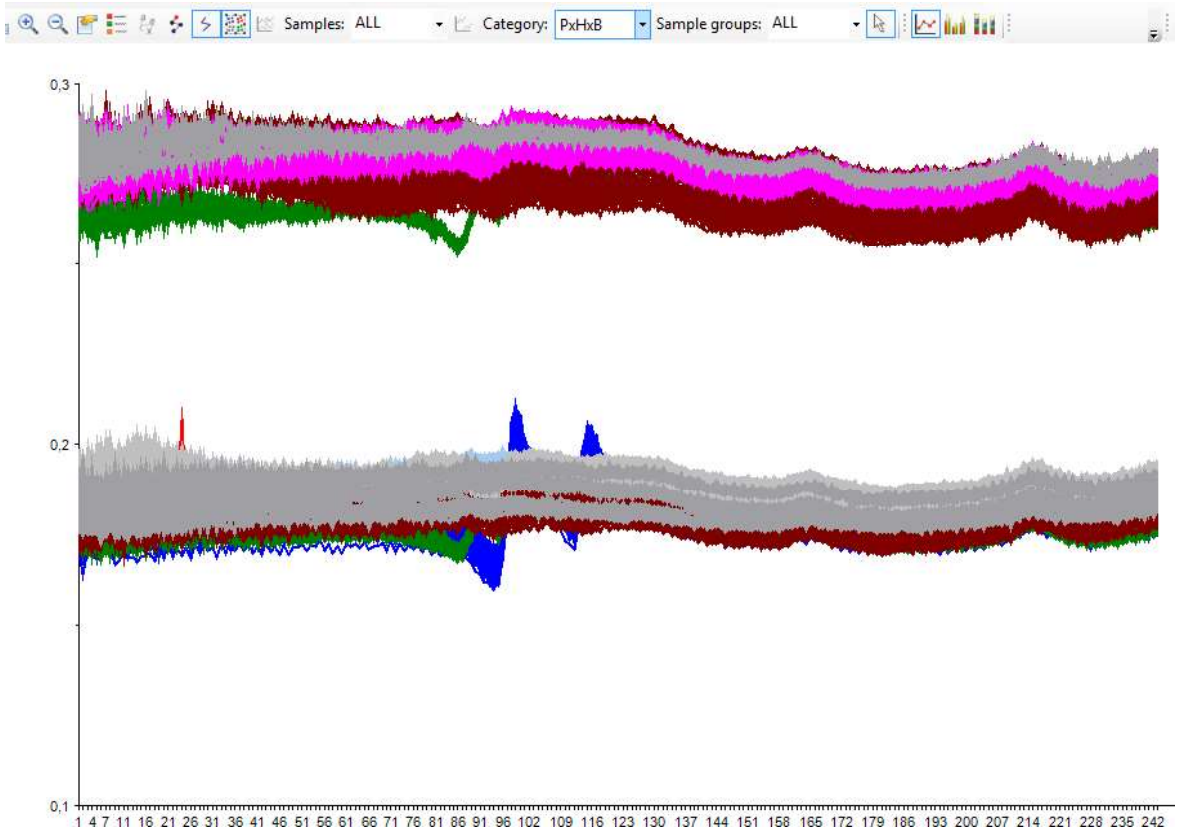


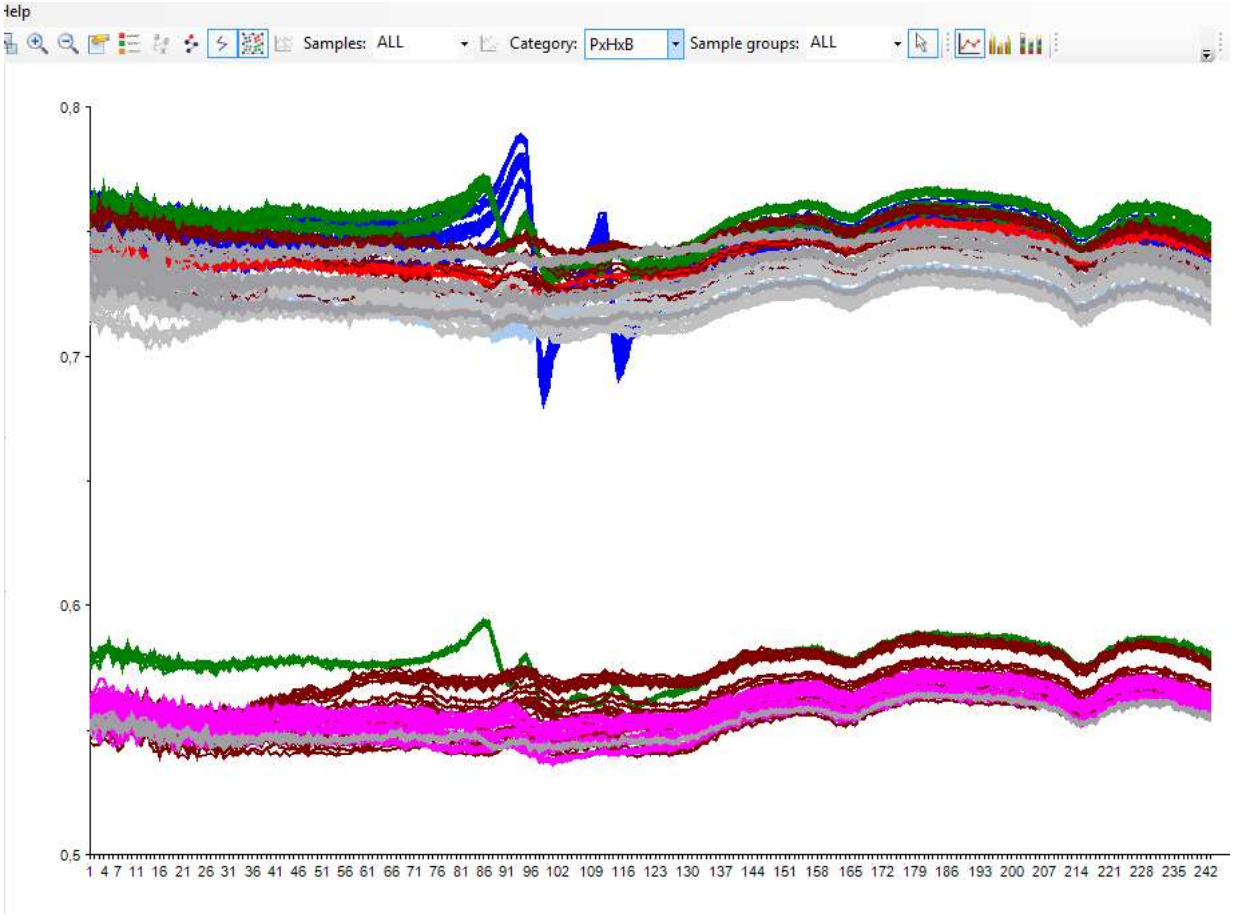
# Example spectra for different polymers



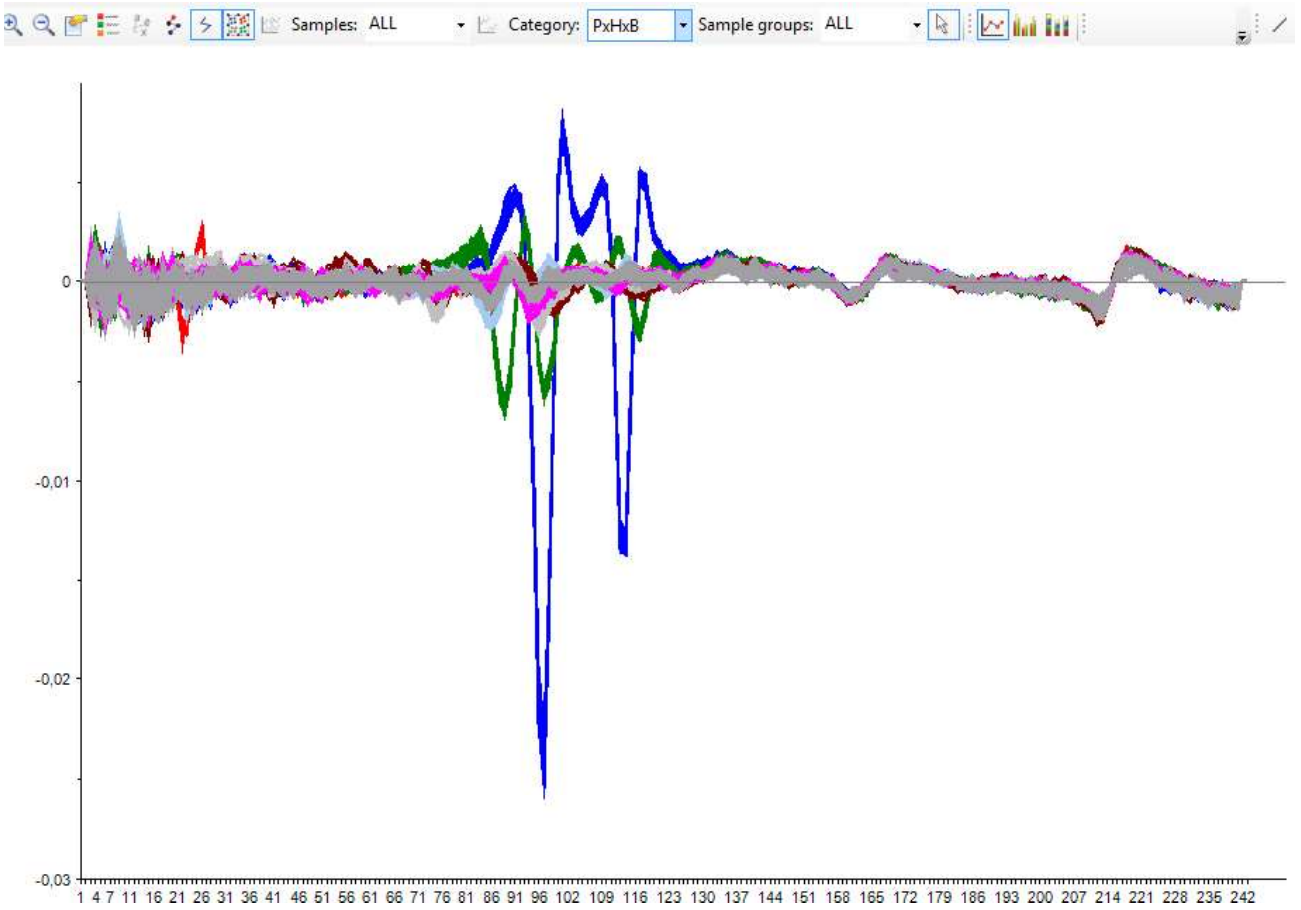
Using the software „the Unscrambler“ by Camo, a more elaborate analysis was performed:
50 reflectance spectra of each polymer



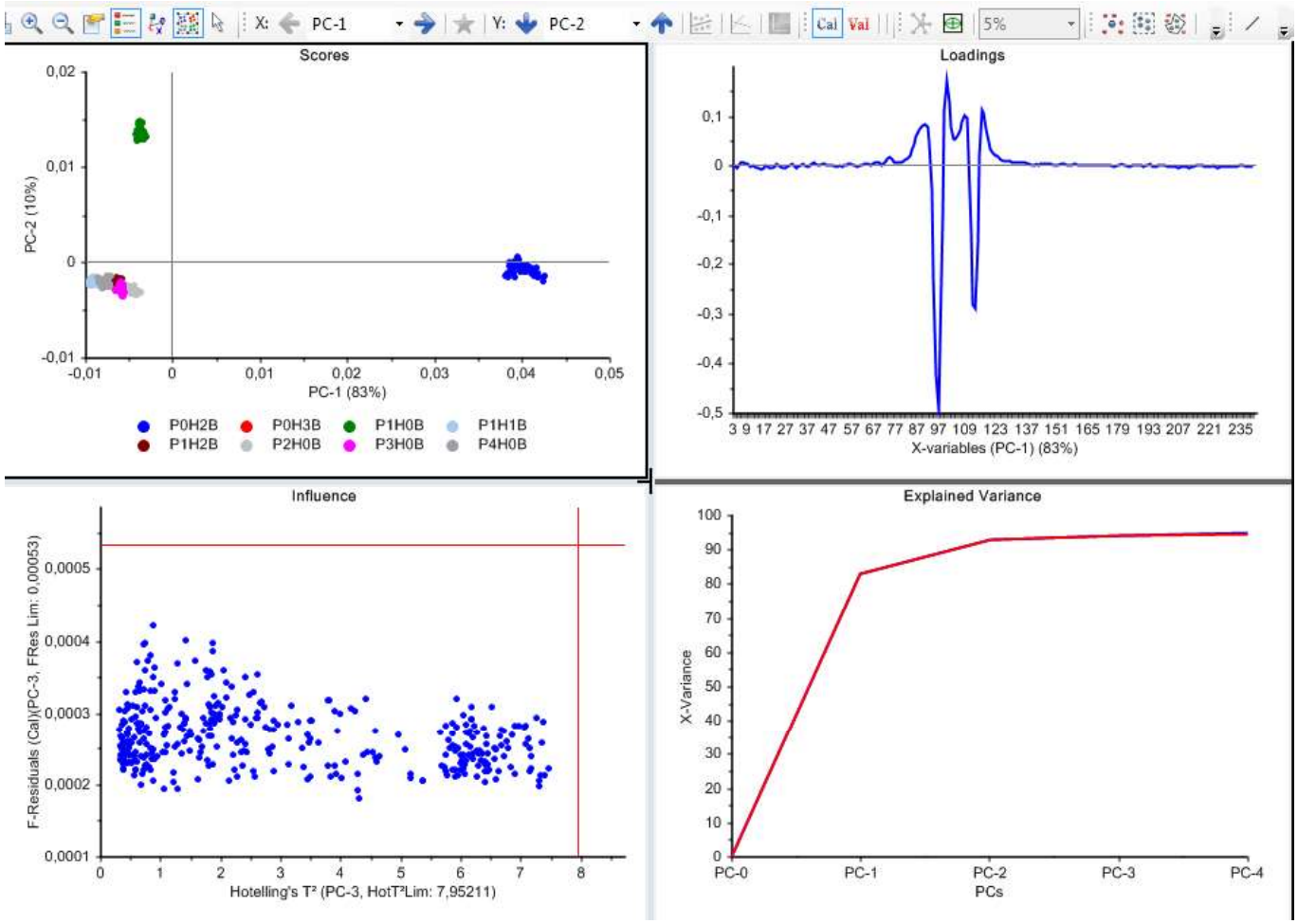
# Transformation to absorbance units and averaging over 5 spectra



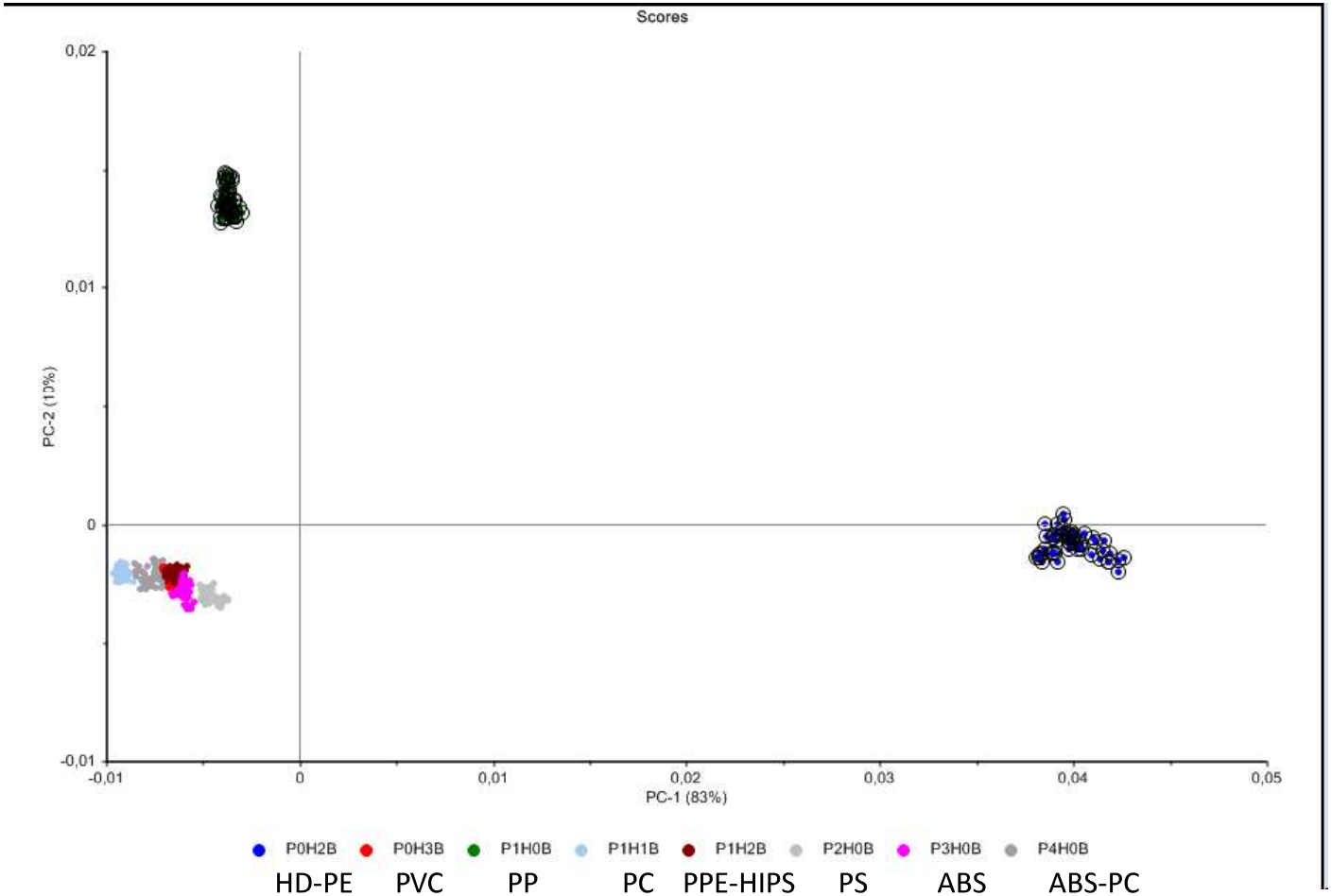
# First derivative and smoothing



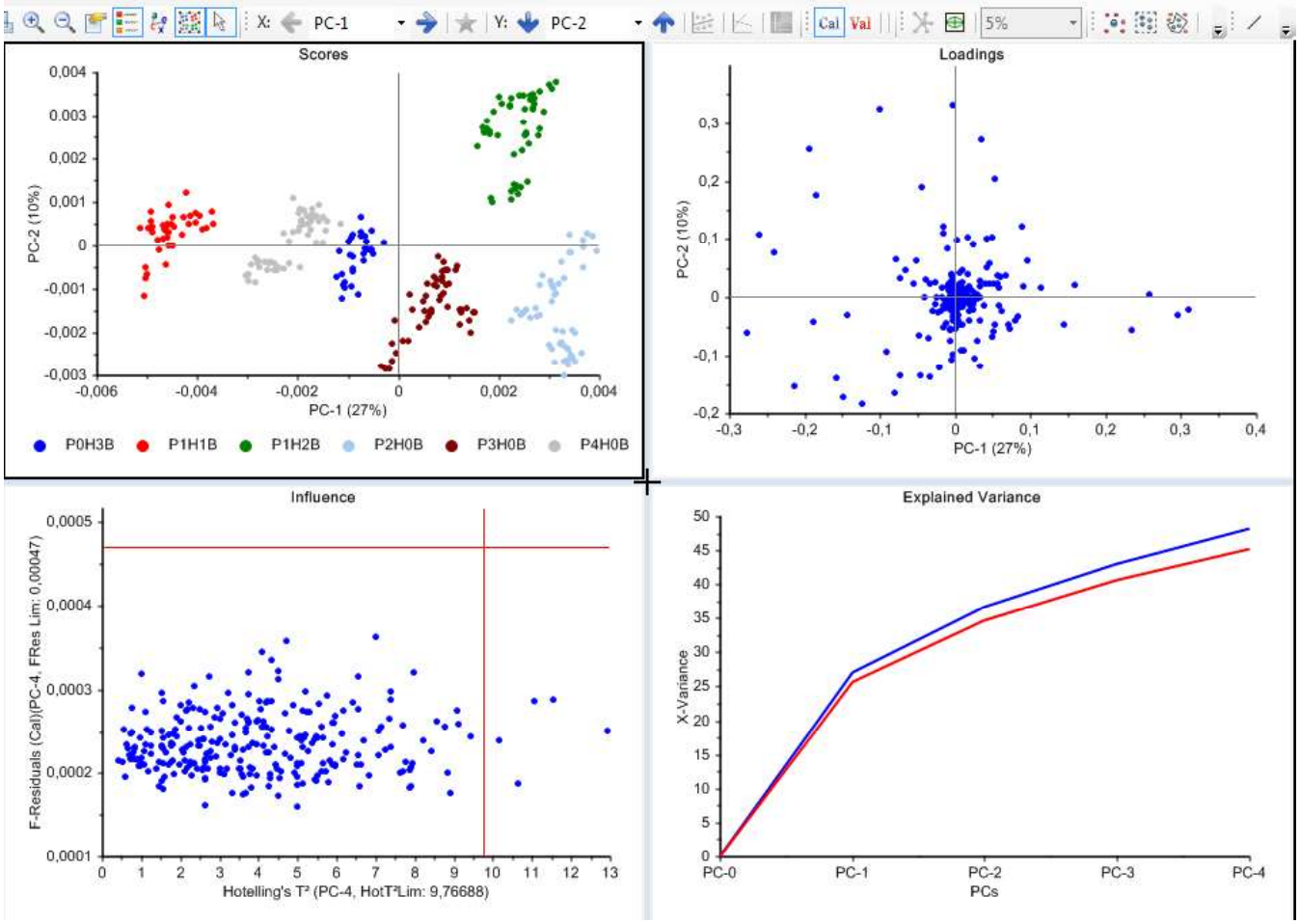
# Overview first PCA



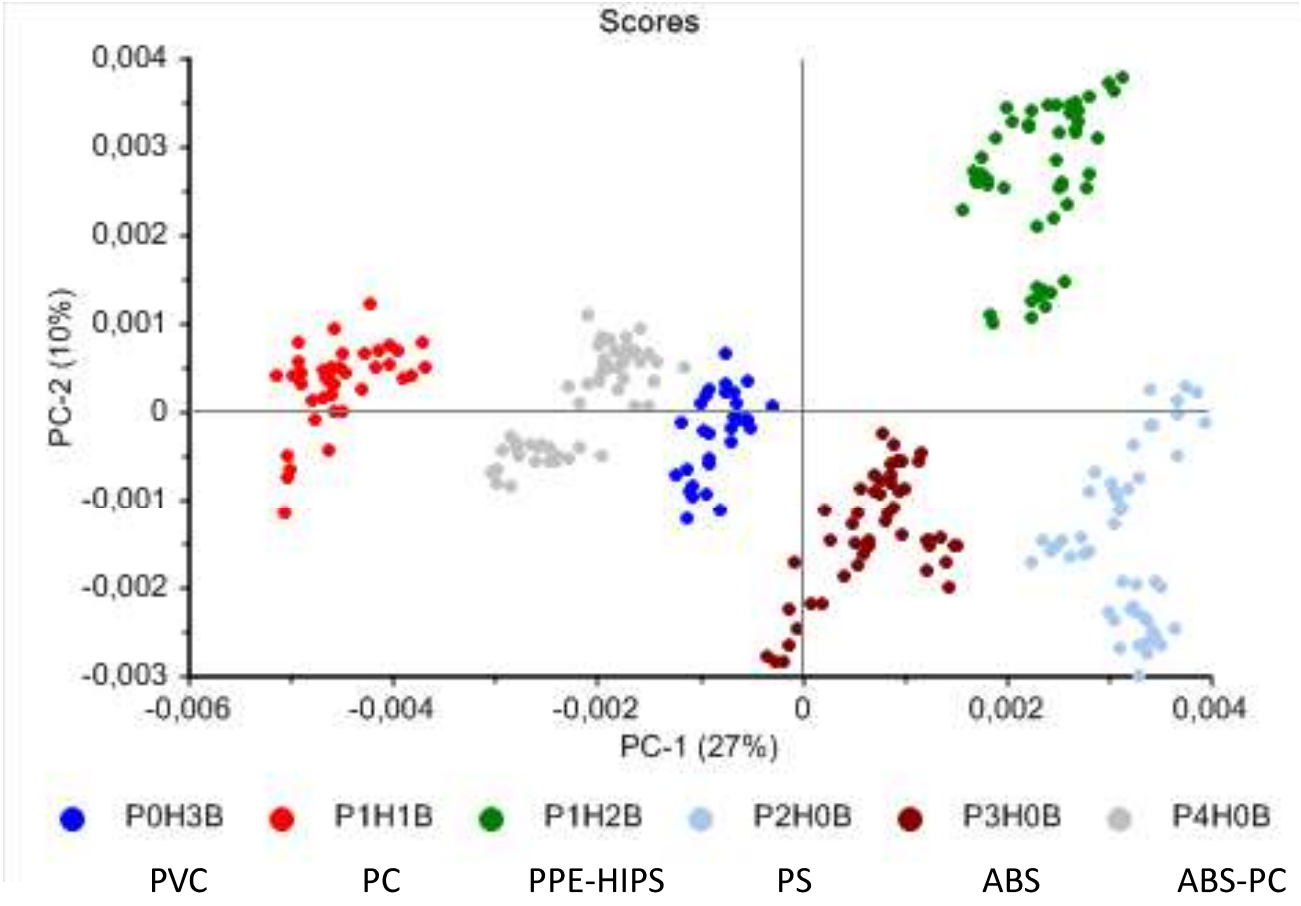
## First PCA. The marked spectra of HD-PE and PP that are most clearly separable were deleted for a second PCA.



# Overview second PCA



## Scores plot second PCA. The six residual polymer types are also clearly separable by their spectral information.



# Summary

- Eight black polymers with different black colour additives were investigated by MIR hyperspectral imaging
- A rough first analysis showed that the polymer types should be distinguishable
- The data was preprocessed (conversion to absorption units, averaging and 1st derivative) and a PCA performed. Two polymers were easily distinguished in this first PCA (HD-PE and PP). These were deleted and the remaining data was used for a second PCA
- In the second PCA, the residual six polymers could also clearly be separated
- In a further analysis (not shown here), it was demonstrated that the polymer types are separable irrespective of the black colour additive used (i.e. the type of additive does not influence the determination of the polymer type)

# BlackEye (2900 nm – 4200 nm)

## Benefits of the technology

- Contactless
- non-destructive
- Simple sample preparation
- fast and reliable evaluations


## Benefits of Inno-Spec

- Robust construction
- In-Line suitable
- High measuring rates (383 Hz frame frequency)
- Measurement area in an atmospheric window for distance-independent measurements

# Analyzing with Mid Infrared Hyperspectral Imaging provides…

- Information on molecular structure
- suitable for dark surfaces
- Superior sensitivity
- precise Classification & Identification
- Sorting black plastics

# Physical Backgrounds

- Interaction between light and matter
- Is part of vibration spectroscopy
- Determines the absorption or reflection rate of a photon by the sample
- Illuminated with IR-emitters

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