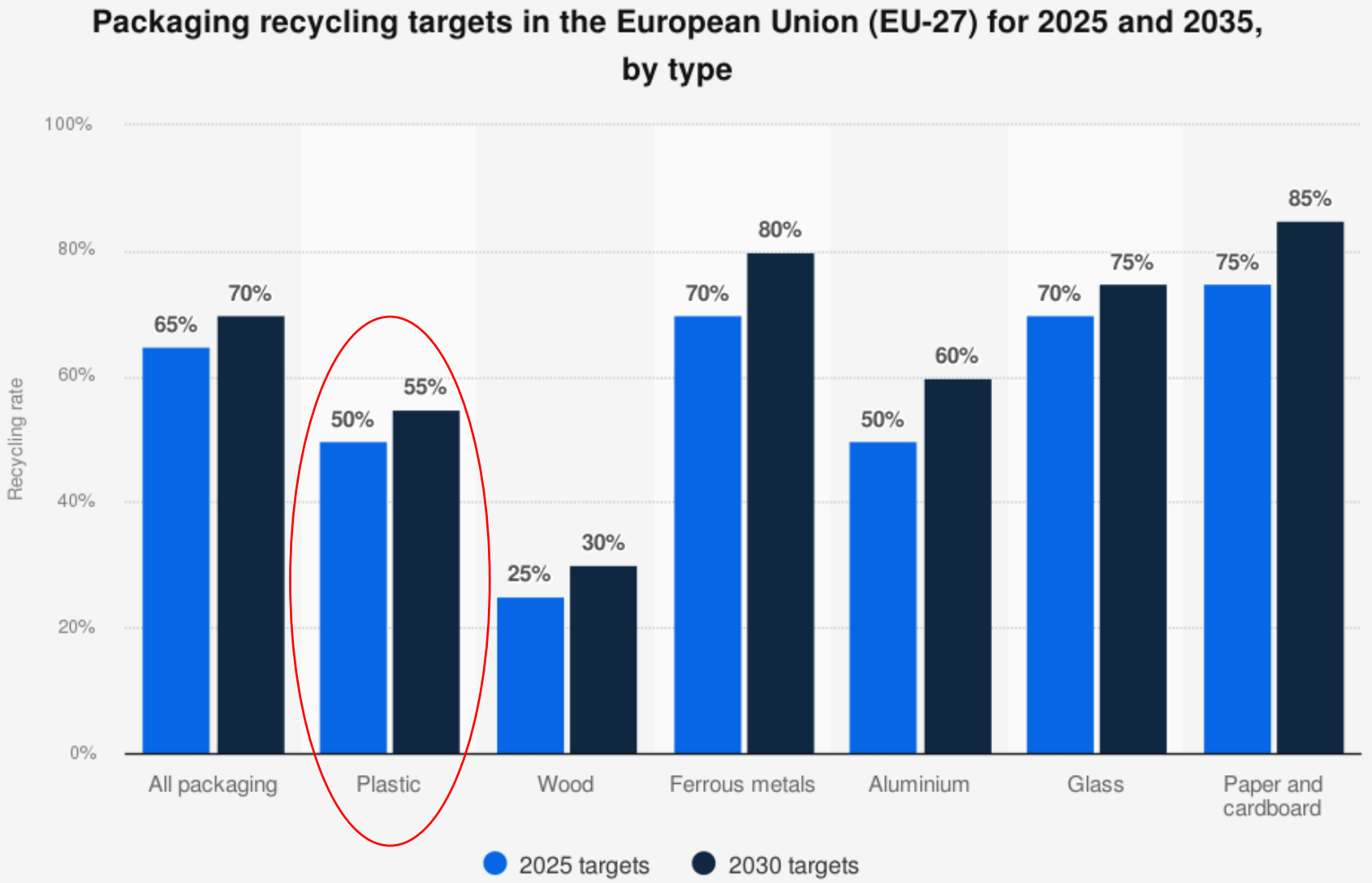
METHOD DEVELOPMENT FOR FAST CLASSIFICATION OF WASTE PLASTIC MULTILAYER POLYOLEFIN FILMS USING NEAR-INFRARED (NIR) HANDHELD SPECTROMETER

Hana Stipanovic
Gerald Koinig
Alexia Tischberger-Aldrian

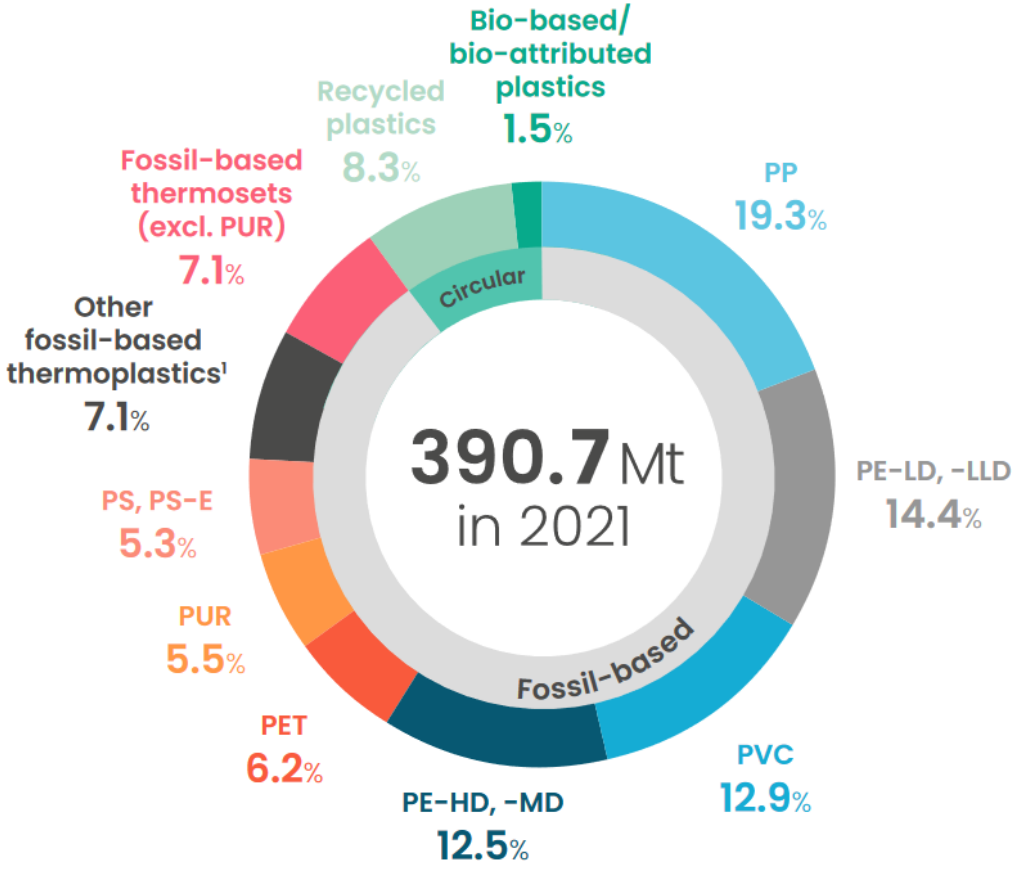
THE CHAIR OF WASTE PROCESSING TECHNOLOGY AND WASTE MANAGEMENT (AVAW)

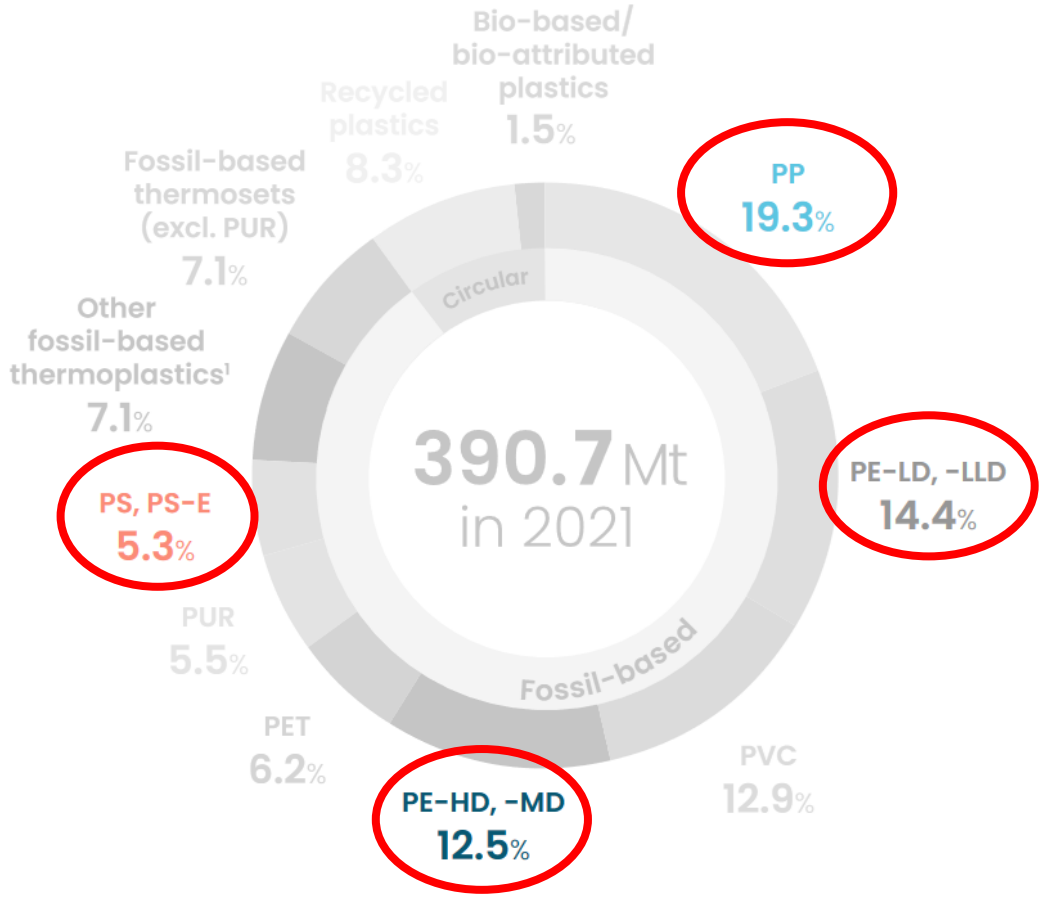


HOW TO REACH THE TARGETS?

Distribution of the global plastic production by type

Source: Plastics Europe 2022

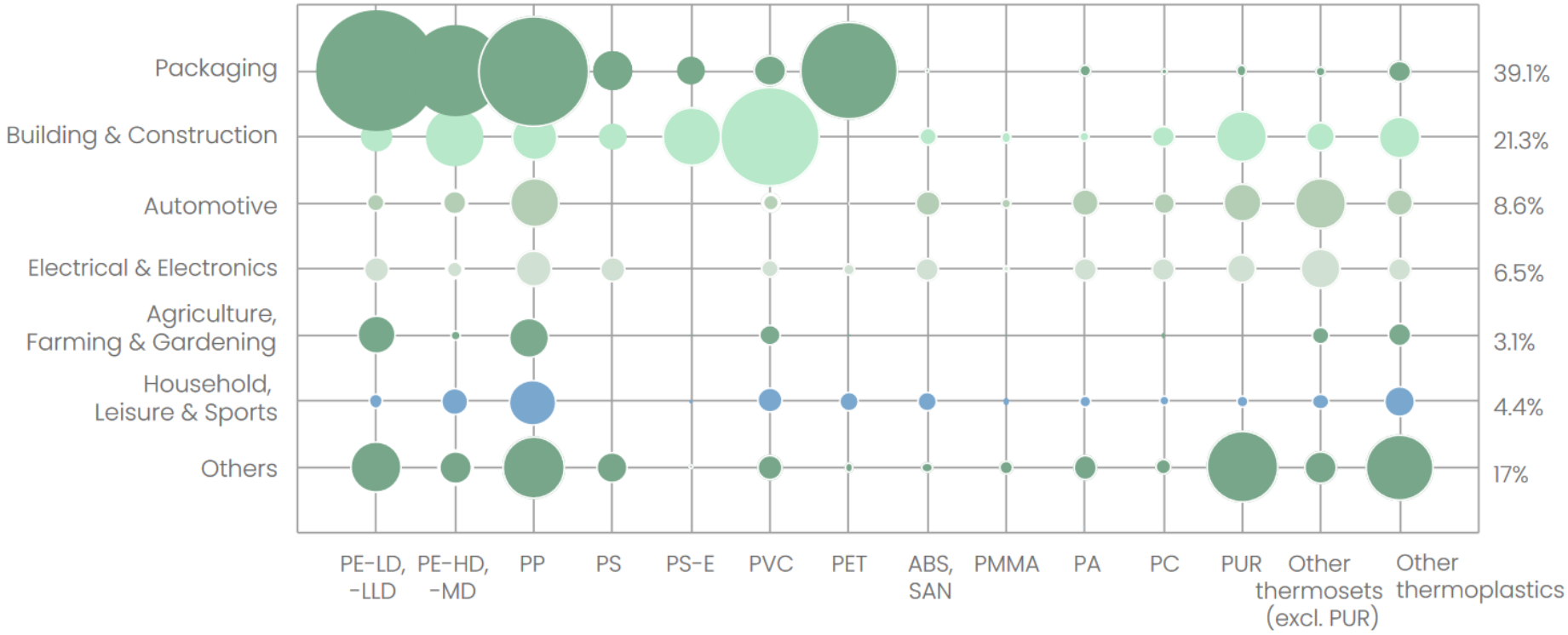




51.5% POLYOLEFINS (PO)

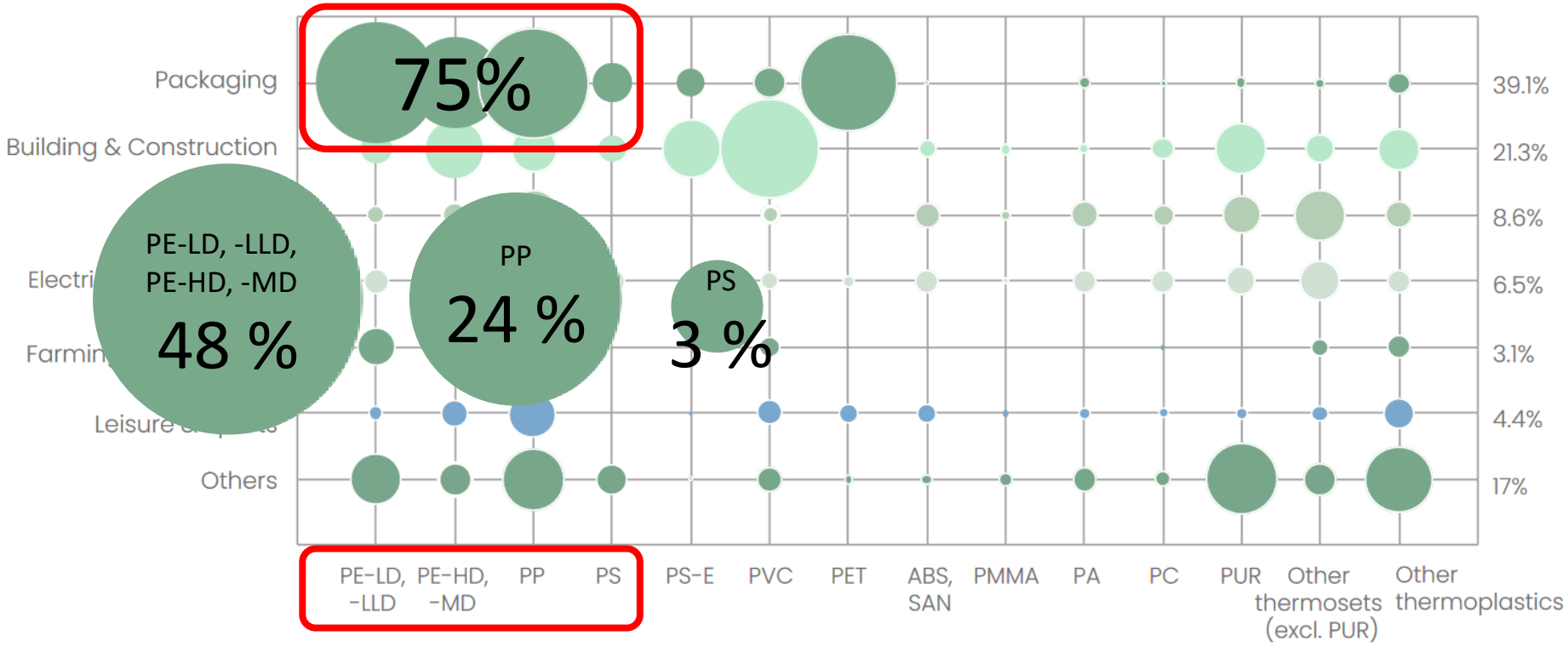
European plastic converters demand by application and type

Source: Plastics Europe 2022



European plastic converters demand by application and type

Source: Plastics Europe 2022



WHY ARE MULTILAYER FILMS PROBLEM?

MULTILAYER FILMS

In separately collected waste in Austria, 30 wt% are flexible 2D plastic packaging, films, from which 20 wt% are multilayer films

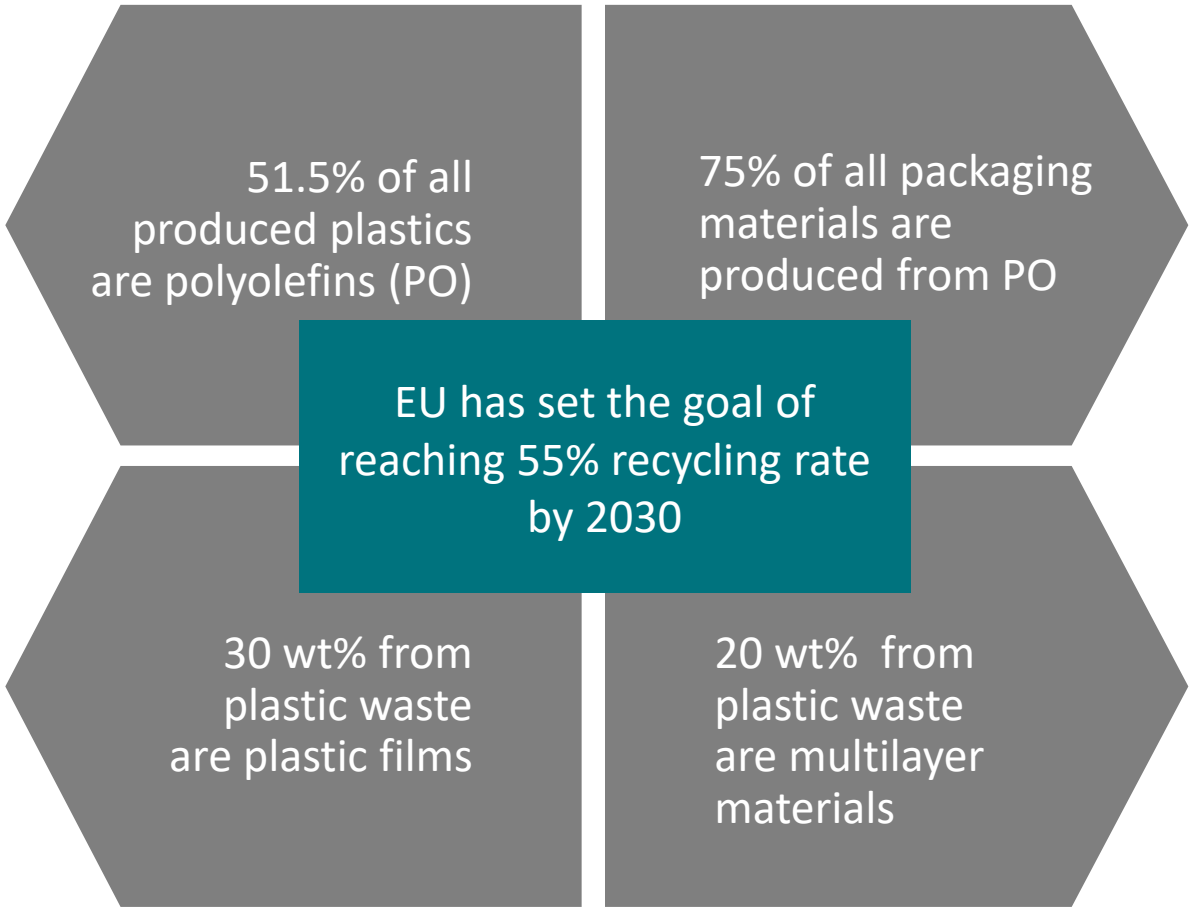
PLASTIC FILMS

Small thickenss and bulk density – leads to technical issues during conventional recycling process

MULTILAYER PLASTICS

In the recycling process presence of different polymers is lowering the purity of the input material and eventually the quality of the recycled material

Uneconomic for recycling companies



WHAT WE KNOW SO FAR?

RECYCLING OF POLYOLEFINS

MECHANICAL RECYCLING

The process can degrade the mechanical properties of plastic materials – down-cycling

Regulations prevent mechanically recycled polyolefins from being used in food contact applications.

CHEMICAL RECYCLING

Converting plastics into valuable feedstock, which can be used to produce virgin-like plastics without lowering the quality and without any restrictions on the type of applications

Giving the possibility of recycling mixed polyolefin waste, including multilayer packaging films

CHEMICAL RECYCLING

WHAT ARE THE REQUIREMENTS?

The need for high-purity input material

HOW TO REACH HIGH-PURITY?

High quality sorting of plastic waste.

The need for method for fast, on-site quality control of delivered input material.

WHICH METHOD IS SUITABLE FOR ON SITE QUALITY CONTOL?

Near-infrared (NIR) handheld device

NIR HANDHELD

Near-infrared (NIR) spectroscopy is state-of-the-art technology for waste classification and separation

NIR handheld - more flexibility and a possibility for on-site and in-field measurements.

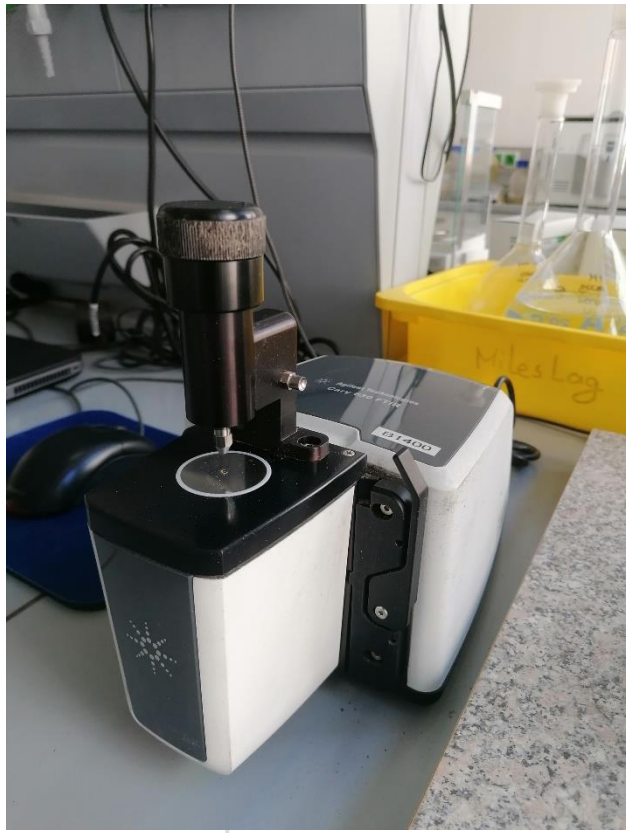
Utilization for monolayer plastic waste materials has already been proven.

Source: Packaging 360, 2023

GOAL OF THE RESEARCH

Classification of multilayer PO plastic films

Simple classification – from only one side of the sample



PET-PE

PA-PE

PE-PP

PET-PP

PO (PE-PP)

NPO (PET-PE, PA-PE, PET-PP)

Training set (70%)

Test set (30%)

FTIR (Fourier-transform-infrared) spectrosmeter

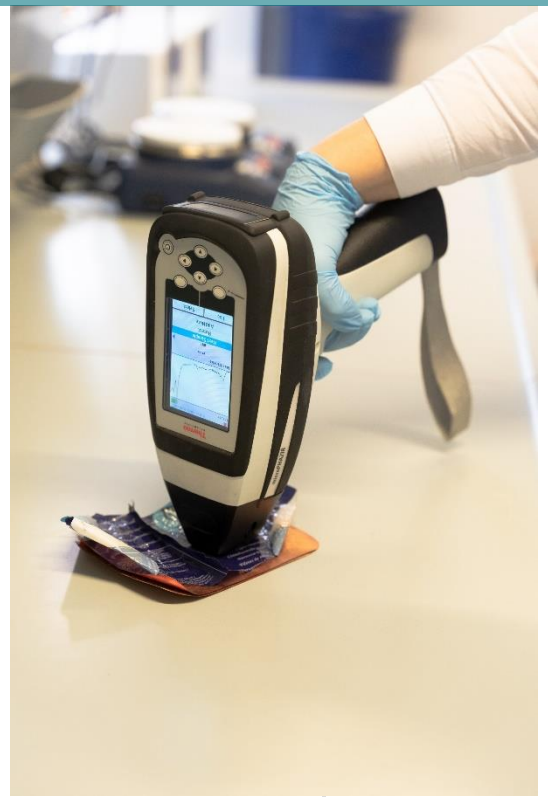
Analyse from both sides of samples

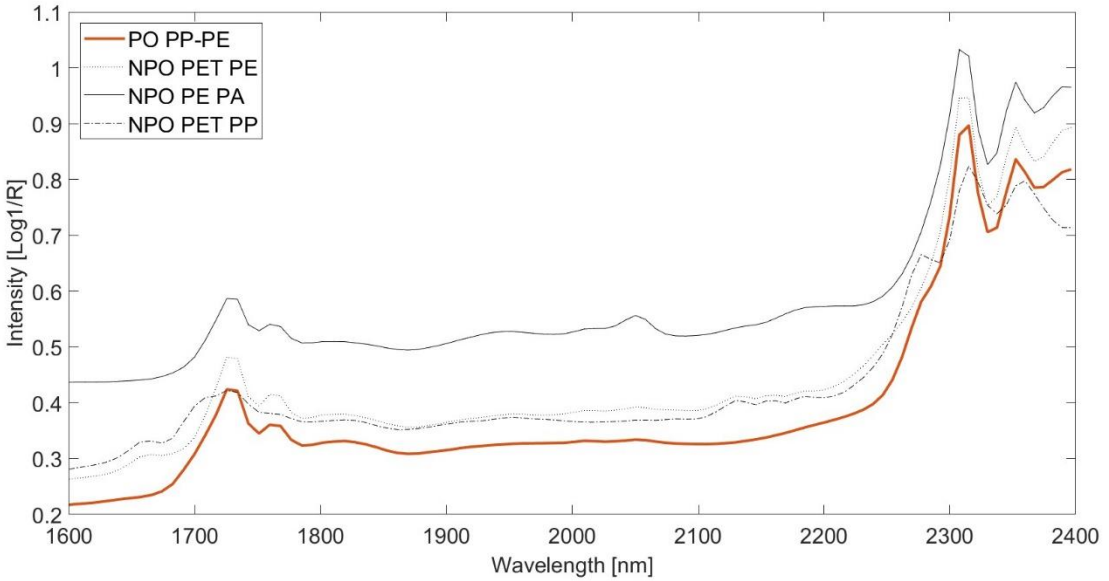
Classified fractions

Fractions split into polyolefins and non polyolefins

Additional split for further analysis

Training set



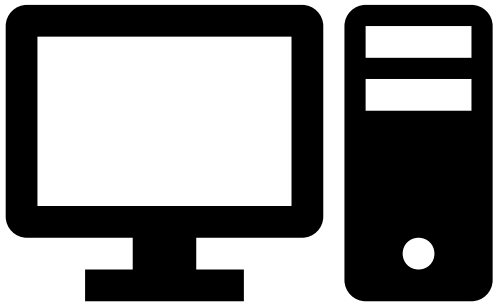


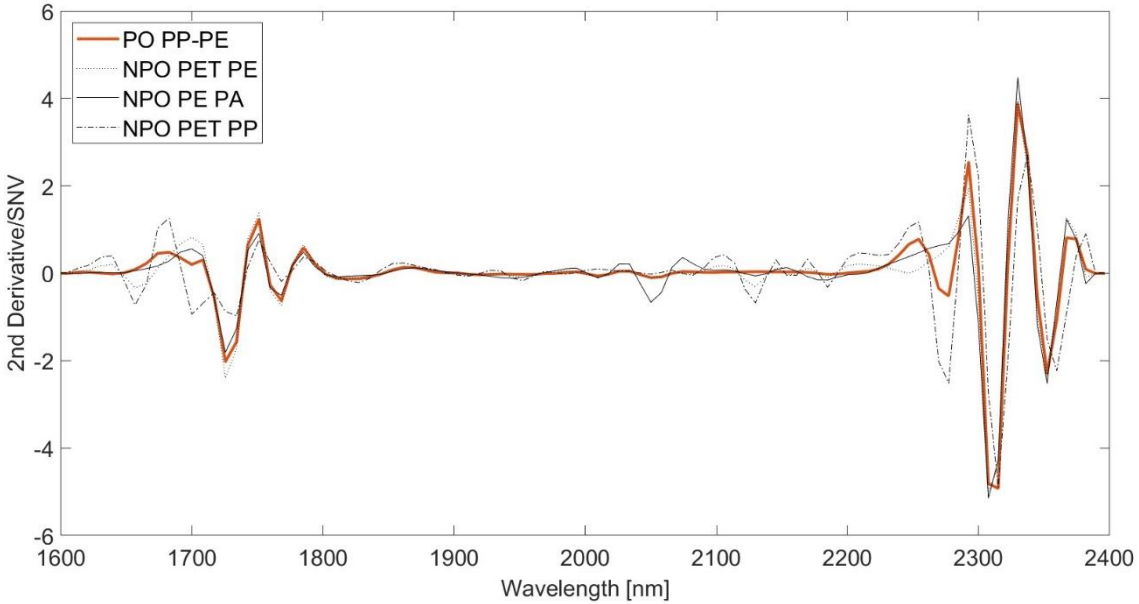
Performing measurements

Because of improving spectral quality using copper as background

Obtained raw spectra

Training set





Pre-processing

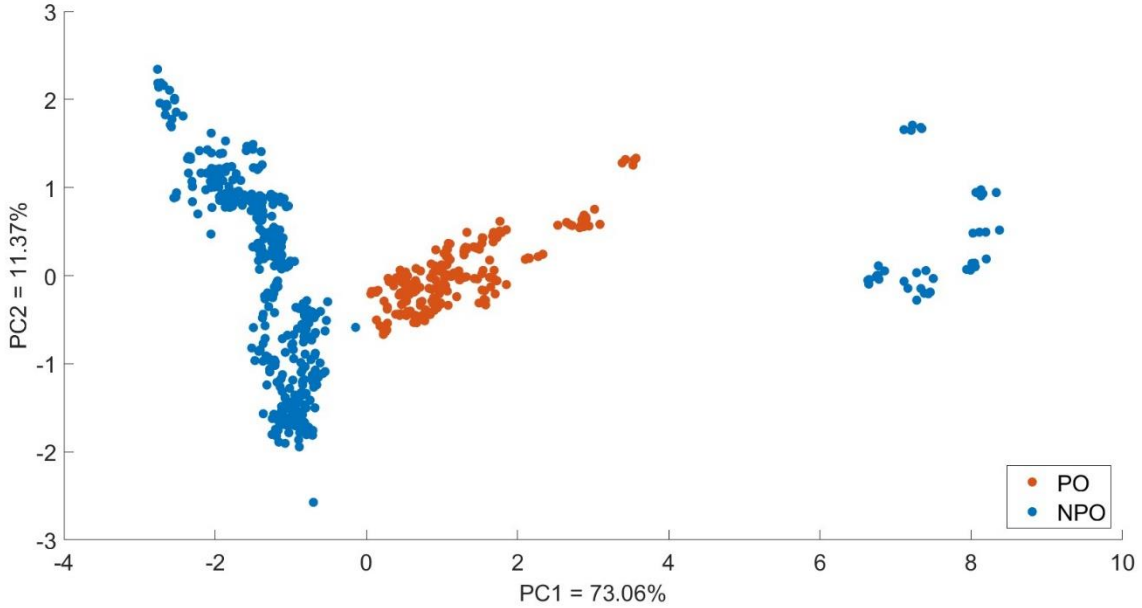
Savitzky Golay second derivate
Standard Normal Variate (SNV)

Pre-processed spectra

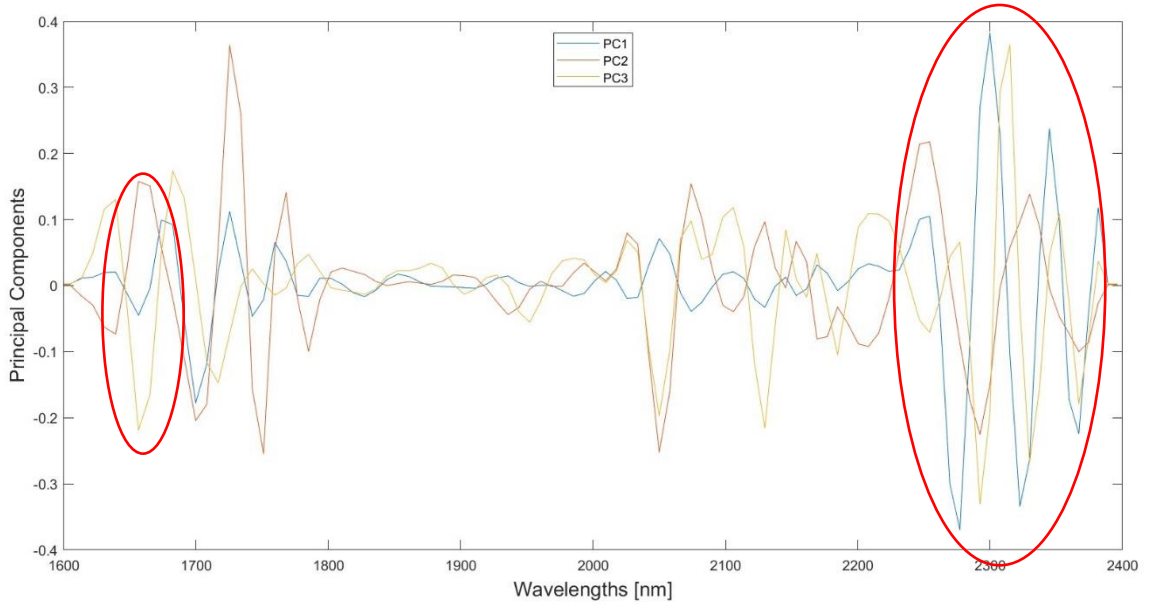
Training set

Principal component analysis (PCA)

Extracting the data information and creating a smaller set of values called principal components

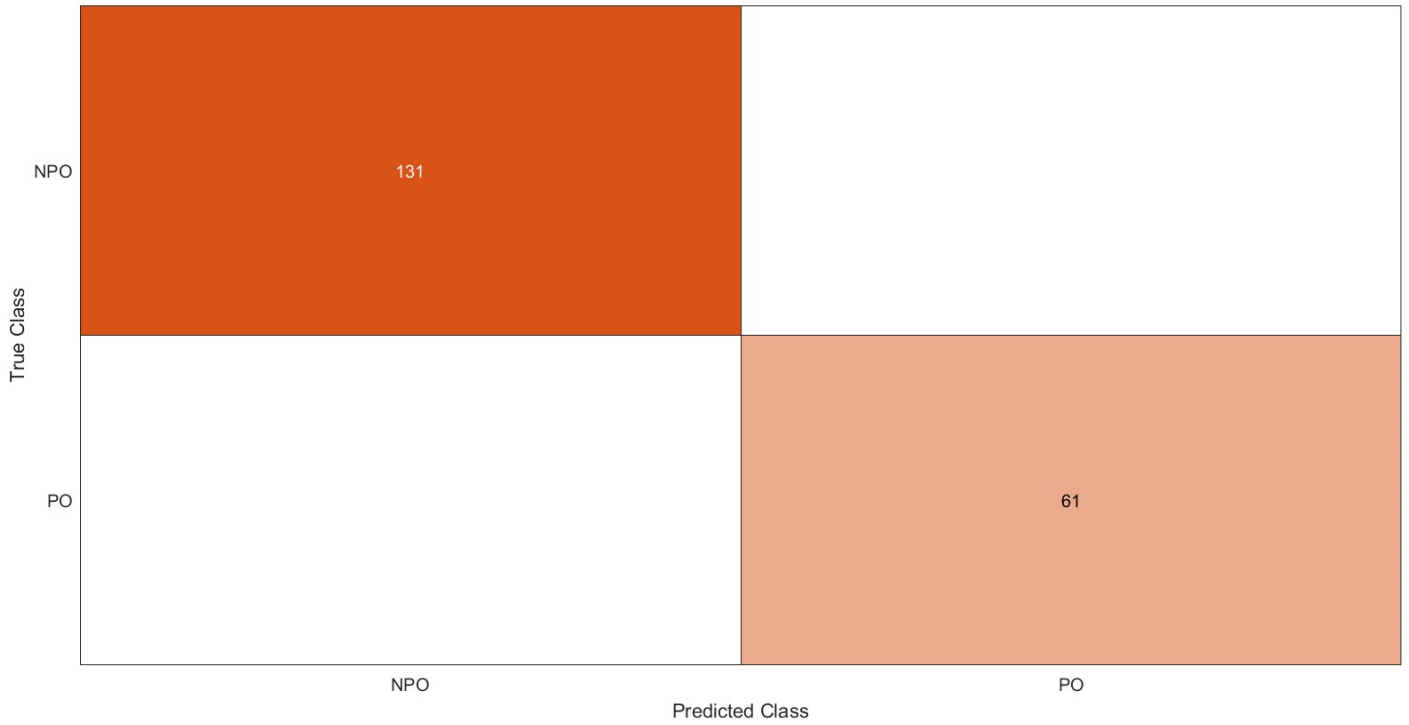


PCs displayed depending on wavelenght



Training set

k-Nearest Neighbours Algorithm (KNN Classification)

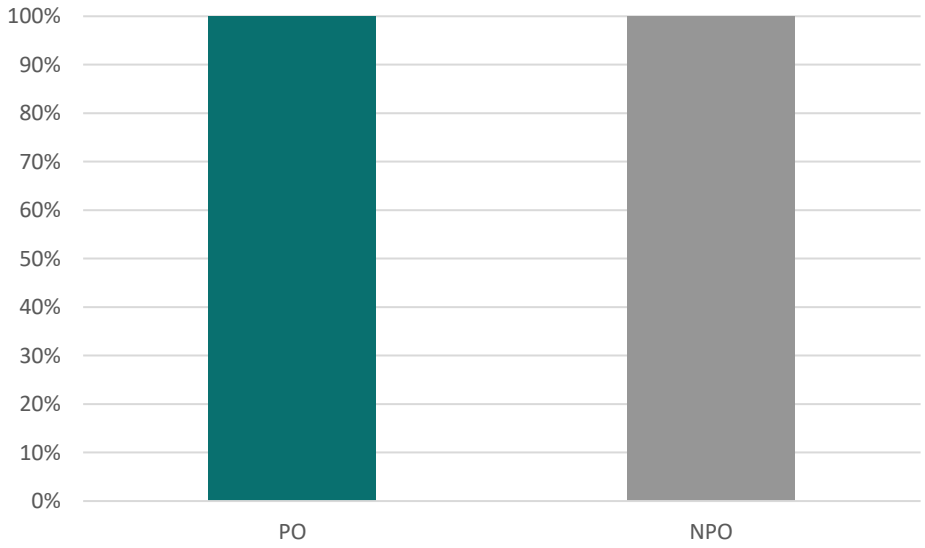


Test set

Acquired spectra of training set used to develop the test method

Using test set the method was tested

Method accuracy after testing the developed method using test set



CONCLUSION

Performed measurements with further chemometric analysis and classification proved the possibility of utilizing NIR handheld device for classification of polyolefin multilayer films

Next steps: Cross-validation

THANK YOU!

hana.stipanovic@unileoben.ac.at
+43 677 640-21350
avaw-unileoben.com