**HySpex**
by neo

Hyperspectral imaging for plastic recycling

Classifying mixed plastic waste

Plastic waste has in recent years become one of the world's biggest environmental concerns due to its wide and versatile use. More than 300 million tons of plastics is produced globally every year while as much as half of this is thrown away. In Europe, plastic waste that can enter the circular economy only accounts for 30%. This is because conventional recycling is struggling with the increasing amounts and complexity of plastic waste.

To reduce landfill or litter of plastics, there is an urgent need to develop innovative techniques to increase the recycling efficiency and lower the cost. One important aspect is to sort the different plastic types prior to re-melting as recycling of mixed plastics result in reduced quality limiting its applicability, but also the number of times it can be reused. Hyperspectral imaging has exhibited great potential in solving this problem in a time- and cost-efficient way.
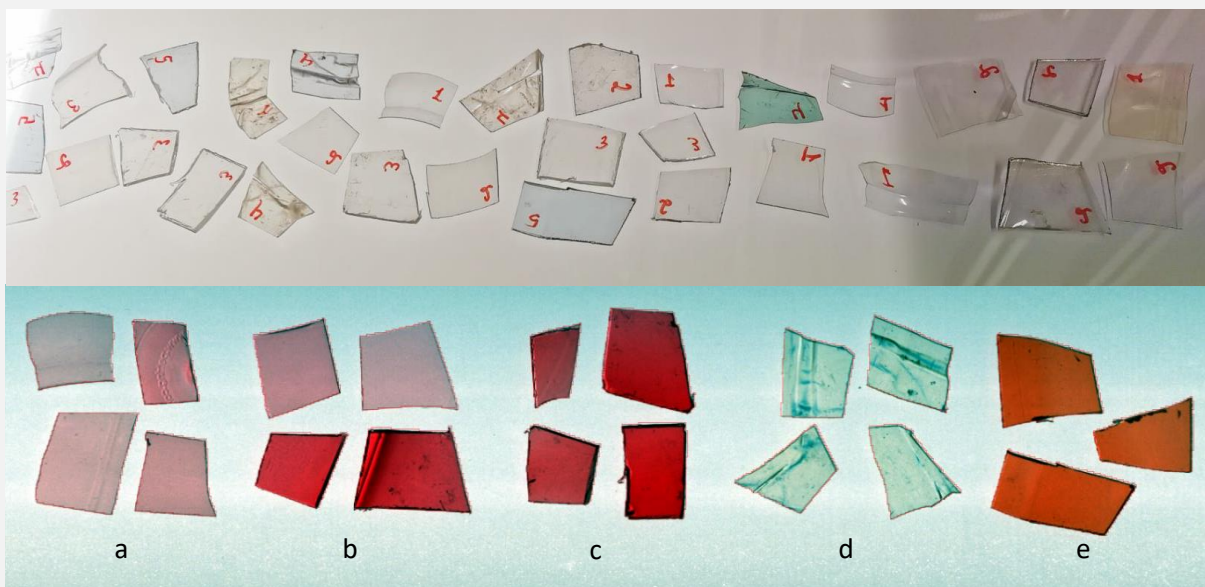

A normal RGB image of the mixed plastic waste (top) and a SWIR-based false colour image (bottom) of five types of plastic waste: PET Bottle (a), PET Sheet (b), PET G (c), PVC (d) and PC (e). The samples appear transparent in the visual range are difficult to identify accurately and repeatably by visual inspection.

In this study, five types of plastic materials were used to demonstrate the performance of HySpex hyperspectral imaging system to identify and classify mixed plastic waste. The samples including polyethylene terephthalate bottle (PET BOTTLE), polyethylene terephthalate sheet (PET SHEET), polyethylene terephthalate glycol (PET G), polyvinyl chloride (PVC), and polycarbonates (PC). PET is normally used for drink bottles, PVC for the construction of pipes, and PC for electronic components. The five different plastic types look visually similar and cannot be separated accurately based only on a normal RGB image or visual inspection.

Spectra acquisition was carried out with HySpex SWIR-384 camera (930 – 2500 nm), with spatial resolution of 60 µm and spectral resolution of 5.45 nm. The plastic samples were placed on a moving stage mimicking the movement of an industrial conveyor belt. Broadband halogen lamps were used as the illumination sources.

The acquired hyperspectral image data was analysed using the Breeze software, powered by Prediktera. A PLS-DA model for classification of the five types of plastics was built based on a small set of sample pieces of each plastic type. The model was then tested on a mix of plastics.
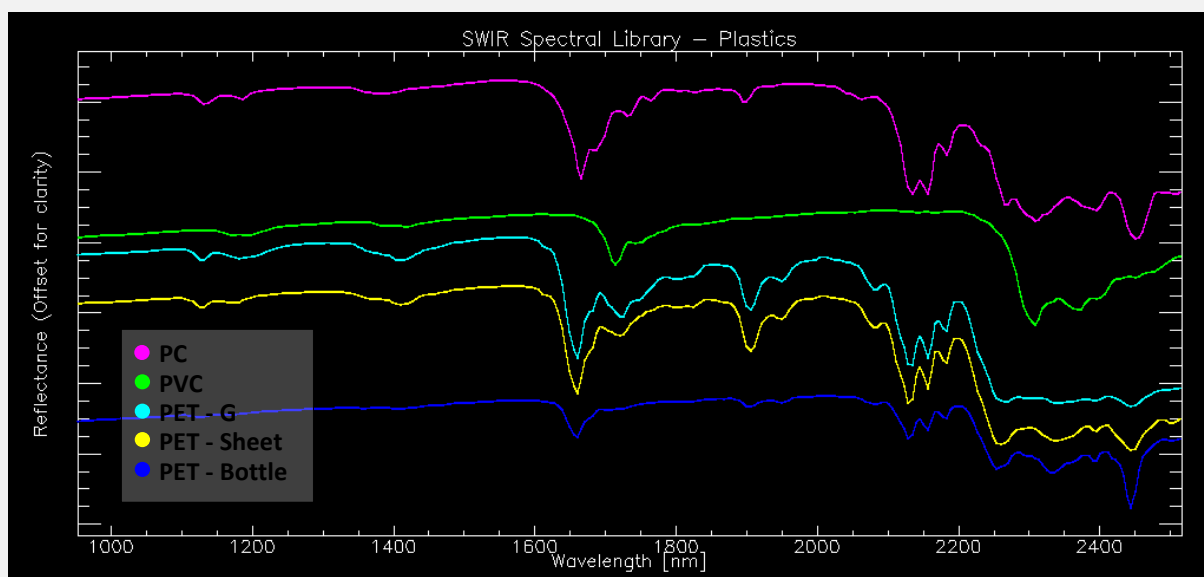
Average SWIR transmission spectra of the five different plastic materials.

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The different plastic types all have their unique spectral properties in the SWIR range (960-2500 nm), but due to their similar chemical structures, the spectral differences are small. To achieve a good separation, a high spectral resolution is therefore required. A high spatial resolution is also recommended to separate small plastic pieces at high conveyor belt speed. The HySpex cameras offer both high spectral and spatial resolution with low smile and keystone effect[**]. This allows for differentiating closely packed spectral features and pixel-size objects, respectively.

The spectral differences identified during the data analysis permitted creating a robust classification model. All plastic pieces in the mix were correctly assigned to their corresponding classes using the classification model based on the hyperspectral images.

Classification image of the five plastic types. ● **PC,** ● **PVC,** ● **PET-G,** ● **PET Sheet and** ● **PET Bottle.**
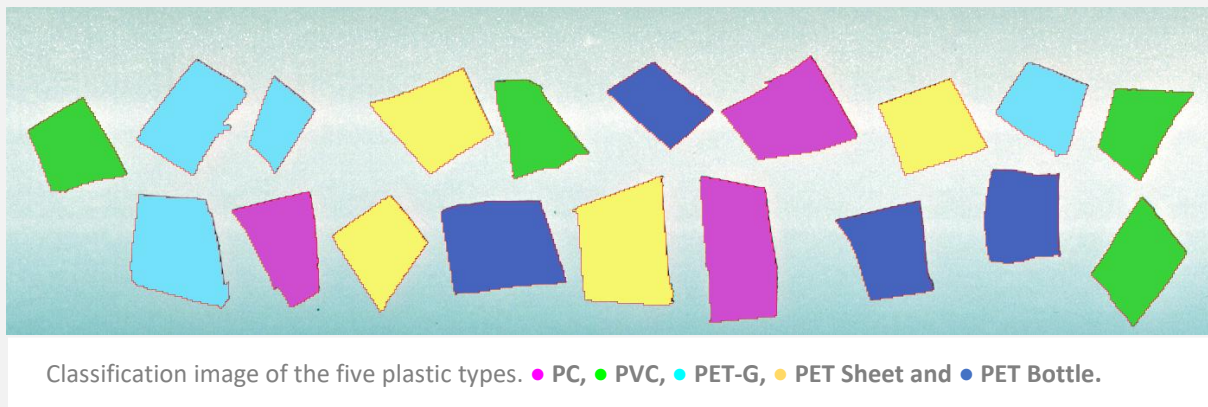
This example shows that hyperspectral imaging can be used for rapid, no-contact, real-time scanning and sorting of complex plastic samples, making it possible to improve the efficiency of the existing recycling process. This can also be expanded to the characterization, classification, and sorting of a wide range of chemical materials or waste mixtures. HySpex hyperspectral cameras in combination with Breeze software can provide high quality, customized, industrial scale, turnkey solutions to plastic industries and recycling sector. Contact us to discuss your application and requirements with our specialists.

** Spectral and spatial misregistration. Visit www.hyspex.com for technical information on high-end hyperspectral cameras.

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