End-of-life textile characterization by short-wave infrared spectroscopy

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During their lifetime, textiles have a significant negative impact on the environment. Reusing and recycling end-of-life (EoL) textiles is a successful approach to develop sustainable and circular strategies in the apparel industry. Textile reuse and recycling can help to reduce the environmental impact of the fashion and textile industry by preserving natural resources and reducing waste.

Textile fibers recognition and sorting, according to material composition, are of primary importance for the implementation of efficient and sustainable recycling strategies. In this work Short-Wave InfraRed (SWIR: 1000-2500 nm) spectroscopy was applied to extract information regarding the fabric composition of different EoL textiles. A schematic representation of the adopted procedure is reported in **Figure 1**.

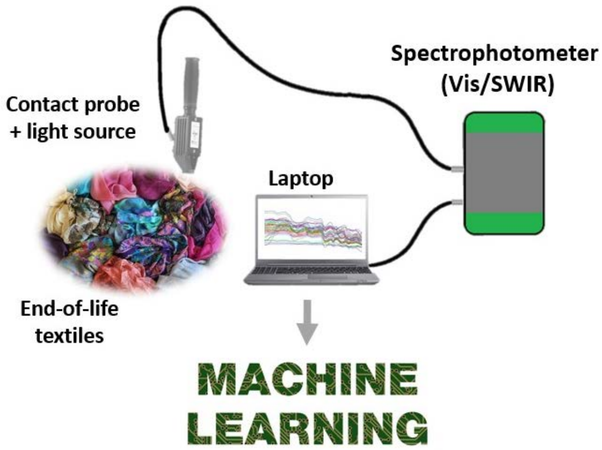

Figure 1 - Schematic representation of the SWIR spectroscopy adopted procedure.

A portable spectrophotoradiometer ASD FieldSpec4 Standard – Res spectrophotoradiometer, working in the VIS/SWIR (350-2500 nm) range, equipped with a contact probe was used to collect reflectance spectra of different fabrics. For each fabric sample, 5 reflectance spectra were randomly acquired. The instrument was calibrated before sample acquisition by referencing the dark current calibration file and by mean of the white reference measurement (i.e. standardized white Spectralon ceramic material). Data acquisition and calibration procedure were carried out using the ASD RS3 software. Collected data were analysed using the Eigenvector Research Inc. PLS_toolbox in MATLAB environment. Data was reduced to 1000-2500 nm in order to investigate the SWIR range.

Spectral data pre-processing techniques were preliminary applied both to enhance sample differences and to reduce instrument noise, scattering and other physical phenomena. An exploratory examination of spectral data was performed using Principal Component Analysis (PCA). The spectral data of the samples were classified using the pattern recognition technique Partial Least Squares-Discriminant Analysis (PLS-DA). Classifications were performed according to the material classes (i.e. silk, cotton, wool, viscose, linen, jute, polyester and blends) and to the nature of the composing fibers (i.e. vegetable-derived, animal-derived, synthetic and man-made textiles).

Textiles were correctly classified depending on their spectral characteristics using the proposed chemometric approach. Obtained results are really promising and can be considered as a valuable insight into the EoL textile recycling sector.

These analytical techniques could be used to effectively automate the recycling process, complementing or replacing manual operations and to improve sorting procedures.