Investigation on the use of laser-induced fluorescence for the recycling of black plastics

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Abstract

The proposed study was carried out to develop an efficient sorting strategy for black plastics in recycling plants, based on laser-induced fluorescence (LIF) technique. Black polymers cannot be sorted by near infrared sensors commonly utilized in recycling plants due to their low reflectance. The use of LIF was investigated as identification tool for black plastics, in order to improve their recovery, in agreement with the principles of circular economy. Four different types of plastic waste samples were chosen for the study among the most commonly found in household waste, i.e., expanded polystyrene (EPS), polystyrene (PS), polypropylene (PP) and polyethylene (PE). A punctual scanning LIF system was used on selected black plastic waste samples in the ultraviolet spectral range (270-750 nm). Fourier transform infrared spectroscopy in attenuated total reflection (FT-IR/ATR) was applied on the same samples in order to validate LIF results. Different preprocessing techniques and principal component analysis (PCA) were applied to LIF measurements for explorative purposes. A hierarchical model based on partial least squares-discriminant analysis (PLS-DA) was built on LIF data, and its performance was evaluated, showing sensitivity and specificity values in prediction phase equal to 1. Therefore, LIF technique combined with a machine learning approach showed promising results to identify EPS, PS, PP and PE samples, demonstrating the capability to distinguish different black plastics based on their fluorescence fingerprints.

Keywords: Laser-induced fluorescence (LIF), machine learning, black plastic recognition, plastic recycling.