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Potential of optical sensors for polymer type identification in e-waste recycling streams

Andréa de Lima Ribeiro[1], Margret Fuchs[1], Christian Röder[2], Nadine Schüler[3], Sandra Lorenz[1], Yang Xiao Sheng[4], Johannes Heitmann[2], Kay Dornich[3], and Richard Gloaguen[1]
[1]Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz Institute Freiberg for Resource Technology, Chemnitzer Str. 40, 09599 Freiberg, Germany (a.de-lima-ribeiro@hzdr.de)
[2]Institute of Applied Physics, Technische Universität Bergakademie Freiberg, Leipziger Str. 23, 09599 Freiberg, Germany
[3]Freiberg Instruments GmbH, Delfter Str. 6, 09599 Freiberg, Germany
[4]Geological Survey of Finland (GTK), Tutkijankatu 1, 83500 Outokumpu, Finland

Plastics are major components of waste from electrical and electronic equipment (WEEE, or e-waste) accounting for up to 25% of annual e-waste production. The composition of such plastics varies greatly according to their original function in the electrical and electronic equipment, and may include additives such as dark pigments and brominated compounds. With WEEE becoming the fastest growing waste stream in recent years, the recycling of polymers became a keystone for waste management and closing material loops. Closing the loops in material life cycles requires that type-pure plastics are obtained at the end of the recycling chain. Accordingly, the identification of polymers prior to their sorting in recycling lines is a fundamental prerequisite.

Here, we explore how an innovative combination of optical sensors can aid the identification of plastics in the plastic recycling environment in order to increase recovery rates and quality of recyclates.

We have selected 23 different polymer samples, representative of the plastic types commonly found in e-waste. We investigated the sequential use of high-speed hyperspectral imaging (HSI) and Raman spectroscopic sensors for digitalization of the waste stream and identification of polymer composition. HSI-reflectance sensors in the short-wave infrared (HSI-SWIR, Specim AisaFenix, 970 - 2500 nm) domain acquired simultaneously spatial and spectral information, allowing for mapping and initial identification of certain transparent and light-coloured polymers (PE, PP, PET, and PC). Raman measurements, collected at specific points and with integration times < 2 seconds, allowed for specific identification of all polymer samples, including black plastics. The use of both sensor technologies on conveyor belts has the potential to fully characterise the WEEE plastics stream, generating identification signals serving as input for sorting machines or simulation models. The combination of latest high-speed sensors and data processing opens many further fields of material stream characterisation and monitoring, which come with high data acquisition rates and volumes.

Consequently, a smart selection of sensors along with a tailored and learning data processing will

be key to innovations towards more complex and agile recycling processes. In this context, our multi-sensor solution focuses on a combination of advantages from HSI and Raman spectroscopy aided by efficient data integration (‘RAMSES-4-CE’ project, supported by the EU EIT Raw Materials).