ABSTRACT

In this study, a NIR-based identification system for recycling purposes of plastics from eletronic devices has been constructed and tested with 91 typical samples, such as computer housings. The system consisted of a robust NIR-spectrometer with a fast InGaAs-diode array detector, a conventional halogen lamp as light source an standard PC for signal processing. Spectra have been collected in the wavelength range between 800 and 2200 nm. Chemometric data analysis with appropriate data preprocessing (smoothing, differentiation) led to the desired distinction of the different plastic types. It was shown, that the presented system has, due to its speed, the potential of being applied to high throughput recycling streams.

INTRODUCTION

The rising production of electronic devices produces an exploding amount of electronic waste. Recycling therefore becomes more and more important. There is need for a fast, robust and reliable identification method, that allows with seperation of the different types pf polymers out of the recycling stream. Typical materials that are used for computer housings, for example, are PMMA (polymethylmethacylate), PVC (polyvinylchloride), ABS (acrylonitrilebutadiene-stryrene), PC (polycarbonates) and blends of PC/ABS.

The identification problem can be solved by NIR - spectroscopy. The combination of robust monochromators with fast detector materials allows the construction of contactless on-line identifiers, which can be attached to conveyor belts in industrial environments, allowing high-throughput recycling streams. Irradiated by NIR-radiation - as produced by halogen lamps - polymers absorb parts of the radiation. The recorded NIR - spectra show bands for every absorbing group, mainly C-H or O-H. In the wavelength area between 800 and 2200 nm only overtones and combination bands can be observed. The Polytec diode array spectrometer system with a 256 elements InGaAs detector was used. Industrially required seperation speed can be achieved since the time necessary to receive a full spectrum (800 - 2200 nm) is only 10 ms.

The spectral resolution is 10nm. The light source consists of a standard consumer 220 V / 500 W halogen lamp. The distance between sample and light source is variable, also the distance between the coupling optics and the sample. In the laboratory setup the distances were about 50cm. A fresnel lens collects the light and a standard biconvex lens guides it into a 400µm quartz fibre.

An advantage of this particular approach is cost reduction due to a recently developed fast hight-throughput optical multiplexer. In combination with this optical multiplexer, a single spectral unit could serve up to eight dissamssembly lines. The industrial suitabilily has already been demonstated by successfully integrating the whole scheme into a sorting plant for household plastics.

CONCLUSION

NIR - spectroscopy is shown to be a powerful tool for a very fast and incomplicated identification of different types of plastics such as used in electronic devices. With automatization of the measurement and classification system, by implementing a multiplexer and using conveyor belts for sample presentation, a large amount of plastics can be separated in a time.

NIR - spectroscopy is not dependent on the sample colour; only black samples cannot be identified, becouse carbon black is a strong absorber in the NIR region, which results in featureless spectra. The distinction between ABS, PA, PET, PBT, POM, PVC, PP and PMMA is performed by aid of principal component analysis.