VERSATILE WASTE PLASTIC IDENTIFIER
BASED ON RAMAN SPECTROSCOPY FOR MATERIAL RECYCLE

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Abstract

Various techniques have been introduced for plastic recycling, but no versatile techniques is available at the moment. We have been approaching this problem using Raman Spectroscopy. It is a technique of molecular structure analysis, similar to IR absorption. The Raman spectroscopy is not affected from water so we could adapt it to wet plastics, and its sharp peaks make easy to gain signal-to-noise ratio which enable us definite identification unlike NIR technique. Those features of Raman spectroscopy works well when it comes to industrial uses. On this paper, we introduce the portable plastic identifier we have developed and demonstrate applications to wet surface conditions, identifications of similar or black plastics and detections of RoHS restricted substance and additives.

Keywords: *Plastic recycling, Material Recycling, Raman spectroscopy, Black-color plastics, RoHS restricted substances*

1. Introduction

Raman spectroscopy apparatus is known to have high price until recently, therefore, this technology was not available for industrial field. However, The rapid development in the telecommunication system is making the price of optical components and laser diode lower. As the equipment price decrease, the industrial use of this technique also begins to take place. Our group applies this technique for plastic recycling, and we are successfully demonstrated the accuracy and performance in the material recycle of shredder dust coming from Japanese household electric home appliance recycling plant [1,2].

In the ordinary plastic recycling plant, identification of plastics is done by touched feeling and observing the frame when it ignite with lighter for cigarette. This technique is simple and easy to use, on the other hand, you need experience, and the accuracy is not good even with experienced person. This is because, similar material is commonly existed and additives in plastics make it harder to analyze. In the material recycle, even the similar materials causes problem. Therefore, we need molecular structural analysis in the plastic recycling.

As the tool used in the industrial environment, it should have following feature;
1. easy to use, and quick response,
2. able to work with any color, water or dust on the surface,
4. able to work with bended or scrunched surface condition,
5. able to detect bromine compound restricted by RoHS.

On this paper we demonstrate possibility of Raman spectroscopy in industrial plastic recycling by using newly-developed plastic identifier.

2. Materials and Methods

In this experiment, we use portable Raman plastic identifier developed by Saimu Corporation. Real waste plastics as test samples are collected from a local plastic recycling plant.

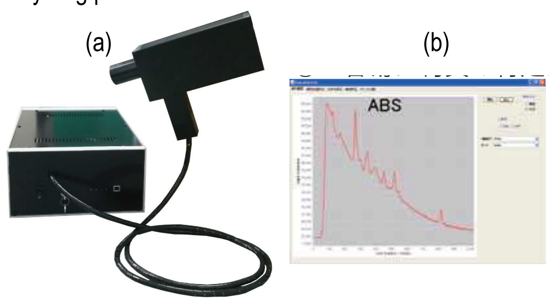
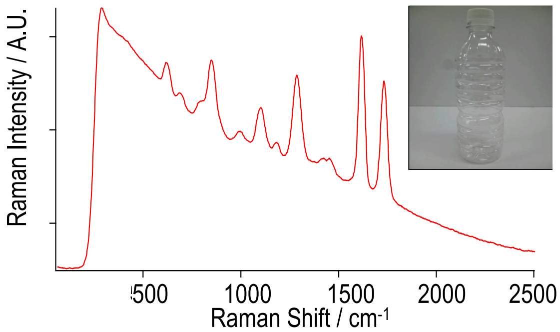


Figure 1: (a) Portable Raman Plastic Identifier, (b) software which displays a measured Raman spectrum and determined material name.

3. Results and Discussion

In this section, used PET Bottle is measured with Raman Plastic Identifier. Then, PS, HIPS and AS is scanned as for example of similar plastics. And, DeBDE and TBBA mixed with PP are measured to show the detection of RoHS restricted substance. At last, determination of black waste plastics is demonstrated.



Fgure 2: Raman spectrum of wet PET bottle.

Figure 2 shows a Raman spectrum of a wet PET bottle. The Plastic Identifier display on the software shows the material name is PET resulting from the peak analysis in figure 2. It is done by seeking at unique peak at 1600cm^{-1} and 1700cm^{-1}. Peak at 1600cm^{-1} is coming from Benzene structure and peak at 1700cm^{-1} is the signal coming from ester bonding.

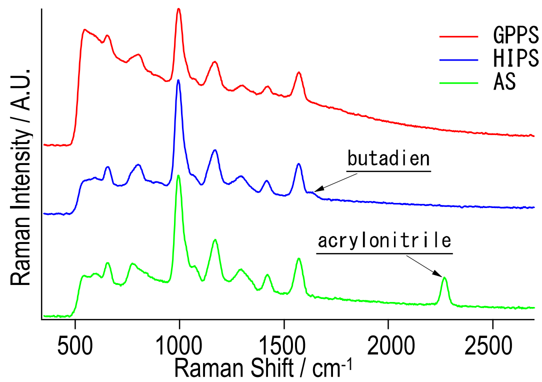


Figure 3: Identification of similar type of plastics.

Figure 3 shows Raman spectra of general purpose polystyrene (GPPS), high impact polystyrene(HIPS), and acrylonitrile polystyrene (AS). It is possible to differentiate by looking at peak coming from butadiene and acrylonitrile. It also possible to estimate component fractions in composite materials by further analysis.

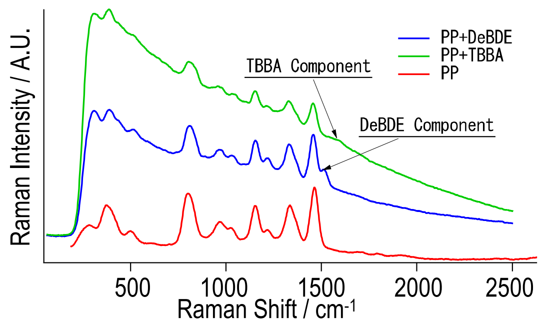


Figure 4: Identification of bromine compounds on PP

Figure 4 shows Raman spectra of polypropylene (PP) and PP with deca-brominated diphenyl ethers (DeBDE), PP with tetrabromobisphenol A (TBBA). By seeking the peak originated in added substance. It is possible to detect RoHS restricted substances and other additives as well.

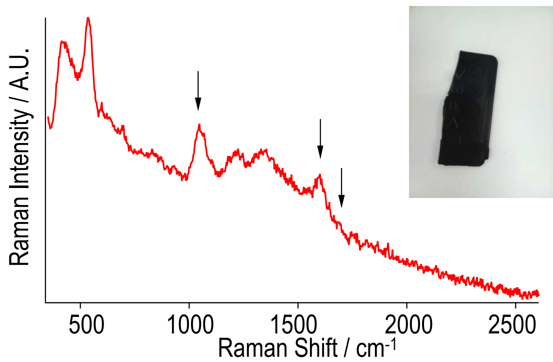
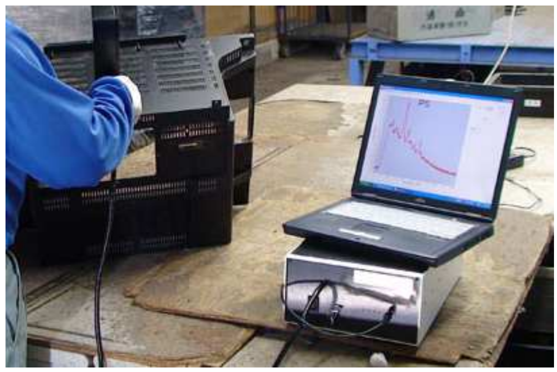


Figure 5: Identification of black plastic.

Figure 5 shows a Raman spectrum of a piece of black plastic. The software shows the material is HIPS. The pointing peaks could be used for the identification of black plastic.

4. Conclusions

We successfully demonstrate the versatile application in the industrial plastic recycling by using the Raman identifier developed. It is commercially available at this time.



References

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