CHEMICAL RECYCLING OF ELECTRONIC DEVICES COMPOSED OF THERMOSETTING RESIN AND INORGANIC COMPOUNDS

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Abstract

It is not easy to recover organic and inorganic compounds from waste electronic devices because valuable materials of them were covered and protected by thermosetting resin such as phenol resin. In this study, we have carried out the decomposition reaction of thermosetting resin in supercritical liquid such as high-temperature water and high-temperature alcohol.

Keywords: *electronic device, IC package, supercritical water, supercritical alcohol, thermosetting resin*

1. Introduction

Recently, it is a big social trouble to increase waste matter such as plastic materials and electronic device, to decrease final disposal site. Effective recycling process of waste compounds is desired. Especially, thermosetting resin can not be applied to material recycling like thermoplastic resin by heating or remolding. It is necessary to replace reclamation and direct burning as polite resource management.

In the other sense, supercritical water has been received more and more attention as a medium for chemical reaction, because supercritical water has low dielectric constant and behaves similar to organic solvents having high thermal stability [1,2].

We have already confirmed that waste plastics such as phenol resin decompose into their monomeric compounds in sub and supercritical water.

In this study, to obtain information on decomposition reaction of IC package contained in electronic device to recover organic and inorganic materials by using super critical liquid only.

2. Materials and Methods

Decomposition reactions in high-temperature water were carried out with IC package by using 10mL tubing bomb reactor. The reaction was carried out at prescribed temperature and time. After decomposition reaction, solid residuum was dried, and analyzed by SEM and EDS. The liquid product was extracted with organic solvents and identified by GC/MS and quantified by GC with a flame ionization detector (FID).

3. Results and Discussion

Fig.1 shows the raw material, and decomposition products of IC package after the reaction. Compared to direct heating IC package and decomposition IC package in water, there is no change in appearance. However, in the case of shocked IC package after the reaction for 2h in water 2.0mL , it can be broken easily. It was difficult to break the raw and direct heating IC package by shocking the same level power. It was considered that the impact resistance of the IC package reduced.Organic part of IC package was resolved. Furthermore, it is confirmed that physical proportion like used high-temperature alcohol by CO_2 addition in water 2.0mL at 350ºC [3]. However, chemical change such as increase decomposition product can't be observed.

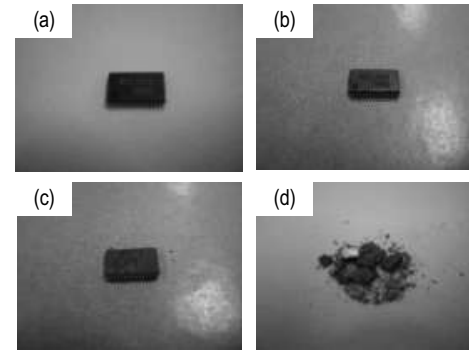

Fig.1. Photographs of (a) raw IC package, decomposition products of IC package after the reaction for 2h (b) direct heating at 400ºC. (c) in water 2.0mL at 350ºC, (d) in water 2.0mL adding CO_2 0.5g at 350ºC.

When ether extraction, extraction ratio improved that physical changed IC package irrigate and recover by diethylether. GC/MS chromatograms shows that bis(2-ethylhexyl) phthalate used as plasticizer was recovered as shown in Fig.2.

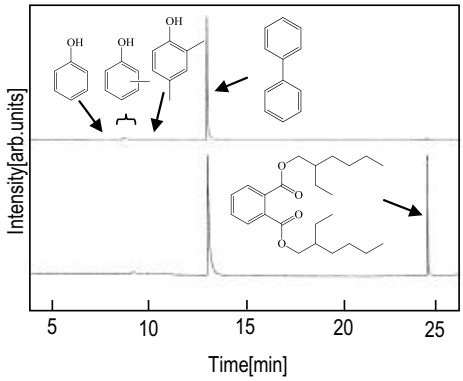

Fig.2. GC/MS chromatograms of the decomposition reaction products of IC package for 2h (a) in water 2.0mL at 350ºC and (b) in water 2.0mL adding CO_2 0.5g at 350ºC.

SEM image and EDS patterns suggest the presence of C, Cu, O, Si, Sn and S on metal surface. Fig.3 shows EDS pattern. After the reaction, Sn was removed and Cu and Si increased. It is considered that coated Sn detached, Cu exposed by high-temperature water treatment.

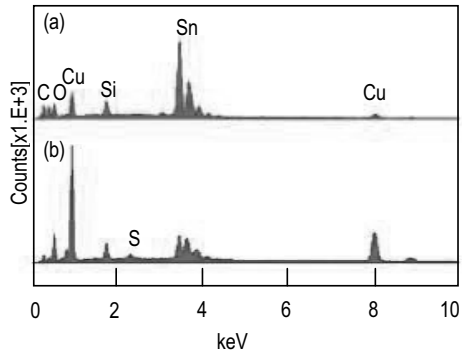

Fig.3. EDS pattern of (a) raw material, (b) decomposition products of IC package after the reaction for 4h in water 3.0mL at 350ºC.

4. Conclusions

IC package composed of thermosetting resin and inorganic material solubilized in high-temperature water. By adding CO_2, confirmed physical change on condition that lower temperature compared with only water. However, chemical change can't be observed.

References

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