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The possibility of recycling of multilayer packaging waste: Reducing Environmental impacts

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Abstract

Multilayer Packaging Waste (MPW) represents the largest fraction of packaging waste and is mainly composed of multiple plastic films laminated with Al foil (Ec.europa.eu. (2018). Packaging waste statistics). The most produced multilayer film is based on the different polymers, such as polyester (PET), polypropylene (PP), and polyethylene (PE) as main components, and an aluminum layer (European Commission JRC Technical reports). According to Eurostat Statistics Explained, the amount of packaging waste generated in the EU between 2007 and 2016 was estimated at 79 ± 1.25 million ton per year. Because of that, this type of waste is difficulty recyclable, its representative one of the biggest polluter in the environment. Research aims were to recover valuable materials from MPW in order to reduce the waste stream and reduce environmental pollution.

Keywords: Plastic; Environment Pollution; Recyclability Al

1. Introduction

During the last 50 years, plastic has become the main material taking over other materials and being part of the day a day in modern society (EllenMcArthurFoundation (2016)). Nowadays everyone and mostly every activity involve the use of plastic, there are a considerable number of plastics available and due to their lightness, versatility and price different markets have been adapting their products and incorporating plastics as part of their designs (European Strategy for Plastic in a Circular Economy (2018)). On the other hand, in food packaging, plastic helps to ensure food safety as well as reduce the carbon footprint that results from transporting heavier materials. This type of packaging is usually referred to as "multilayer flexible packaging" (MFP) and represents 17% of all produced packaging films (J. R. Wagner; C. F. Stroller at all; Driving circular economy in ASIA; K. Kaiser at all.) The structure of such MFP normally includes one or more adhesive layers and printing layers. Currently, MFP is widely used for the preservation and distribution of food, beverages, pharmaceuticals, and other consumable products; the plastic packaging used for this purpose represents 40% of the total production of plastic in the EU and requires more than 19 million tons of oil and gas to produce, with an estimated annual increase of 5–7% (Flexible Plastic Packaging Market by Type - Global Forecast to 2022; Plastics Europe Plastics – The Facts 2016). At the end of its shelf-life, MFP becomes waste, but crucially with poor recyclability due to its complex structure, and therefore most of these bulk materials are processed either in sanitary landfills or by incineration or thrown away into the ocean ((Fig.1).

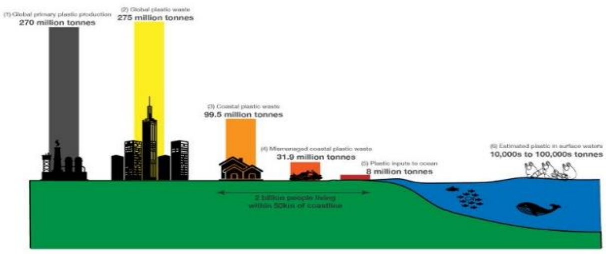


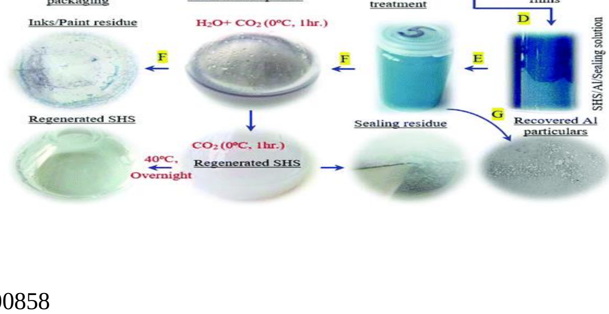
Figure 1. The number of Plastics which enters in the World's Ocean (2010). Recourses: Data based on Jambeck et al. (2015) and Eriksen et al. (2014).

2. Experimental

2.1 Materials and Methods

For the current research, three samples of multilayer packaging materials were selected from food and medicines packaging (candy wraps, chocolate/chips pack and blister packaging) for the laboratory experiment which was produced by local shops and pharmacy in Lithuania; Chemicals: Concentrated Nitric Acid and Sulfuric Acid. Energy consumption, emission, and waste generation were maximally avoided during the experiment. The waste separation process is shown on the scheme (Fig. 2). [T. Mumladze at all. Samy Yousef at all.]

Figure 2. Schematic flowchart of multilayer flexible packaging waste separation.



3. Recovered Material Characterizations

Fourier transform infrared spectroscopy (FTIR, Vertex70 spectrometer) was used to analyze and identify the chemical compounds of the recovered polymers and the regenerated DMCHA. Additionally, scanning electron microscopy (SEM; model BPI-T) and energy-dispersive X-ray spectroscopy (EDS) was used to investigate the chemical composition of the recovered metal layers. Finally, thermogravimetric analysis (TGA-DTG; model TGA Q500 supplied by TA instruments) was used to check the thermal stability and glass transition temperature of the polymers recovered from the samples.

4. Results and Discussion

The experiment was carried out in the following conditions: The volume of used acids 50-100 ml; Time 5-10 Minutes; The temperature is 0 °C; Mechanical stirring ≈300 rpm; After 10 minutes of experimentation, the first layer of polymer separated without heating and mixing. In order to accelerate the process, magnetic stirrer and heating were used. After that, it became noticeable that the samples had at least three polymers and one-layer Aluminum. The results of the experiment are shown in

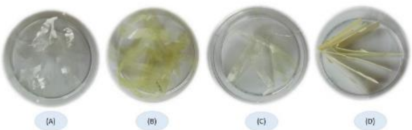


Fig. 3; Fig. 4 and Fig. 5.

Figure 3. and **Figure 4.** Materials recovered from Pharmaceutical Blister Packaging.

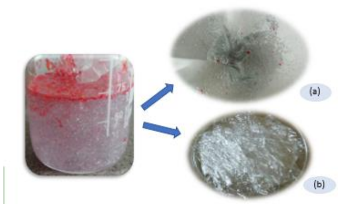


Figure 5. Recovered Al powder (a) and Polymer (b) from candy wraps.

5. Conclusion

The study has shown that the multilayer packaging materials waste can be processed in an environmentally safe and economically favorable way. During the experiment, there was a small loss of materials, and finally, the processing rate was increased. The experiment was 100% successful for blister packaging materials, and for the rest of the samples from 50% to 70%. Because of the rest waste materials are nor recyclable, it is possible to use it for energy production. Waste is treated almost 100%. After recycling, it is possible to regenerate of solvents and can be reused again.

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