doi:10.1017/S1431927622003130
Microsc. Microanal. 28 (Suppl 1), 2022

Microscopic Characterisation of the Effect of Low Temperature Oxygen Plasma Treatment on Recycled Polyethylene Terephthalate (Pet)

Gautam Chandrasekhar[1], Vijaya Rangari[1*]

[1.]Department of Materials Science and Engineering, Tuskegee University, Tuskegee, USA.
[*]Corresponding author: vrangari@tuskegee.edu

One of the major challenges that humankind is facing nowadays is waste management and dependency on fossil fuels. To address these issue researchers are developing techniques to either develop materials from sustainable resources, or modify existing materials with sustainable processes. The materials thus developed can be utilized in the field of composites, energy storage and tissue engineering [1-4]. Plastic industry generates a lot of waste, according to a survey conducted by Plastics Europe, the total amount of plastics produced in the world in 2021 was 367 million tons. Plastics which take hundreds of years to degrade are better recycled or upcycled rather than being dumped in landfills [5].

Among the common thermoplastic polymers, Polyethylene Terephthalate (PET) is a widely used polymer because of its high tensile strength, excellent chemical resistance, light weight, elasticity, and stability at elevated temperatures. Polyethylene Terephthalate is a resin of the polyester family formed by the esterification of ethylene glycol with terephthalic acid or dimethyl terephthalate. PET is widely used to manufacture synthetic fibers (about 60%) and bottles (about 40%). Since PET bottles are a major source of plastic waste, it is important to recycle or upcycle it. Instead of simply dumping the PET bottles, it can be used for other applications by modifying their basic characteristics. One of the methods for surface modifications of PET bottles is oxygen plasma treatment [6].

Upon surface modifications, materials with low surface energies and chemical reactivity are found to demonstrate good interactions with other materials [7]. In this research, oxygen plasma treatment was employed for surface modifications of recycled PET films. Plasma surface modifications such as etching, and surface functionalization depend on numerous factors such as power source type, working gas used, design of the plasma chamber, position of electrodes, radio frequencies and duration of the treatment [8-9].

In this research, used PET water bottles are cleaned and shredded into small PET films. Shredded PET films are then subjected to oxygen plasma treatment for durations of 10 minutes and 20 minutes. Low temperature plasma surface modifications were performed in a PE-100 equipment from Plasma Etch. The chamber pressure was 0.1 Torr and radiofrequency power (RF) of 150 W generated at a standard frequency of 13.5 MHz. The flow of oxygen was maintained at a constant flow rate of 30 ccm. Effects of plasma treatment are analyzed by using scanning electron microscopy (SEM) using JOEL JSM-7200F.

SEM characterization of the plasma treated shredded PET films revealed that the etching on the neat PET films increases upon exposure to the Oxygen plasma treatment. Also, it was found that the etching on the PET films is increasing proportionally with the duration of the oxygen plasma treatment. Further characteristics and effect of etching on other properties of the polymer are under investigation.

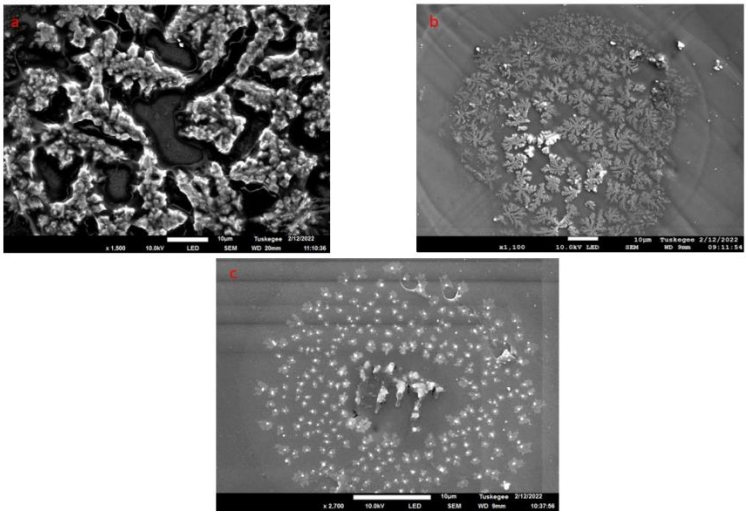

Figure 1. SEM Micrograph of the shredded PET films (a) Neat, (b) 10-Minute oxygen plasma treated, and (c) 20-Minute oxygen plasma treated.

References:

[1] Okoro, Chinedu, et al. "Plasticizing effect of biodegradable dipropylene glycol bibenzoate and epoxidized linseed oil on diglycidyl ether of bisphenol A based epoxy resin." *Journal of Applied Polymer Science* 138.28 (2021): 50661.
[2] Mohammed, Zaheeruddin, Shaik Jeelani, and Vijaya Rangari. "Effective reinforcement of engineered sustainable biochar carbon for 3D printed polypropylene biocomposites." *Composites Part C: Open Access* 7 (2022): 100221.
[3] Idrees, Mohanad, et al. "3D printed supercapacitor using porous carbon derived from packaging waste." *Additive Manufacturing* 36 (2020): 101525.
[4] Hembrick-Holloman, Vincent, et al. "Ecofriendly production of bioactive tissue engineering scaffolds derived from egg-and sea-shells." *Journal of Materials Research and Technology* 9.6 (2020): 13729-13739.
[5] Plasticseurope.org, https://plasticseurope.org/knowledge-hub/plastics-the-facts-2021/ (February 11th, 2022)
[6] L.D. Poulikakos et al., Resources, Conservation and Recycling **116** (2017), p. 34.
[7] Mohammed, Zaheeruddin, Shaik Jeelani, and Vijaya Rangari. "Low temperature plasma treatment of rice husk derived hybrid silica/carbon biochar using different gas sources." *Materials Letters* 292 (2021): 129678.
[8] Mrsic, et al. Applied Surface Science **536** (2021) 147782, p. 1, 2.
[9] Mohammed, Zaheeruddin, Shaik Jeelani, and Vijaya Rangari. "Effect of low-temperature plasma treatment on surface modification of polycaprolactone pellets and thermal properties of extruded filaments." *JOM* 72.4 (2020): 1523-1532.

https://doi.org/10.1017/S1431927622003130 Published online by Cambridge University Press