

Behavior of polyethylene films in soil

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Introduction

Plastics waste is a major environmental problem. One of the solutions to remove throwaway plastic products is making them biodegradable. In spite of the expansion of plastics recycling, yet much polyolefin-based plastics end up in landfill. What happens to the deposited polyolefin-based plastic bags? This is the subject of this presentation.

Experimental

Bags out of the plastic films (6 x 10 cm) were made and the experiment was set with 12 repetitions for monthly sampling. The plastic bags were filled with soil and placed in a beaker containing soil, thus the plastic bags were surrounded by soil. Measuring electrodes were put into the soil that was in the plastic bag, and into the soil that surrounded the plastic bag. The beakers were placed in plastic boxes with previously set moisture content, and aerated on a regular basis. Virgin middle density polyethylene (MDPE) film, MDPE films containing pro-oxidant and thermoplastic starch and a commercially available biodegradable film were monitored in soil monthly for one year. Conductivity and capacity of the soil, visual, mechanical (Instron), structural (FTIR, ESR) and morphological (POM, SEM) changes in the films were tested. The soil used for the investigations was brown forest soil originated from Gödöllő-Száritópuszta.

Setup of the experiments

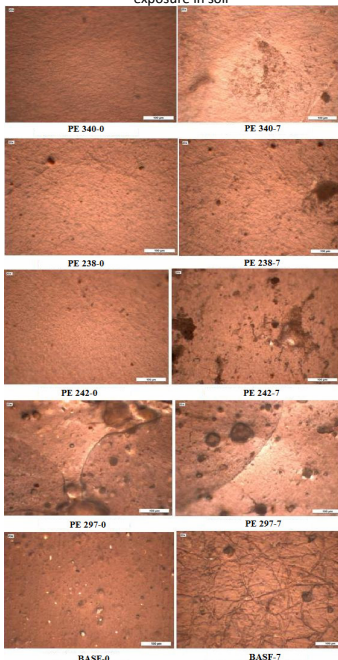


Tested PE samples	Composition
PE 340	FS 340-03 middle density polyethylene, MDPE (TVK)
PE 238	MDPE + pro-oxidant (Fe 0,072 %, Co 0,015 %, Zr 0,031 %, Mn 0,006 %, total metal content 0,124 %) (BME-Qualchem Zrt)
PE 242	MDPE + pro-oxidant (Fe 0,051 %, Co 0,025 %, Zr 0,024 %, Mn 0,044 % - total metal content 0,144 %) (BME-Qualchem Zrt)
PE 297	MDPE + 8,75% thermoplastic starch + pro-oxidant (Mn 0,0103 %, Co 0,0094 %, total metal content 0,0197 %) (BME-Qualchem Zrt)
BASF	polyester + polylactic acid blend (Ecovio - BASF)

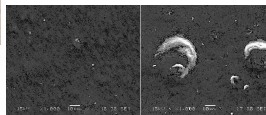
Results and discussion

Based on the capacity and conductivity measurements among the MDPE films the thermoplastic starch containing film decayed the most. The smallest change showed the pure polyethylene film. The BASF film degraded the most in the soil. This was supported by the visual appearance, POM and SEM investigations of the films, by the change in thickness and in the mechanical properties.

POM images of the films before and after 7 month exposure in soil



SEM images of PE 297 film before and after 7 month exposure in soil



Polarization microscopy and SEM did not reveal much change in the morphology of the films buried in soil except the thermoplastic starch-containing film, in which holes could be detected. On the image of BASF film thready structure could be seen, which may be due to fungus formation.

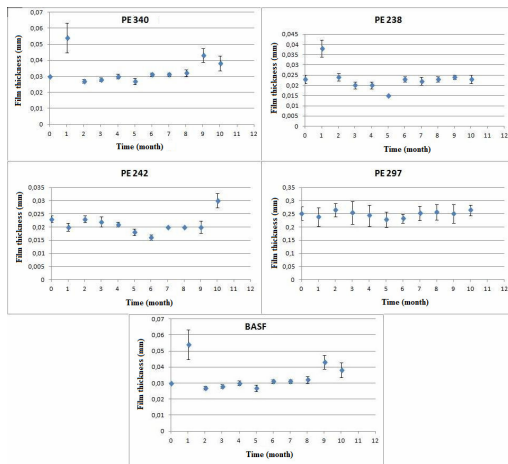
Conclusions

The polyethylene-based films suffered pure degradation in soil compared to the biodegradable one. Films containing pro-oxidative additives slightly changed after the experiment, since UV light and oxygen was lacking.

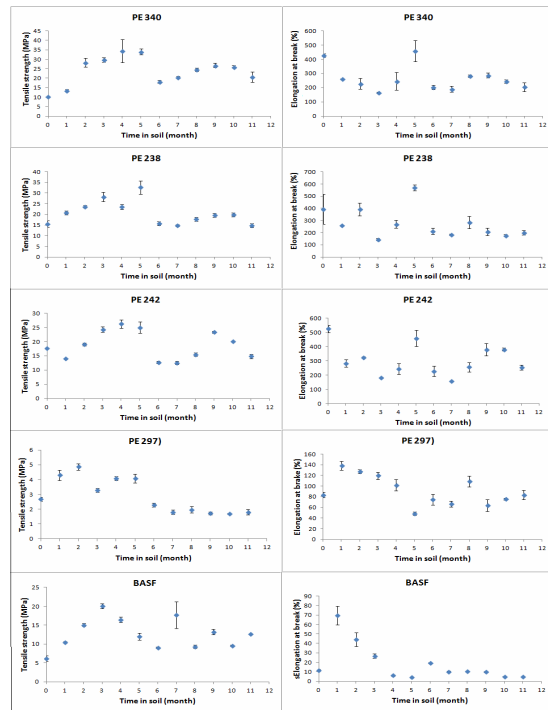
Acknowledgement

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Increase in film thickness with the elapse in time may be due to biofilm formation.



Significant change in mechanical properties of the films buried in soil was observed only in the biodegradable BASF film.



Decrease in molecular mass could be detected in samples 238 and 297 containing pro-oxidant and thermoplastic starch, polydispersity however changed in all polyethylene-based samples. This refers to initial degradation, although this may not be biodegradation. Films in which the molecular mass increased after 11 months in soil might have suffered cross-linking. This may also be the sign of starting degradation.

Tested film	Mw	Mn	Pd
PE 340-0	120765	13320	9,066
PE 340-11 months	128844	15887	8,110
PE 238-0	126108	9831	12,827
PE 238-11 months	36420	5925	6,114
PE 242-0	107019	4960	21,572
PE 242-11 months	113092	3319	34,072
PE 297-0	128770	10274	12,533
PE 297-11 months	117404	6895	17,026