Behavior of polyethylene films in soil

**Tamás Heffner[1], Gabriella Réthháti[2], Krisztina Pogácsás[2], László Korecz[3], Zsolt László[4]
Imre Czinkota[2], László Tolner[2], Ottó Kelemen[5], Viktória Vargha[1]**

[1]*Budapest University of Technology and Economics, Department of Physical Chemistry and Materials Science, H-1111 Budapest, Műegyetem rkp. 3-9. e-mail: heffnertomi@gmail.com, vvargha@mail.bme.hu*
[2]*Szent István University, Institute of Environmental Sciences, Department of Water and Waste Management, H-2103 Gödöllő, Páter K. str. 1. e-mail: rethati.gabriella@mkk.szie.hu, pogacsas.krisztina@gmail.com, imre.czinkota@gmail.com, tolner.laszlo@gmail.com*
[3]*Hungarian Academy of Sciences, Research Center of Natural Sciences, Institute of Molecular Pharmacology, H-1025 Budapest, Pusztaszeri út 59-67. e-mail: korecz.laszlo@ttk.mta.hu*
[4]*TVK, Member of the MOL group, TVK Development, Product- and Application Development, H-3581 Tiszaújváros Pf. 20. Hungary, e-mail: laszlozsolt@tvk.hu*
[5]*Qualchem Zrt., H-2072 Zsámbék Új Gyártelep, e-mail: qualchem@qualchemrt.hu*

Introduction

Plastics waste is a major environmental problem. One of the solutions to remove throwaway plastic products is making them biodegradable. Inspite of the expansion of plastics recycling, yet much polyolefin-based plastics end up in landfill. What happens to the deposed 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 (Table 1). 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 (Figure 1). Virgin middle density polyethylene (MDPE) film, MDPE films containing pro-oxydant 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-Szárítópuszta.

Table 1 The tested plastic films

Sample No.	Composition
340	FS 340-03 middle density polyethylene, MDPE (TVK)
238	MDPE + pro-oxydant (Fe 0,072 %, Co 0,015 %, Zr 0,031 %, Mn 0,006 %, total metal content 0,124 %) (BME-Qualchem Zrt)
242	MDPE + pro-oxydant (Fe 0,051 %, Co 0,025 %, Zr 0,024 %, Mn 0,044 % - total metal content 0,144 %) (BME-Qualchem Zrt)
297	MDPE + 8,75% thermoplastic starch + pro-oxydant (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 of the films, by the change in thickness and in the mechanical properties

Figure 1 Setup of the experiments

Decrease in molecular mass (Table 2) could be detected in samples 238 and 297 containing pro-oxydant 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. 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.

Table 2 Results of GPC analysis before and after 11 months in soil

Sample No	Mw	Mn	Pd
340-0	120765	13320	9,066
FS 340-11 months	128844	15887	8,110
238-0	126108	9831	12,827
238-11 months	36420	5925	6,114
242-0	107019	4960	21,572
242-11 months	113092	3319	34,072
297-0	128770	10274	12,533
297-11 months	117404	6895	17,026

Conclusions

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

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