The peculiarities of electret effect in corona electrets based on nonpolar and polar polymers with dispersed montmorillonite

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Introduction

The development of electrets based on common and commercially available polymers by corona charging is an attractive goal. For example, polyethylene (PE) is widely used in various applications due to its low cost, availability, optimal complex of physical and mechanical properties. However, improvement of electret properties in such materials is still a big challenge [1].

Polylactide (PLA) has become one of the most popular materials having a huge growth potential in global industry [2]. It is a durable and plastic polymer that is also biodegradable. However, the corona discharge treatment is not an effective way to produce electrets based on PLA. New ways to improve PE and PLA electret properties including the introduction of dispersed fillers into their compositions are of great importance. Thus, the comparison of mechanisms responsible for the electretization and charge relaxation, along with the structural changes investigations are crucial for the understanding of the electret state nature in such different polymers and compositions based on them.

The present work mainly focuses on the influence of finely dispersed montmorillonite (MM) on the structure of PE and PLA, as well as the determination of their electret characteristics.

Results and Discussion

In this study, polyethylene (PE 15803-020, density 0.92 g/cm^3, T_m = 109 ºC) and D-polylactide (density 1.24 g/sm^3, T_m = 165 ºC) were used. MM (15A, density 1.66 g/sm^3, average particle size 6 μm, specific surface area (700 ± 100) m^2/g) was used as a filler.

The introduction of dispersed MM into the PE and PLA polymer matrices has influence on their electret properties, depending on filler content (Table 1). It has been found that the addition of the filler leads to changes in polymer chemical structure (in the number of oxygen-containing groups due to the mechanochemical destruction processes), changes in the electrical and dielectric properties of the polymer, as well as to the creation of the new traps for injected charges located at the polymer-filler interfaces.

TABLE I
ELECTRET PROPERTIES OF THE COMPOSITIONS

Composition	V_{ef}, κV	E, κV/m	σ_{ef}, μC/m^2
PE	0,12	7,60	0,07
PE + 2 vol.% MM	0,17	9,53	0,08
PE + 4 vol.% MM	0,14	8,23	0,08
PLA	0,04	2,71	0,03
PLA + 2 vol.% MM	0,12	7,43	0,06
PLA + 4 vol.% MM	0,17	9,12	0,07
PLA + 6 vol.% MM	0,13	7,94	0,06

Supplementary information on polymers and composites under investigation was provided by means of the DSC, TMA, IR-spectroscopy, capillary viscometry and open-circuit TSDC (Fig. 1) methods.

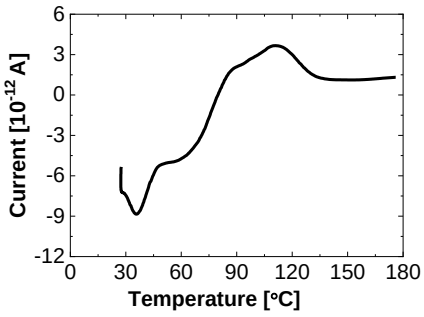

Figure 1: The open-circuit thermally stimulated depolarization current on PLA.

Conclusion

Filling of PE and PLA with MM (2-4 vol.%) allows to improve their electret properties due to changes in heterogeneous structure and has no significant influence on service properties.

References

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