MICROHARDNESS OF MULTIPHASE POLYMER BASED SYSTEMS

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1. INTRODUCTION

Polymer blends and composites are increasingly used for manufacturing of broad range of different engineering materials. At present moment growth rate of polymer blends and alloys is overtaking that of common polymers by at least 2 % [1]. During exploitation engineering materials are subjected to various environmental and technological effects, including wear. Hardness together with abrasivity, in its turn, is quite often used in the field of wear resistance as the criteria for judging surfaces of the alloys, castings, hardfacings and overlays. This research is devoted to the investigation of microhardness phenomena of poly (ethylene terephatalate) (PET) blends with polyolefins and thermoplastic elastomers.

2. EXPERIMENTAL

Heterogeneous multiphase composition systems of PET with polyolefins (PO) and of PET with thermoplastic elastomers (TE) (φ_{PET} = 10, 30, 50, 70, 90, 95 wt. %) were obtained by melt mixing in a twin screw extruder. Certain compositions of PET/PO and PET/TE blends were modified by means of γ-radiation (up to absorbed doses of 50 kGy and 150 kGy) or maleic anhydride grafted polypropylene compatibilizer. Effect of the compatibilization on the micromechanical properties (i.e., microhardness Hu, microhardness modulus E_{Hu}, indentation work W, microcreep h_{Hu} determined by universal microhardness) as well as certain structural characteristics (crystallinity χ, melting characteristics) of the investigated multiphase systems was determined. Effect of radiation modification on the structure of the investigated compositions was determined by means of gelfraction measurements.

3. RESULTS AND DISCUSSION

Under the scope of this investigation, several characteristic features of the micromechanical behavior of PET based multiphase composition systems with POs and TEs were found. Considering specific crystallization behavior of PET, micromechanical properties of the investigated compositions – especially those with higher PET content –, were strongly dependent from the crystallinity of polyester. Consequently different micromechanical properties were observed near the surface and in the bulk of the tested specimens: more crystalline core (crystallinity degree ca 33%) was covered with amorphous surface layer, with crystallinity, highly dependant from the manufacturing conditions. It should be, however, mentioned that overall trends of the $Hu(\varphi_{PET})$, $E_{Hu}(\varphi_{PET})$, $W(\varphi_{PET})$ and $h_{Hu}(\varphi_{PET})$ change were not influenced.
It was determined that by increasing PET content in the investigated multiphase systems universal microhardness and microhardness modulus increased, but microcreep decreased, that allowed assume that wear resistance of the compositions also increased. At one and the same PET content in the blend, higher microhardness and microhardness modulus are for PET compositions with PO, although these differences are rather small for PET matrix blends: evidently PET as dominating component determines micromechanical behavior in this case.
It was found out that microhardness of the investigated systems increase with the irradiation dose. It is believed that these effects are due to the complex set of the radiation induced restructuring processes (cross-linking, grafting and cleavage of the macromolecular chains) in the investigated materials [2,3], as determined by gelfraction measurements. Although gelfraction measurements showed that radiation induced cross-linking and grafting processes more intensively are occurring in the PO and EOC phases, significant differences in the micromechanical property change in the result of radiation modification were not observed.

4. CONCLUSIONS

Microdeformative stress-strain properties of poly(ethylene terephtalate) multiphase compositions with polyolefines and thermoplastic elastomers were investigated. It was concluded that micromechanical properties of the investigated compositions – especially those with higher PET content – were strongly dependent from the crystallinity of polyester. By increasing PET content in the investigated multiphase systems universal microhardness and microhardness modulus increased, but microcreep decreased, that allowed assume that wear resistance of the compositions also increased. Besides it was found out that as a result of radiation modification microhardness of the investigated compositions increase.

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