Type of presentation: Poster

MS-6-P-2125 Microstructure and micromechanical properties of PP/HDPE/EPDM blends

Situm A.[1], Nevoralova M.[1], Slouf M.[1], Vranjes N.[2], Rek V.[2]

[1]Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic, Heyrovsky Sq. 2, 162 06 Prague 6, Czech Republic, [2]University of Zagreb, Faculty of Chemical Engineering and Technology, Marulic Sq. 19, 10 000 Zagreb, Croatia

Email of the presenting author: Slouf@imc.cas.cz

Introduction. Like most polymers, isotactic polypropylene (PP) and high-density polyethylene (HDPE) are immiscible. Consequently, PP/HDPE blends exhibit phase separation, coarse phase morphology, poor interphase adhesion and bad mechanical properties [1]. Nevertheless, morphology and properties of immiscible polymer blends can be improved by compatibiliziation, i.e. by the addition of a copolymer called compatibilizer that improves interphase adhesion [1]. This contribution is focused on morphology and micromechanical properties of PP/HDPE blends, both non-compatibilized and compatibilized with ethylene, propylene, and diene-component terpolymer (EPDM).

Materials and methods. PP (HC206TF, Borealis), HDPE (Lupolen 5031L, Basel) and EPDM (Nordel IPNDR 4520, Dupont Dow Elastomers) are commercial products. PP/HDPE/EPDM blends with various compositions were prepared by melt-mixing (extrusion and injection-moulding) [2]. Morphology was visualized by SEM microscopy of fracture surfaces and smoothed, permanganic mixture-etched surfaces [3]. Microhardness (MC) and microcreep (MC) were measured by Vickers microhardness tester and compared with theoretical predictions as described elsewhere [4, 5].

Results and conclusions. SEM micrographs of fracture surfaces exposed the two-phase morphology of non-compatibilized blends (Fig. 1a). Voids could be observed, indicating a low interphase adhesion between the components. Finer morphology, with particles of minority phase better incorporated in the matrix, was obtained by addition of the EPDM compatibilizer (Fig. 1b). Smoothed surfaces revealed the inhomogeneity of the systems (Fig. 2a) and the lamellar structure of HDPE (Fig. 2b). The PP/HDPE interphase reduces MH values below the prediction based on the Additivity law [4]. The systems have also shown some trend in the measured values of MC (Fig. 3b), which slightly increased with the concentration of PP. We conclude that agreement among composition, micromechanical properties and theoretical predictions [4, 5] was found (Fig. 3). Nevertheless, the inhomogeneous morphology (Fig. 2a) explained why both MH and MC values were rather scattered (Fig. 3a). This re-confirms close relationship between morphology and micromechanical properties and points out the importance of microscopic investigation for correct interpretation of MH and MC results.

References

[1] Horak Z et al.: Polymer Blends. Encyclopedia Of Polymer Science and Technology (2005)

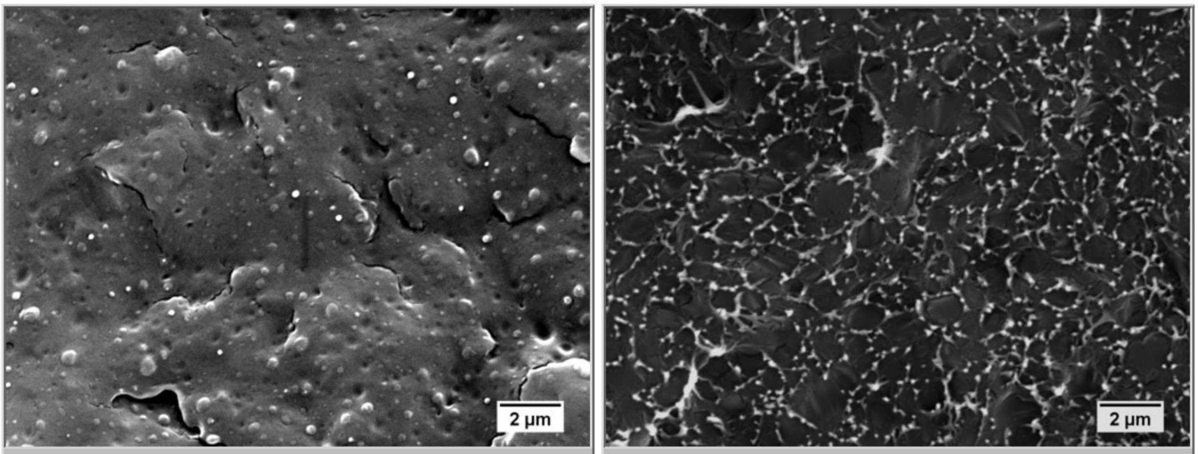
[2] Vranjes N et al.: Macromol Symp, 258 (2007) 90-100

[3] Slouf M et al.: Polym Eng Sci, 47 (2007) 582-592

[4] Calleja F et al: Microhardness of polymers. Cambridge university press (2000)

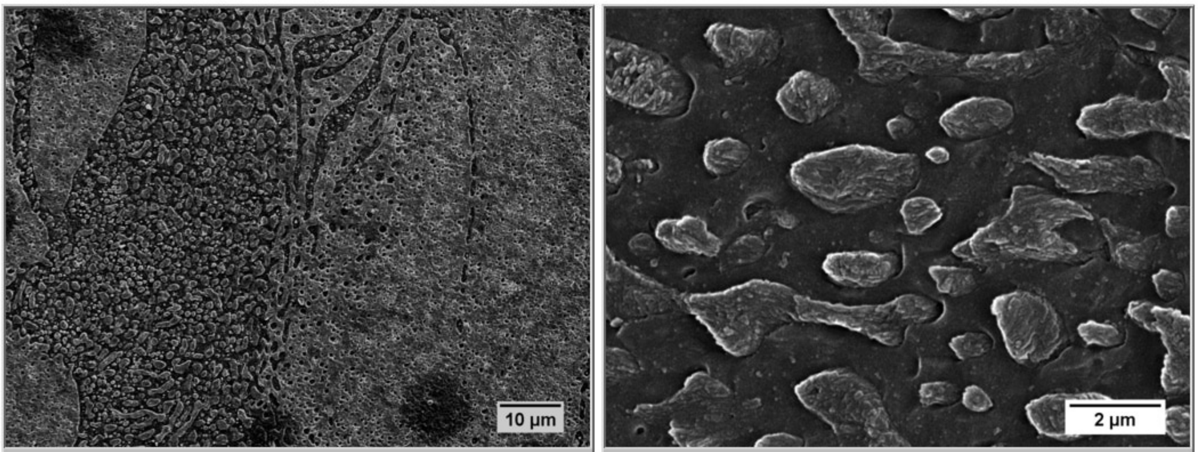
[5] Vackova T et al.: Eur Polym J, 48 (2012) 2031-39

Acknowledgement: TACR TE01020118 and MZOS (Croatia) 125-1252971-2578.



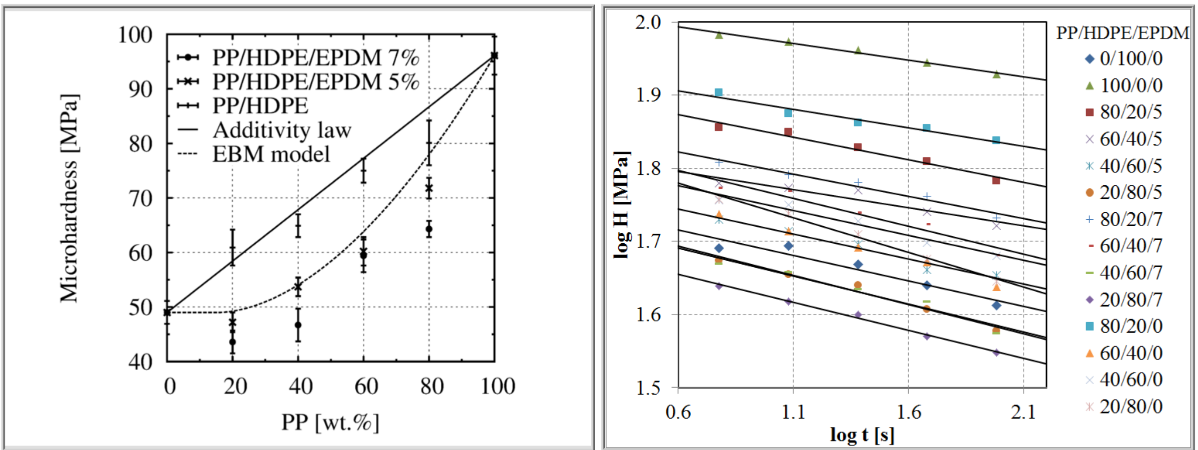
(a) PP/HDPE 80/20 (b) PP/HDPE/EPDM 20/80/7

Fig. 1: SEM micrographs showing phase morphology of (a) non-compatibilized blend PP/HDPE (80/20), and (b) compatibilized blend PP/HDPE/EPDM (20/80/7).



(a) PP/HDPE 80/20 (b) PP/HDPE/EPDM 60/40/5

Fig. 2: SEM micrograph showing (a) non-homogeneity and phase inversion of PP/HDPE (80/20) system and (b) crystalline lamellae in PE particles within PP/HDPE/EPDM (60/40/5) blend.



(a) Microhardness (b) Microcreep

Fig. 3: Micromechanical properties of polymer blends: (a) microhardness and its comparison with linear model and equivalent-box model, (b) microcreep measurements.