Natural polyphenols as pro-ecological antioxidants and pigments for polymer composites

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ABSTRACT

In our studies, we propose the use of natural, pro-ecological substances such as polyphenols to protect elastomers against ageing. This natural compounds were incorporated into ethylene- norbornene (COC-material is commercially available under the name of TOPAS); then, the composites of TOPAS containing the antioxidant under investigation were subjected to ageing processes. The changes in deformation energy, colour and cross-linking density and OIT index of the composites of TOPAS were measured before and after each ageing process. The test results obtained show that all applied flavonoids have a very positive influence on the stability of the TOPAS, protecting them against the negative effects of ageing. In addition to its anti-oxidative function, flavonoids change the colour of the final polymeric product, fulfilling the role of a natural pigment. Thus, natural polyphenolic compunds are not only a natural antioxidant but also a pigment in the polymers (natural indicators of ageing time), imparting to them the features of pro-ecological materials [1-6].

Keywords: ageing, polyphenols, polymer, stabilization

1. Object and methods of studies

The natural antioxidants which were added to ethylene-norbornene elastomer (polyolefin elastomer-TOPAS).

The mechanical properties of the composites were determined according to ISO-37 using a ZWICK 1435 universal machine. Thermal ageing studies were carried out in a dryer with thermo circulation at 70°C in 7 days. Atmospheric ageing studies were carried out using Atlas Weather Ometer Ci 4000 equipment, in 100 h using selected day and night panels with parameters as: day panel – time 240 minutes, energy of radiation 0,7 W/m^2, humidity 60%, night panel – time 120 min., humidity 50%. The UV ageing studies were carried out using Atlas UV 2000 equipment. The parameters of the process were: time 100 h, day panel – 320 min., energy of radiation 0,7 W/m^2, temperature 60°C, night panel – 160 min., temoerature 50°C.

For every type of ageing studies the ageing coefficient K (1) was calculated according to equation:

$$K = (TS*EB)_{aged} / (TS*EB)_{before\ aging} \qquad (1)$$

where TS – tensile strength, EB – elongation at break.

Results and discussion

Table 1. Mechanical properties of the Engage vulcanizates subjected to ageing. TS – tensile strength [MPa], Eb – elongation at break [%]

Composite	TS	E_b	TS	E_b
	MPa	%	MPa	%
	Before ageing		weathering	
Topas/wzorzec	37,2	450	16,5	363
Topas/trans-chalcone	28,9	456	12,9	312
Topas/Silymarin	30,4	427	26,9	475
Topas/Tocopherol	34,4	433	39,5	505
Topas/Quercetin	36,5	448	35,8	465
Topas/Rutin hydrate	14,8	344	25,95	476
Topas/Hesperidin	25,6	430	32,5	510

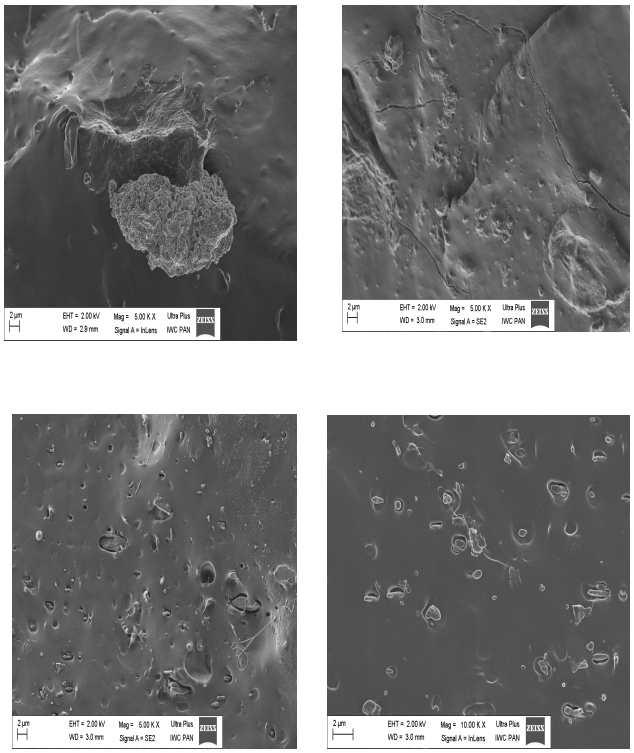

Fig. 1 Morphology of composites containing silymarin and quercetin measured by the method of SEM (scanning electron microscopy).

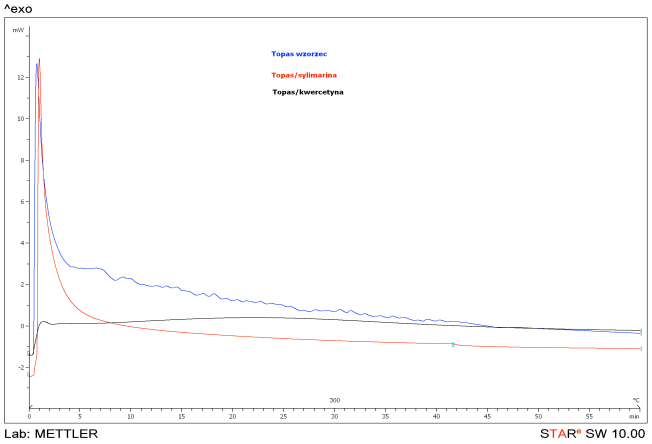

Fig. 2 OIT (oxygen induction time) values of Engage vulcanizate containing morin hydrate

Based on the test results obtained, we conclude that the natural derivative morin hydrate can be undoubtedly used as a natural anti-ageing additive for polymers. The addition of morin hydrate considerably improves the stabilisation of polymer. Quercetin has shown to be a good stabiliser as well as a protecting agent against the climatic factors. Moreover, this natural pigment imparts colour to final polymeric materials. The colour imparted is sensitive to UV radiation; hence, such polymers assume the features of smart materials. Materials susceptible to colour change under the influence of specified factors may be used in certain applications.

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