THERMAL CHARACTERISTICS OF POLYPROPILENE FILMS WITH ADDITION OF Dk_2(10-40%) NANOGEL

M.A RAMAZANOV[1], R.L. MAMEDOVA, R.B. ASLANOV, A.A. KHADIYEVA, A.R. SADIKHOVA

[1]G.M. Abdullayev Institute of Physics of Azerbaijan NAS
AZ-1143, H.Javid ave., 33,
BSU, Baku, Z. Khalilov str., 23, Azerbaijan

The derivatograms of pure polypropylene (PP) and its mixture with nanogel volume content 10, 20 and 40 vol.% are presented. The nanogel addition in PP leads to total amorphisation of matrix crystalline phase, as the result of which the endothermal effects corresponding to the melting disappear on DTA curves. Note that exothermal effects on DTA curves in 210-310^{0}C interval are caused by thermal-oxidative destruction; the endoeffects at 275-290^{0}C are connected with break processes of weak bonds and endoeffects at 390-465^{0}C are connected with depolimerization processes. The nanogel particles in the quantity 20 vol.% influence very significantly that probably is connected with PP matrix crystalline part.

Keywords: Polypropylene, nanogel, thermal characteristics, derivatogram.
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INTRODUCTION

It is known that the use of different polymer material modification methods leads to significant expansion of their field application. Moreover, the directed structure change and polymer properties are carried out either in synthesis process or by the influence on the ready product by the introduction of another chemical nature fragments into macromolecule. Last time at the creation of polymer materials with the given properties, the modification of their surface is paid the special attention, as especially the surface layer structure mainly defines their behavior in operating conditions [1-4].

It is known that aging of polymer and its composites is connected with high local anisotropy of force field, caused by strong force difference of intramolecular and intermolecular interaction. From theory of heat properties of polymers and composites on its base follows that the presence of local anisotropy and conservation of macromolecule individuality in polymer compositional systems are able to lead to appearance of heat capacity specific regularities, negative coefficients of thermal expansion and series of another abilities.

It is mentioned in literature the fact that DTA can be express-method of organic synthesis allowing the revealing the substance behavior in wide temperature interval with the minimal use of portions and the definition of optimal temperature interval of process carrying in the case of their intra- and intermolecular interaction [5]. Earlier we have been studied the PP films treated by electrothermopolarization action filled by MnO_2 in quantity 0,5 and 1 vol.%. At influence of electrothermopolarization E=7·10^{6}V/m as the result of aging the amorphisation of PP matrix crystalline part occurs and because of that the thermostability decreases on 40°C in the comparison with PP which isn't treated by electrothermopolarization. It is established that electric field action leads to both total amorphization of PP+0,5vol.%MnO_2 composition and total depolymerisation accompanying by evaporation of formed intermediate products in quantity 100% [6]. Taking into consideration this fact the PP+D_{k2} samples are not treated by polarization.

Thermal characteristics of PP films with addition D_{k2}(10-40%) nanogel are investigated in the present paper. The powder mixtures of PP, D_{k1} and D_{k2} in different component ratios are prepared, further the nanocomposites PP+D_{k1} and PP+D_{k2} in the film form with further cooling are prepared from these mixtures by the method of hot pressing at melting temperature of polymer matrix at pressure 15MPa during 15 minutes. The samples are obtained in different temperature-time crystallization modes and especially, at slow cooling (SC) when samples are cooled up to room temperature with velocity 2 grad/minh and rapid cooling (RC) in the ice-water mixture with velocity 30 deg/min. RC samples are investigated by us.

The derivatograms are taken on G-derivatograf of "MOM" firm (Hungary) in temperature interval 20-500^{0}C in platinum crucible with heating velocity 5deg/min. The sensitivity by channels: DTA is 1/5; DTG is 1/15mg- 200. Al_2O_3 is used in the capacity of inert material at 1000^{0}C calcination during 24 hours [7].

The derivatograms of pure PP and its mixture with nanogel volume content 10, 20 and 40vol% : В С, Д correspondingly, are presented on fig.1. The changes of PP thermal characteristics after filling are presented in the table. According these data after nanogel turn from 10 up to 40vol.% on DTA curves, the following changes are observed: 1) beginning the introduction from 10vol.% nanogel in PP the amorphization of PP matrix crystalline part takes place; 2) the beginning of thermo-oxidative destruction temperature decreases up to 210^{0}C with increase of nanogel concentration up to 40vol.%, the bond breakage at 270^{0}C, the depolymerization at 370^{0}C. These data in initial PP are observed at T = 230^{0}C, 318^{0}C and 465^{0}C correspondingly. As it follows from above mentioned data the nanogel addition in PP leads to total amorphization of matrix crystalline phase as the result of which the endothermal effects corresponding to

melting disappear on DTA curves, i.e. the total amorphization of matrix crystalline phase takes place. The data analysis on DTA, ДТG and TG curves allows us to conclude that amorphization of PP crystalline part is caused by polymer structural changes on molecular and permolecular levels existing under influence of nanogel addition particles. Thermal characteristics of PP+20vol% nanogel mixture strongly differ from another ones (fig.1, C).

The decrease of temperature of thermo-oxidative destruction beginning up to 210^0C (see table), temperature of bond breakage up to 270^0C and depolymerization up to 380^0C, bond breakage up to 230^0C is connected with the fact that all nanogel particles destroy the crystallization centers of PP matrix crystalline phase and occur the total crystal amorphization. Probably, in amnorphization process the crystal dropping to matrix amorphous part takes place and the PP amorphous part is enriched. Note that exothermal effects on DTA curves (fig. 1 A,B,C,D) in interval 210-310^0C are caused by thermo-oxidative destruction. The endoeffects at 275-290^0C are connected with processes of weak bond breakage, endoeffects at 390-465^0C are connected with depolymerization processes.

Thus, the nanogel disperse particles on PP structure all levels leads to total amorphization of filled material. The most significant influence on these properties has the nanogel particles in quantity 20 vol.% that probably is connected with crystalline part of PP matrix .

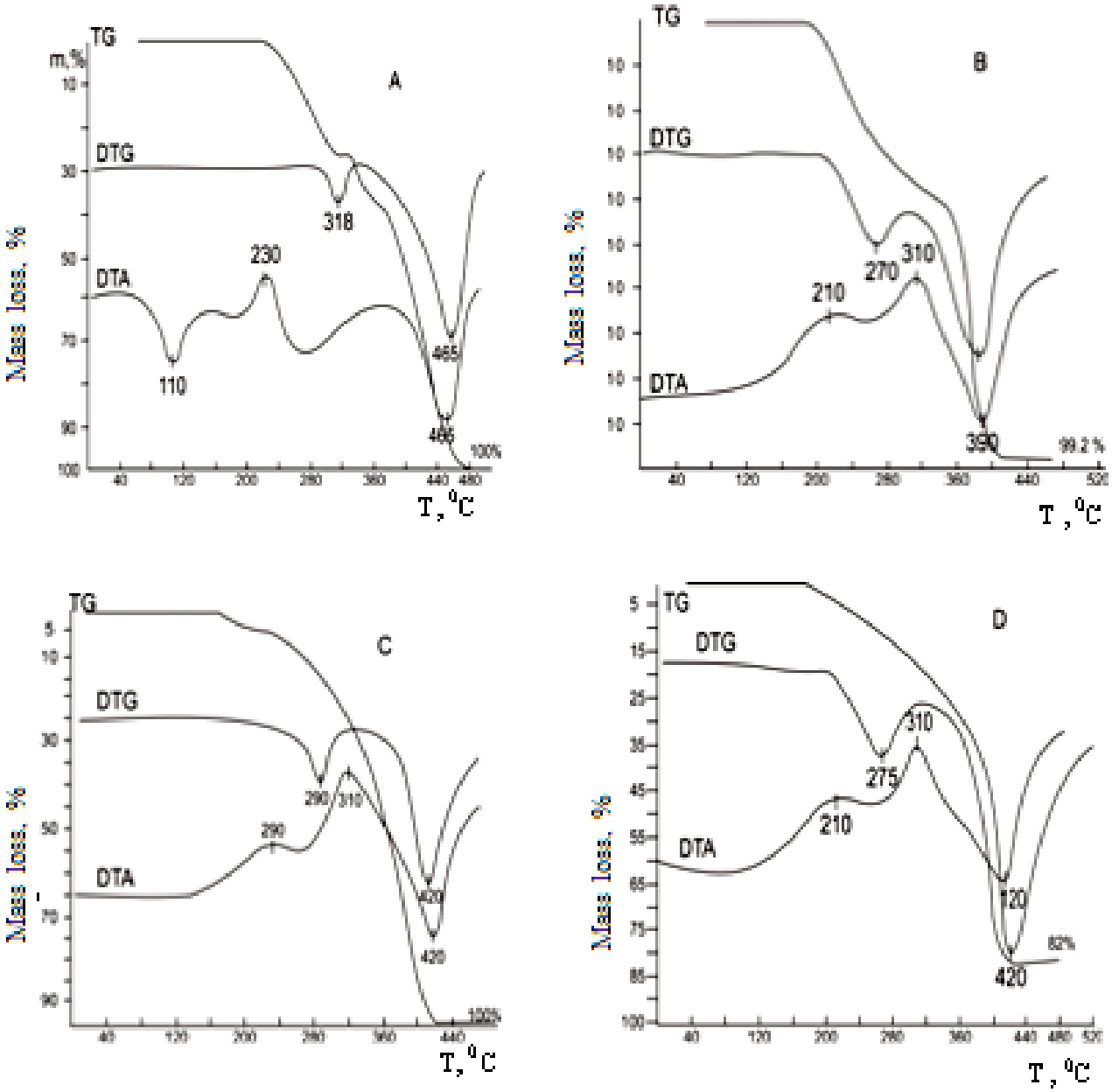

Fig. 1. Derivatograms of PP films with nano-gel addition: A) initial PP, B) PP+10%, C)PP+20%, D)PP+40% of nanogel.

Table.

Thermal characteristics PP films with addition of Dk_2(10-40%) nanogel

Material	Tcr. ^{0}C	K,%	Td, ^{0}C	Tb, ^{0}C	Tdep, ^{0}C
PP pure	110	48	230	318	465
PP+10%nanogel	-	-	210	270	390
PP+20%nanogel	-	-	290	310	420
PP+30%nanogel	-	-	240	310	410
PP+40%nanogel	-	-	210	275	420

Notes: Tcr is crystal melting temperature;
K is crystallinity degree;
Td is temperature of thermo-oxidative destruction beginning;
Tb is temperature of bond breakage;
Tdep is depolymerization temperature.

[1] *N.A. Eyubova, A.M. Maqerramov, V.P. Malin, Yu.N. Qazaryan.* Issledovanie elektrichrskogo stareniya plenki polietilena derivatograficheskim metodom.V sb.: Radiaciya v fizike i ximii. Baku, Elm, vip1, s.9-13. (In Russian).

[2] *M.A. Baqirov, N.A. Eyubova, V.P. Malin, A.A. Aliev, A.M. Maqerramov.* Vliyanie elektricheskoqo stareniya na kristallichnost polimernix dielektrikov. Visokomolek. soed, M, 1987,t. 29A, №5, s.917-919. (In Russian).

[3] *I.Yu. Apalikova, Yu.I. Suxarev, T.Q. Krupnova.* Derivatoqraficheskie issledovaniya oksiqidratov jeleza (III), poluchenn;x applikachionniem metedom. Yujno-Uralskiy qosudarsstvenniy universitet., q. Chelyabinsk, Rossiya.(In Russian).

[4] *V.I. Povstuqar, V.I. Kodalov, S.S. Mixaylova.* Starenie I svoystva poverxnosti polimernnix materialov. M., 1988. (In Russian).

[5] *A.S. Kozlov, S.B. Piraqov, I.B. Chelinskiy.* Sankt-Peterburg,1980, 13.(In Russian).

[6] *M.A Ramazanov, A.S. Quseynova, N.A. Eyubova* Optoelectronics and advanced materials-Rapid communications. Ruminiya. Vol.5, №4, April 2011, p 410-413

[7] *V.S. Qorshkov, B.B. Timashev, B.Q. Savelev.* Metodi fiziko-ximicheskoqo analiza vyajushix veshestv. M.:Visshaya shkola, 1981 s.37-42.(In Russian).

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