S02 - Polymer Blends and Alloys

Keynote

S02-131

Efficient hydrosilylation reaction in polymer blending: An original approach to structure PA12/PDMS blends at multiscales

Cassagnau, Philippe; Uttendorfer, Thomas; Stadlbauer, Wolfgang*

Abstract

An in situ amide hydrosilylation reaction was developed to prepare polyamide 12 (PA12)/polysiloxane by reactive blending. This reaction is focused on the addition of hydrogenosilane groups (SiH) from polysiloxane to the carbonyl group from the PA12 amide function. To evidence this carbonyl hydrosilylation onto an amide based polymer, an approach on model compounds (use of N-methylpropionamide) was carried out. The mechanism and kinetics were investigated with multinuclear NMR (1H, 13C and 29Si). During kinetics studies, the concentration of N-silylated copolymers can reach 70 mol% after 2 hours reaction at 100 °C. Amide hydrosilylation reaction was extended to the reactive blending of polyamide 12 with PDMS under molten processing conditions. Formation of a structured blend was investigated by rheology and electronic microscopy at different scales. The impact of both shearing and reaction on the final morphology was deeply studied and the interfacial enhancement by compatibilization was confirmed. As a result, the dispersion of PDMS domains decreased from 3-4 ìm to around 0.8 ìm in diameter forming submicronic morphology. Furthermore, it is possible to control the dispersion of PDMS at different scales by modifying the physico-chemical parameters (molar mass and functionality) of the two components.

S02-207

Extruded blends of PLA and PBAT: correlation between com-position and fracture behaviour

Gigante, Vito; Coltelli, Maria Beatrice; Cinelli, Patrizia; Aliotta, Laura;*
Canesi, Ilaria; Lazzeri, Andrea

Abstract

Poly(lactic acid) (PLA) is a remarkable biopolymer for packaging applications because it derives from renewable resources and it presents the great advantage to be biodegradable[1]. Nevertheless its high stiffness, low thermal stability and brittleness does not allow the use of PLA in a wide range of applications. Rub-ber toughening of PLA is a promising strategy to improve its mechanical charac-teristics [2]. In this work blends of PLA with poly(butylene-adipate-co-terephthalate) (PBAT) have been studied; PBAT is an oil-based material, but bio-compostable, capable to improve thermal and rheological properties of PLA [3]. Tensile tests, Impact tests and Fracture Characterization of PLA-PBAT blends (prepared by extrusion and injection molding with HAAKE MiniLab MiniExtruder and MiniJet) obtained as a function of composition in terms of PBAT weight percentages were carried out to evaluate blends fracture behavior. The results were discussed by using different testing methods and varying the test speed, the rubber content and temperature. Specific attention at the modifications of brittle/ductile transition [4] changing these parameters has been placed, studying analytical models to predict them.

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S02-230

Rheological and morphological correlations in PP/EVA blends containing nanoclay in presence of a halogen-free flame retardant

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Abstract

Abstract In this work attempts were made to establish correlation between rheological and morphological properties of nanoclay-filled polypropylene/ethylene vinyl acetate copolymer (PP/EVA) blends containing a new generation of halogen-free flame retardants commercially known as "NOR116". Scanning electron microscope (SEM), transmission electron microscope (TEM) and wide angle X-ray scattering (WAXS) analyses were implemented in order to investigate the morphological properties. Effect of presence of two different types of compatibilizer, the flame retardant and organoclay on morphology of the nanocomposites was explored. By considering chemical nature of compatibilizers and the SEM and TEM micrographs, organoclay localization was accurately predicted. Using rheological measurements in three different modes of frequency, temperature and time sweeps, linear viscoelastic properties alterations of the samples in terms of temperature variations and consequent morphological evolution were investigated. Using the frequency sweep experiment miscibility level of blends and their interfacial properties were also studied. A good correlation between these properties and morphological observations was established. Also, it was found that the temperature dependence linear viscoelastic properties alterations strictly depend on the blend morphology and chemical structure of components. In case of neat blend a single phase morphology indicating of enhanced miscibility was detected at higher temperatures.

S02-355

Melt strengthening of poly (lactic acid) and its blends: Shear and elongation rheological investigations for forming process

Maazouz, Abderrahim; Khalid, Lamnawar*

Abstract

The poly (lactic acid) (PLA), through its organic origin and its biodegradation properties, can be a good alternative to petroleum-based polymers. Through this work, we present some promising routes to enhance its processing ability which presents several challenges mainly due to the poor shear and elongation properties of this biopolymer. To our knowledge, there is no paper dedicated to the investigation of foaming and/or blown extrusion of PLA that involves structural, rheological and thermo-mechanical properties. Two main routes were selected: (i) the modification of its structure, rheological and thermo-mechanical properties and (ii) blending it with other ductile thermoplastic biopolymer such as the poly (butylene adipate-co-terephtalate) (PBAT) or polyamide (PA11). Various formulations of PLA with multifunctionalized epoxy, nucleants and plasticizer were prepared and characterized on the basis of their linear viscoelasticity and extensional properties. The balance of chain extension and branching has also been investigated using solution viscosimetry, steric exclusion chromatography (SEC) and rheology (Shear and elongation rheology). On one hand, a batch foaming assisted with supercritical CO2 was achieved. The influence of the foaming parameters, the extent of chain modification as well as the contribution of crystallization on cell morphology was evaluated. Based on these parameters, structures ranging from micro to macro-cellular-cell were obtained. On the other hand, the stability maps of blown processing for neat and modified PLA were established at different die temperatures. We have achieved a great enhancement of the blown processing windows of PLA with high BUR (Blow Up Ratio) and TUR (Take Up Ratio) attained. We were able to demonstrate that a higher kinetic of crystallization can also be reached for chain-extended and branched PLA formulated with adequate amounts of nucleants and plasticizers

S02 - Polymer Blends and Alloys

Oral Presentations

S02-25

Compatibilization effect of Silica nano particles on Rheology, morphology and mechanical properties of immiscible PA6/LDPE blends

Malekmohammad, Melika

Abstract

A series of Nylon 6/ Low-density polyethylene (PA6/LDPE) (90/10 w/w) and (10/90 w/w) containing 0.25, 0.5, 0.75 and 1% phr modified Silica nanoparticles were melt processed and the effect of nanoparticles on morphological properties was investigated. SEM micrographs revealed a decrease in the average number of domain diameter (Dn) of LDPE phase for Silica nanoparticles amount up to 0.5% phr in the PA6-rich blend, whereas, an increase in Dn of PA6 was observed up to 0.75 phr silica nanoparticles which led us to conclude the preferential location of nanoparticles in PA6. Rheological relaxation time of the blends also suggests that the morphology transition can be related to the changes in dynamic asymmetry between PA6-rich and LDPE-rich phase. Improvement in storage modulus measured by DMTA was relatively more in PA6-rich blend than LDPE-rich blend which is attributed to the reinforcing effect of nanoparticles arising from the interaction with the PA6 chains.

S02-71

Effects of Epoxy-POSS Nanoparticles on the Compatibility of PLA/PBAT Blends

Tuccar Kilic, Nilay; Can, Buse Nur; Kodal, Mehmet; Ozkoc, Guralp*

Abstract

Poly(lactic acid)(PLA) is the most generally chosen bio-polymer because of its lower price and commercially availability in the market. Although PLA has high strength and modulus, its inherent brittleness and low toughness limits its usage [1]. Poly(buthylene adipate-co-teraphthalate) (PBAT), is an aliphatic-aromatic copolyester that can be used to toughen PLA [2]. Due to incompatibility between PLA and PBAT, in the absence of a compatibilizer they exhibit poor mechanical properties [3]. Polyhedral oligomeric silsesquioxanes (POSSs) are new generation organic/inorganic hybrid materials that have an inorganic Si-O case with functional organic groups. Epoxy functionalized POSS nanoparticles are potential nanoparticles that can be used to compatibilize PLA/PBAT blends since epoxy group can react with -COOH groups in a wide temperature range [4]. In this study, it was aimed to observe the potential of epoxy-POSS nanoparticles to be used as a compatibilizer for PLA/PBAT blends. Three different types of epoxy-POSS types were used. Blends were prepared by melt compounding process. In order to characterize properties of blends, morphological, mechanical, thermo-mechanical, thermal and rheological tests were examined. The results showed that epoxy-POSS types can be used as a compatibilizer for PLA/PBAT immiscible blends. Acknowledgement: This study is financially supported by TUBITAK (Grant Number: 115M576)

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S02-143

The influence composition on the properties of polyethylene based blends

Burgstaller, Christoph; Uttendorfer, Thomas; Stadlbauer, Wolfgang*

Abstract

In packaging applications, nowadays typically multilayer films are applied to fulfil a variety of requirements like tenacity, printability, barrier properties and food contact approval. One persistent problem with such films is their recycling, even as low contaminated post-industrial waste, which is present as start-up materials and edge-trim, as the different layers are usually incompatible, thus re-melting results in degraded properties, which are insufficient for most applications. Therefore, the aim of this work was to investigate the composition effects of polyethylene based formulations, containing polyamide as the main component, but also barrier layer materials like ethylene vinyl acetate and ethylene vinyl alcohol. The different formulations were melt blended, with or without compatibilisation, in a twin-screw extruder, where for selected formulations processing parameters and screw geometry were varied. The materials were further processed via injection moulding to retrieve universal test specimen for mechanical testing (tensile and impact tests). Further characterisation, via scanning electron microscopy or rheology (represented her by melt flow rate determination), was carried out to investigate the correlations between composition, morphology and properties. We found, that the morphology is formulation dependent, and, that it is possible to compatibilise such formulations by applying maleic anhydride grafted polyethylene, so that the blends properties were sufficient for application again. Also, the mechanisms of the compatibilisation and the resulting morphologies can be, besides some processing influences, related to the chemical compositions of the components and their possibilities of interaction. These findings can help in the mechanical recycling of multilayer film based on polyethylene.

S02-155

Development of a Block Copolymer for Impact Modification of Polyhydroxyalkanoate (PHB)

Goebel, Linda; Bonten, Christian*

Abstract

Bioplastics, which will see rising demand in the next years, have to be compounded by using a twin screw extruder like fossil based plastics as well as non-biodegradable plastics. Polyhydroxybutyrate (PHB) belongs to the family of polyhydroxyalkanoates (PHA) and is both, biobased and biodegradable. PHB is insoluble in water and, in contrast to many other bioplastics, has a good barrier effect against water vapour. But PHB is like other bioplastics extremely brittle and cannot use due to that for film applications. This paper shows the synthesis of a PHB-block copolymer by using the twin screw extruder without any catalyst, solvents or purification processes. By using a twin-screw extruder with a special screw design the molecular weight of PHB can be controlled degraded. In a second step the PHB and soft phase can be compounded to a block copolymer by means of reactive extrusion. This improves the ductile properties of the material without changing the thermal or chemical characteristics. The analysis of the block copolymer is executed by using a plate-plate rheometer, a differential scanning calorimeter (DSC), an infrared spectroscopy as well as different microscopes. So by formation of a PHB block copolymer the elongation at break of 1 % for the pure PHB could be increased to 35 % in the block copolymer.

S02-178

STRUCTURE PROPERTIES RELATIONSHIPS OF PA6/EOR BLENDS

Heyn, Johannes; Bonten, Christian*

Abstract

Impact modifiers in polyamide 6 could lead to an improvement of (un)notched impact properties in some cases. The effect of particle size or the interparticle distance on this improvement is not yet totally clear. There are also questions about the influence of the phase connection. For daily use, low testing speeds are very interesting, but in most of the investigations only impact tests at high testing speeds are examined. In this work, it can be shown that the criterion of the critical interparticle distance for notched impact tests cannot be considered to be universal. It can also be proven that the criterion of the optimum particle size is only valid for notched impact tests if an adequate phase connection is given. Based on the findings of this work, the two most to important factors for a toughness optimization at low testing speeds in PA/EOR blends are a phase connection as strong as possible and particle sizes as small as possible.

S02-196

Development of highly functional butyl –etherified starch/ poly [(butylene succinate)-co-adipate] nanocomposites using reactive extrusion

Maubane, Lesego Tabea

Abstract

Increasing environmental awareness has encouraged a lot of researchers to progress to biodegradable materials. Amongst biodegradable polymeric materials, starch is one of the most studied biopolymer; however, thermoplastic starch materials possess poor mechanical properties and suffer from water sensitivity. To overcome these challenges, butyl-etherified starch (BES) types were melt processed with poly (butylene succinate adipate) (PBSA) respectively in the presence of hydrophilic silica particles and maleic anhydride (MA). Results indicated that butyl-etherification of starch improved compatibility while highly branched amylopectin structures of BES increased miscibility with PBSA and properties of BES improved with the increasing PBSA content. Silica particles preferentially localized inside the dispersed BES phase and resulted in increased viscosity which led to limited improvement in droplet breakup. Furthermore, the presence of MA led to hydrolysis of BES phase resulting in reduced molecular weight, viscosity and inadequate improvement in mechanical properties. Therefore, this study is expected to shed some light into the use of butyl-etherified starch blends with PBSA for packaging applications and urge interest for further research in the area of reactive extrusion with different filler materials.

S02-228

Development of PLA/PBAT and PLA /PBSA bioblends: Effects of processing type and PLA crystallinity on morphology and thermomechanical properties

Oguz, Hazal; Dogan, Cisem; Kara, Deniz; Ozen, Zeynep Tutku;
*Ovali, Didem; Nofar, Mohammadreza**

Abstract

In this study, immiscible blends of 75 wt% polylactic acid (PLA) with 25 wt% of poly[(butylene adipate)-co-terephtalate] (PBAT) and poly[(butylene succinate)-co-adipate] (PBSA) were prepared through injection-molding (IM) as well as twin-screw extruder (TSE) followed by IM. An amorphous and a semi-crystalline PLA were also used as the matrix. The effects of PBAT and PBSA, various processing, and crystalline/amorphous PLA matrices on the morphology development of blends were explored through using a scanning electron microscopy (SEM). Furthermore, the materials and morphological variation influences on the thermal and mechanical properties of PLA-based blends were investigated and compared using a differential scanning calorimeter (DSC), dynamic mechanical analyzer (DMA), and tensile and three-point bending tests, respectively.

S02-250

Investigation of PLA-biopolymer Blends to Improve Properties

Kassos, Nikolaos; Kelly, Adrian; Gough, Tim; Gill, Andrew*

Abstract

Polylactic acid (PLA) is the most widely used biopolymer with applications in fields such as packaging and textiles. Increased usage of biopolymers can help to reduce the accumulation of disposed plastics in the environment and reduce dependency on oil based polymers. PLA can be processed using conventional polymer processing techniques and can provide a diverse range of properties, making it a good candidate for replacing fossil based polymers. PLA has high strength and stiffness below its glass transition temperature (50-70°C), making it suitable for disposable packaging applications at low temperatures; however it is limited by its brittleness and low melt strength. Although developments in polymer chemistry have led to significant improvements in its properties, more immediate and lower cost solutions are required to enhance properties and extend applications. In this study, a commercially available grade of PLA has been blended with two bio-degradable polymers in an attempt to modify its properties and processability. Binary and tertiary blends of a PLA matrix with polybutylene succinate (PBS) and polycaprolactone (PCL) were produced by twin screw extrusion, up to 30wt% loading. Mechanical (tensile, impact and flexural), thermal and rheological characterisation was used to quantify properties of the different blend formulations. Phase separation and miscibility were also investigated using scanning electron microscopy and Raman imaging. Results showed that addition of both PBS and PCL caused a reduction in melt viscosity, elastic modulus and tensile strength, whilst causing an increase in impact strength and extension to break. Analysis of morphology suggested that immiscibility was apparent, particularly at higher PCL and PBS loadings. Results indicated that optimum properties and miscibility was obtained at low loadings in binary and tertiary blends.

S02-251

Development of highly-filled polymer compounds for fused filament fabrication of ceramics and solvent debinding

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Kukla, Christian; Holzer, Clemens

Abstract

Fused Filament Fabrication (FFF) is one of the most widely used additive manufacturing processes in the world, due to its simplicity to use and lower cost of the processing equipment. It has been demonstrated that it is possible to produce complete ceramic parts shaped by FFF combined with thermal debinding and sintering [1, 2]. In order to be able to use conventional FFF machines for the shaping of ceramic parts, a highly-filled compound of polymer and ceramic powder needs to be prepared. This compound has to fulfil many requirements: for a constant flow of material a filament must have constant dimensions and shape; the filament should have sufficient stiffness so that it can be pushed without buckling during printing; the filament should be flexible enough to be spooled for easy storage and feeding to the FFF machine; and the polymeric binder should be able to be removed without destroying the printed part. The objective of this investigation was the development of polymer compounds being able to carry out the FFF process and at the same time to be debindable by a solvent. By leaching the major part of the polymers in a first stage with the solvent debinding process, a shorter thermal cycle is required for the degradation of the rest of the polymers, greatly speeding the overall removal of the polymeric binder prior to sintering. Several compounds (feedstocks) were prepared by mixing different polymer combinations with a ceramic powder. The viscosity of the compounds was measured. Filaments were prepared and their tensile properties were analysed. Finally, debinding by immersion in an organic solvent was investigated.

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S02-271

Compatibilization of PET-PE blends for the recycling of multilayer packaging foils

Delva, Laurens; Deceur, Cédric; Van Damme, Nicolas; Ragaert, Kim*

Abstract

Multilayer foils like PET-PE food trays are quite challenging to recycle efficiently. The different polymers are physically attached to one another and cannot be separated into mono-streams of PET and PE. The material must be recycled as a blend. This blend, composed of PET and PE, is inherently immiscible, leading to inferior mechanical properties. Consequently, these materials are currently not recycled mechanically. At best, they go to energy recovery. At worst, to landfill. Effective compatibilization of the PET and PE phases is key to making these materials industrially recyclable. In a first section, this paper discusses the effective compatibilization of a 80:20 virgin PET:PE blend by adding different percentages of a compatibilizing agent (CA) with grafted maleic anhydride (MA) as a functional group. Two different backbone structures are evaluated: a polyolefin elastomer (POE), which is expected to interact exclusively with the PE phase and a styrene ethylene butadiene styrene rubber (SEBS), which is expected to interact also with the PET phase through dipoles. Experimental validation include tensile, flexural and impact testing as well as physicochemical and morphological evaluation. In a second part, the transferability of these results from a virgin blend to an effective post-industrial recycled blend with the same 80:20 PET:PE composition is evaluated.

S02-295

Development of shape memory polymers based on TPU/ABS blends containing MWCNT

Memarian, Farzaneh; Fereidoon, Abdolhossein; Khonakdar, Hossein Ali;*
Ghorbanzadeh, Ahangari Morteza

Abstract

Development of shape memory polymers based on TPU/ABS blends containing MWCNT Farzaneh Memarian1*, Abdolhossein Fereidoon1, Hossein Ali Khonakdar2 1Faculty of Mechanical engineering, Semnan University, Semnan, Iran 2Leibniz Institute of Polymer Research, D-01067 Dresden, Germany Corresponding author: Farzaneh Memarian (Email: farzane.memarian@gmail.com) Abstract In this work, shape memory polymers based on the TPU/ABS blends containing pristine and organo-modified multi-walled carbon nanotubes (MWCNTs) were prepared by melt blending technique. Mechanical, Izod impact and shape memory properties of the samples were investigated. Microstructures of hybrid nanocomposites were studied by means of scanning electron microscopy (SEM). The morphology results showed that the pristine MWCNTs were dispersed homogenously throughout the TPU matrix. Unexpectedly, the ABS droplets in nanocomposites with organo-modified MWCNTs were greater than ABS droplets in TPU/ABS/CNT nanocomposites. These differences were attributed to different degrees in interfacial interactions between the modified MWCNT and TPU matrix. The presence of modified MWCNT in TPU matrix could have increased the differences in surface energy and polarity of TPU and ABS phases and it has disturbed the compatibility of the blend considerably. Loading 2 wt.% MWCNTs resulted in a significant improvement in mechanical properties such as tensile strength and Young's modulus. Also, addition of this amount of MWCNT results in 32% increment in impact strength of the nanocomposites at -50 ˚C. In addition it was revealed that, the mechanical properties of nanocomposites with functional MWCNTs are feeble than those containing pristine MWCNTs. The shape memory results showed that the shape recovery and fixity of TPU/ABS blend improved significantly upon increasing MWCNTs loading. Keywords: Thermoplastic Polyurethane (TPU); Acrylonitrile butadiene styrene (ABS); Shape memory; MWCNT; organo-modified MWCNT.

S02-315

Spin-correlated charge transfer in low-band-gap copolymer composites

Krinichnyi, Victor; Yudanova, Evgenija; Bogatyrenko, Victor*

Abstract

Light-Induced EPR (LEPR) study of magnetic, relaxation and dynamic parameters of spin charge carriers stabilized in polyaniline doped with toluenesulfonic acid (PANI:TSA), spin pairs of polarons and methanofullerene ion radicals photoinitiated in bulk heterojunctions formed by fullerene derivative, [6,6]-phenyl-C61-butyric acid methyl ester (PCBM), with low-band-gap poly[2,7-(9,9-dioctylfluorene)-alt-4,7-bis(thiophen-2-yl)benzo-2,1,3-thiadiazole] (PFO-DBT) and poly[N-9'-heptadecanyl-2,7-carbazole-alt-5,5-(4',7'-di-2-thienyl-2',1',3'-benzothiadiazole)] (PCDTBT) copolymers as well as in respective PANI:TSA/PFO-DBT:PCBM and PANI:TSA/PCDTBT:PCBM composites are described. Magnetic resonance parameters of all charge carriers photoinitiated in these composites at wide temperature and photon energy regions were determined from deconvolution of LEPR spectra. The magnetic resonance, dynamics and recombination order of spin charge carriers were first shown to be governed by the structure and morphology of their polymer matrices as well as by the concentration and spatial distribution of spin traps reversible formed in composites under illumination. The concentration and energy depth of such traps are determined by the photon energy. These parameters can be additionally handled by the bringing into their bulk of a guest spin ensemble. Spin exchange interaction was shown to originate spin- and photon-correlate effective charge transfer in such multispin composite. Spin-assisted magnetic, relaxation and dynamics parameters of the PANI:TSA/PFO-DBT:PCBM and PANI:TSA/PCDTBT:PCBM multispin composites was interpreted in the framework of exchange of mobile spin pairs differently distributed in parental polymer matrices. An exchange interaction of localized guest and domestic spins with mobile spin pairs opens independent channels for precision controlling/handling their electronic properties for further creation of organic electronic and spintronic devices.

S02-341

Influence of Glass flake nanoparticles on thermal and dynamic mechanical properties of PP/EVA blends: Correlation with microstructure

Otady, Maryam; Solymani, Maryam; Goodarzi, Vahabodin*

Abstract

In this work attempts were made to establish correlation between thermal, dynamic mechanical properties and morphological properties of polypropylene/ethylene vinyl acetate copolymer (PP/EVA) blends containing glass flake (GF) as an inorganic nano-filler. Compatibilized and non-compatibilized PP/EVA blends loaded with 5 wt.% of GF were prepared by melt mixing process and their thermal and dynamic mechanical properties were determined. TEM investigations revealed that the GF nanoparticles were mainly located within the EVA phase of the blend. Also, microstructure of blends studied by SEM showed that incorporation of GF into the blends led to reduction of dispersed domain size attributed to reduction of interfacial tension due to the filler presence. Melting temperature of PP loaded with 5 wt.% of GF was increased up to 11oC as compared to the neat PP. Addition of GF and PP-g-MAH as compatibilizer to PP/EVA blend increased melting and crystallization temperatures determined by DSC. DMTA studies showed that addition of GF into the blends had no positive effect on the storage modulus of nanocomposites while, their loss modulus were higher than that of the neat PP. Moreover, the β transition temperature of PP phase in the blends loaded with GF and compatibilizer was about 5oC higher than the neat PP. The thermo-oxidative and thermal degradation behavior of developed nanocomposites determined by thermal gravimetric analysis (TGA) showed that thermal stability of nanocomposites was improved and their rate of degradation was reduced which were attributed to network-like structure formation of nano-fillers in the blends. Keywords: Nanocomposites; polypropylene; Ethylene vinyl acetate copolymer; blends; Glass flake; Dynamic mechanical properties

S02-357

Strain sensor with selectively distributed filler network in conductive polymer composites

Cardon, Ludwig; Duan, Lingyan; Luyckx, Geert; Degrieck, Joris; D'hooge, Dagmar*

Abstract

Piezoresistive strain sensor based on conductive polymer composites (CPCs) becomes more intriguing for great potential applications in recent decades. A trade-off relationship between "high sensitivity" and "high linearity and stretchability" in majority of strain sensors was shown. Large stretchability demands the material remains structurally and morphologically intact under strain, while high sensitivity requires substantial structural changes even under small strain. The conductive network morphology and interfacial interaction play the most important roles in determining the sensitivity of blended CPCs. In this research, incompatible ternary composites based on thermoplastic poly(ether)urethane(TPU) and Ethylene-octane block copolymer (OBC) and carbon black (CB) were produced with twin-screw extruder. Post-annealing was also conducted. The preferential distribution of CB in the blends, the conductive network morphology, the resistance variation of the as-prepared and annealed samples during static and dynamic tensile tests were investigated. The exponential revolution of resistive response to strain was also fitted with a model based on tunneling theory to investigate the change in tunneling distance and the number of conductive pathways. In summary, for TPU/CB or OBC/CB binary composites, similar three regimes of the resistance change ratio-strain relationship was shown. As for the strain range of different regimes and the strain sensitivity, especially in regime I, there is no significant difference. And the sensitivity in regime I is quite low. Lower percolation threshold value and monotonic variation relationship and higher sensitivity could be achieved through the construction of conductive network structure with CB selectively distributed in one polymer phase or the interface in TPU/OBC/CB ternary composites and post annealing treatment.

S02-378

Mechanisms of Dual Spherulitic Morphology in Poly(L-lactic acid) Induced by Amorphous Polymer

Lugito, Graecia; Woo, Eamor M.*

Abstract

Surface and interior lamellar assembly of dual-morphological spherulite generated from crystallization of poly(L-lactic acid) (PLLA) in the presence of atactic-poly(methyl methacrylate) (PMMA) have been characterized using polarized optical (POM), atomic forced (AFM), and scanning electron (SEM) microscopes. The formation of spherulite with dual morphologies takes place when the blend is crystallized at intermediate temperatures where the mobility of polymer chains is moderate, yet the crystallization rate is high. Besides the crystallization temperature, other factors such as molecular weight of both polymers, composition of the blends, as well as sample thickness have also been considered regarding their influence on the formation of dual-morphological spherulites (differ in their optical birefringence and lamellar arrangement). Direct observations toward the interior lamellar assembly have been conducted by fracturing the crystallized sample and subsequently etching out the amorphous portions from the spherulites. PLLA crystals are found arranging themselves into sheet-like and rod-like lamellae on the glass substrate. The development of these two distinct lamellar arrangements started from the nucleation site has been recorded. Each bundle of sheet-like lamellae at the nucleation site grows as one fibrous region as they cover a greater area; the area in between is covered by the rod-like lamellae growing to/from the substrate at a slower rate. Differ in their long axes and orders; both types of lamellae grow together composing a dual-morphological spherulite. This study demonstrates the microstructure instability induced by rapid crystallization of PLLA in a miscible blend with an amorphous polymer.

S02-411

Improvement of rheological and mechanical properties of PLA by reactive blending with Poly(MMA-g-GMA)

Karimi, Amirhossein; Garmabi, Hamid; Javadi Azizeh; Ahmadi, Mostafa*

Abstract

The aim of this study is to improve the melt strength of Polylacticacid (PLA) using methylmethacrylate-g-glycidylmethacrylate copolymers, Poly(MMA-g-GMA), that was synthesized by reactive blending at different weight fractions of GMA from 0 to 8 %. Copolymers were blended with polylacticacid (PLA) in internal mixer at different weight fractions from 0% to 15% as chain extender to modify the rheological behavior. The properties of neat PLA and modified PLA were characterized by Gel Permeation Chromatography (GPC), Differential Scanning Calorimetry (DSC) and Rheometric Mechanical Spectrometer (RMS). The balanced torque was increased by increasing the fraction of copolymer chain extender. PLA was even cross-linked when the content of copolymer reached 15%. The number and weight average molecular weights of PLA increased simultaneously as the fraction chain extender was increased. The results showed that Poly(MMA-g-GMA) is an effective chain extender for PLA. The glass transition temperature of PLA was also changed by blending with the synthesized copolymer. The blending affected the cold crystallization behavior and melting behavior of PLA, as well. Dynamic moduli also showed higher viscosities that can lead to higher melt strength. Keywords: PLA; rheological and mechanical properties; reactive blending; P(MMA-g-GMA)

S02-412

Lamellar assembly of Poly(3-hydroxybutyric acid-co-3-hydroxyvaleric acid) Spherulites Crystallized with Poly(Vinyl Methyl Ether)

Chen, Chung-Hao; Woo, Eamor M.*

Abstract

Ring-banded spherulites upon crystallization are common in some semicrystalline polymers including poly(3-hydroxybutyri acid-co-hydroxyvaleric acid) (PHBV). In this study, the lamellar assembly of PHBV spherulite in the blend with amorphous poly(vinyl methyl ether) (PVME) has been examined to elaborate the formation mechanisms of banded PHBV spherulites in non-isothermal crystallization process. The behavior of PHBV crystals at different temperatures (Tcs) was recorded and analyzed by using polarized optical microscopy (POM) and scanning electron microscopy (SEM). Under POM, PHBV/PVME (75/25) exhibits double-ring banded morphology with both orange and blue color bands alternatingly arranged along radial direction at a wide temperature range (60 to 100 oC). However, the band spacing and irregularity of the ring patterns on spherulites vary accordingly with Tc from wider-irregular rings at high Tc into slimmer-regular rings at low Tc. To further determine the correlation between crystallization temperature and spherulitic lamellar assembly, SEM was subsequently utilized on fractured samples. Correlations between top-surface banding patterns and interior lamellar assembly under various crystallization temperatures were collected and analyzed for possible formation mechanisms.

S02-450

Shapememory behavior of nanocomposite based on SBS/LLDPE/CNT

Kardan, Nazanin

Abstract

Shape memory polymers are new model of intelligent polymers that can be able to recover their initial shape by external stimuli such PH,humidity,magnetic,heat,etc. SMPs must have two phases, one fixity phase and one recovery phase. Shape memory polymers could be formed and temporarily fixed in a second temporary shape. In the present work, the blend of SBS/LLDPE was used as the shape memory material. The diffrent amount of CNT were added to the blend and the blend were cured by DCP for improving the mechanical, thermal and SMP properties. Fixity and recovery of final samples were measured and improving of recovery were gained because of improvement of thermal conductivity of the blend caused by CNT. The mechanical properties, morphology and the rheological parameters of samples were obtained. The mechanical properties test were measured by tensile device at room temprature(23 C). The rheological properties measured by RMS device and the morphology of samples were obtained by SEM test.

S02 - Polymer Blends and Alloys

Posters

S02-68

The Usage of Octaisobutyl-POSS in The Blends of PLA/PBAT: “Effects of Molecular Weight of PBAT”

Can,Buse Nur; Tuccar, Kilic Nilay; Kodal, Mehmet; Ozkoc, Guralp*

Abstract

In the last decade, the usage of plastics has become very popular in many areas owing to their several advantages. However the solid waste problem creates morality issues due to environmental problems. In order to prevent the pollution problem, biodegradable polymers have been focused by many researches. Recently, poly(lactic acid) (PLA) becomes most widely desired biodegradable polymer due to its good physical properties and being produced from renewable resources with an economical price [1]. Poly(butylene adipate-co-terephatalate) (PBAT) obtained from petrochemical resources is another biodegradable polymer and that can be easily processed without any converse effects on the environment. It can be also used to toughen PLA via melt blending [2]. Polyhedral oligomeric silsesquioxanes (POSS) organic/inorganic hybrid materials are new generation nano-fillers and could provide molecular reinforcement, increased thermal stability and better flame resistance [3]. The aim of this study is to investigate the effects of octaisobutyl-POSS (OPOSS) on the properties of PLA/PBAT blends. The PBAT molecular weight and OPOSS concentration was taken as the experimental parameters. Blends were prepared in a laboratory twin-screw microcompounder. Mechanical, thermal and rheological properties were characterized. The results showed that the high molecular weight of PBAT improved the mechanical properties of blends such as elongation at break and impact strength. Incorporation of OPOSS enhanced the compatibility between PBAT/PLA regardless of PBAT’s molecular weight. In addition, thermal properties were also affected positively. Acknowledgement: This study is financially supported by TUBITAK (Grant Number:115M576)

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S02-69

Effects of different toughens on the properties of poly(lactic acid)

Can, Buse; Tuccar, Kilic Nilay; Kodal, Mehmet; Ozkoc Guralp*

Abstract

Poly(lactic acid)(PLA) is one of the most extensively studied bio-based aliphatic polyesters that has several properties, such as high strength and stiffness. However the application of PLA is still limited due to its high price, low heat distortion temperature, and brittleness. PBAT is fully biodegradable and flexible polymer makes it a great candidate for the toughness of PLA. Nevertheless PLA and PBAT yields immiscible polymer blends which needs to be compatibilized. The other common polymer used to toughen PLA is thermoplastic polyurethane (TPU). The soft segment of TPU is expected to have a good compatibility with PLA but they make semi-miscible blends. This study focuses on the effect of incorporation of PBAT or TPU in to the PLA to improve the toughness. A styrene-acrylic multi-epoxidized polymeric compatibilizer (Joncryl®) was used in PLA/PBAT blends, whereas a diisocyanate chanin extender was utilized for PLA/TPU system. Blends were prepared in an Xplore Instruments MC15 twin-screw microcompounder. The mechanical, morphological and rheological properties of blends were investigated. The observations showed that Joncryl improved the mechanical and rheological properties of the PLA/PBAT blends, which supported by morphological results. The mechanical properties of PLA/TPU blends were improved with using PDI. PLA/TPU system is found to be tougher in comparison to PLA/PBAT under the experimental conditions.

Acknowledgement: This study is financially supported by TUBITAK (Grant Number:115M576

S02-72

Thermal and Thermo-mechanical Properties of PLA/TPU/Epoxy-POSS Ternary Blends

Tuccar Kilic, Nilay; Can, Buse Nur; Kodal, Mehmet; Ozkoc, Guralp*

Abstract

Poly(lactic acid) (PLA) has received great attention as an eco-friendly polymer because of its competitive price and high strength as well as being renewable and biodegradable. However, neat PLA cannot meet the requirements in some special circumstances because of its inherent brittleness; thus, toughening is required [1]. Thermoplastic polyurethanes (TPUs) can be used to toughen PLA by melt blending [2]. Polyhedral oligomeric silsesquioxanes (POSS) organic/inorganic hybrid materials are nanoparticles containing functional groups that are potential sites for polymerization, grafting, surface bonding etc. Epoxy POSS nanoparticles can react with carboxylic acid and isocyanate end-groups of either PLA or TPU in a wide temperature range [3]. Therefore, it can be used as a compatibilizer for PLA/TPU system. The objective of this study is to observe the effects of TPU content on the thermal and thermo-mechanical properties of PLA/TPU/Epoxy-POSS ternary blends. Blends were prepared by melt compounding process using an Xplore Instruments laboratory compounder. Thermal and thermo-mechanical properties were examined. The results showed that increasing TPU content inclined thermal decomposition temperatures of blends. In addition glass transition temperatures and crystalinity behaviours showed differences according to TPU content. Besides, thermo-mechanical properties showed that storage modulus decreased in case of higher TPU content. Acknowledgement: This study is financially supported by TUBITAK (Grant Number: 115M576)

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S02-73

Immiscible PLA/PBAT blends and Partially Miscible PLA/TPU blends: “Comparison of the Effects of O-POSS on Thermal and Themo-mechanical Properties”

Tuccar Kilic, Nilay; Can, Buse Nur; Kodal, Mehmet; Ozkoc, Guralp*

Abstract

Poly(lactic acid) (PLA) is a biodegradable polymer which can be obtained from completely renewable sources such as corn, wheat and rice; hence, it reduces the degree of dependence on petroleum resources. Despite its numerous advantages such as high strength and stiffness its low toughness and brittleness significantly impede its applications; therefore, toughening is required. Poly(butylene adipate-co-terephthalate) (PBATs) and thermoplastic polyurethane (TPU) are good candidates to toughen PLA [1]. PLA/PBAT blends show immiscible behaviour while PLA/TPU blends exhibit partially miscible behaviour [2]. Polyhedral oligomeric silsesquioxanes (POSSs) are nano-particles that create molecular reinforcement and can improve the compatibility between blends. Octaisobutyl-POSSs (O-POSSs) are POSS types that contain eight isobutyl groups [3]. The objective of this study is to compare thermal and thermo-mechanical properties of immiscible PLA/PBAT and partially miscible PLA/TPU blends in the presence of O-POSS. Melt-blending process is used for the preparation of blends. The results indicated that O-POSS positively affected the properties of partially miscible PLA/TPU blends, whereas negatively affected the properties of PLA/PBAT immiscible blends. Acknowledgement: This study is financially supported by TUBITAK (Grant Number: 115M576)

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S02-253

Mechanical properties of virgin ABS/post-consumer ABS blends

Souza, Adriana Martinelli Catelli; Cucchiara, Mayara Galego*

Abstract

Blends of virgin ABS (acrylonitrile butadiene styrene terpolymer) and post-consumer ABS coming from waste of electrical and electronic equipment (WEEE) was studied. Virgin ABS/post-consumed ABS blends were obtained by extrusion in five different proportions: 100 - 75/25 -50/50 - 25/75 -100 (wt%) using a co-rotational twin-screw extruder. Samples for flexural and impact tests were obtained by injection molding. After this procedure, some specimens were select for characterization and others were ground and injected again. Samples obtained by the first and second injection molding cycle were characterized by flexural and impact tests. Significant differences in mechanical properties were assessed by analysis of variance (ANOVA). vABS/pcABS blends, subjected to two injection molding cycles presented an increase in flexural modulus and flexural strength. Blends subjected to one or two injection molding cycles presented a slight increase in flexural modulus and flexural strength with increasing pcABS concentration. Impact strength of vABS/pcABS blends decreased with increasing pcABS concentration and with increasing the number of injection molding cycles

S02-258

Recycled polycarbonate as impact modifier in polypropylene

*Hau, Jean-Baptiste X MICHEL; Bonse, Baltus Cornelius**

Abstract

Polypropylene (PP) is one of the most widely used commodity thermoplastics, such as in the automotive sector, in part, for being lightweight, flexible and strong, with high flexural fatigue strength. However, it displays low impact strength, which is commonly improved by adding elastomer. Elastomer, however, reduces tensile strength and stiffness. To increase impact strength without reducing tensile strength and stiffness PP was blended with recycled polycarbonate (PC) at 10, 20 and 30 wt%. Since these polymers are incompatible two compatibilizer have been tested in the blends, namely, maleic anhydride grafted PP, PP-g-MA, and a Lotader copolymer ethylene –co-methyl acrylate co-glycidyl methacrylate, P(E-co-MA-co-GMA). Two methods of blending have been tested: (i) tumble mixing of all components with subsequent extrusion and injection molding; and (ii) extrusion of PC/compatibilizer master-batch, with subsequent injection molding of tumble-mixed master batch plus PP. Specimens have been subjected to impact, tensile, and flexural testing as well as scanning electron microscopy analysis. In terms of mechanical properties the best performance was found with the 80/20 PP/PC blend containing 10 wt% Lotader, prepared according to the first method of blending.

S02-330

Morphology, Crystallization Kinetics in Ternary Polymer Blends: Evaluating the Influence of Surface Functionalized Carbon Nanotubes

Kar, Goutam Prasanna; Bose, Suryasarathi*

Abstract

Structural properties, evolution of morphology and crystallization kinetics in immiscible polymer blends filled with multiwall carbon nanotubes (MWNTs) in the droplet phase were systematically investigated in this study. By grafting suitable macromolecules, that can drive the MWNTs to the droplet phase, allowed the understanding of the rate of nucleation and growth of the semicrystalline matrix in droplet-filled blends in contrast to matrix-filled blends. By blending 90 wt% of PVDF with 10 wt% ABS, matrix-droplet morphologies were generated and by grafting (styrene acrylonitrile) SAN onto MWNTs, the localization of the nanotubes was tuned to fill the droplet phase which otherwise prefers the matrix phase (here PVDF); driven by thermodynamics. The evolution of morphology under quiescent annealing conditions was assessed by SEM. The blends with SAN-g-MWNTs also coarsened as a function of time similar to neat blends however, to a lesser extent. Although, droplet laden MWNTs did not suppress coarsening in the blends but it still improved the tensile properties when compared with the neat blends. The fold surface free energy (as evaluated from isothermal crystallization kinetics) was estimated to be less in case of blends with SAN-g-MWNTs in contrast to blends with only MWNTs. This was attributed to the fact that matrix (here PVDF) filled with MWNTs experiences faster crystallization rate due to heterogeneous dispersion of nucleating agents (here MWNTs) in the matrix. However, when the nanotubes were mostly localized in the amorphous dispersed phase (here ABS), PVDF experienced similar crystallization behavior like the neat PVDF/ABS blends. Taken together, our study demonstrates that lower amount of energy is required for the arrangement of PVDF chains into the crystal lattice upon cooling from the melt state and accelerate the crystallization process when the heteronucleating agents are localized in the matrix phase than when they are localized in the amorphous phase.

S02-356

Enhanced thermal conductivity of polymer composites filled with hybrid fillers

Seyed Esfahani, Seyed Armin; Ghahramani, Nikoo; Mehranpour, Milad; Nazockdast, Hossein*

Abstract

Improvement thermal conductivity of immiscible polymer blends filled by hybrid fillers have attracted much attention in many thermal management fields. However, common method for achieving highest thermal conductivity have usually need high amount of conductive filler which result in poor mechanical properties and complex processing. using double percolation method with selective localization can be utilized as a solution for this problem. In the present work, the selective localization of boron nitride (BN) and Reduce graphene oxide (r-GO) in the immiscible polypropylene(PP) and polyamide 6 (PA6) blend is studied and investigation on the synergistic effect of hybrid fillers on thermal conductivity of polymer blend have been made. In this work the different composition of PP/PA6 have been studied in order to produce PP/PA/BN/r-GO thermally conductive composite with minimum volume fraction of fillers. The results of this study showed that hybrid fillers have good synergistic effect on thermal conductivity of PP/PA blend.

S02-358

Nanoparticle Partitioning of MWCNTs Filled PC/PVDF Co-continuous Blends by Rheological Characterization

Ahmadi, Hamid; Hosseini, Seyed mohammad; Javadi, Azizeh;*
Nazockdast, Hossein; Anvari, Mohammad

Abstract

The accurate determination of nanoparticle localization in immiscible polymer blends with co-continuous morphology by rheological technique has always been a difficult job. In this study we showed how the relaxation time spectrum (H(λ)) of polymer blends can be employed to determine the localization of MWCNTs in PC/PVDF Polymer blends with co-continuous morphology. This was carried off by comparing the H(λ) of MWCNTs filled blend samples with the filled and unfilled polymer component. It was demonstrated that MWCNTs is preferentially localized in PC phase which was confirm by TEM micrograph.

S02-362

Investigation on the thermal stability and morphology of PLA/PCL/Starch ternary blends containing hydroxyapatite nanoparticles and triclosan

*Yavarpanah, Shakiba; Seyfi, Javad; Khonakdar, Hossein Ali**

Abstract

Investigation on the thermal stability and morphology of PLA/PCL/Starch ternary blends containing hydroxyapatite nanoparticles and triclosan Shakiba Yavarpanah1, Javad Seyfi1, Hossein Ali Khonakdar2* 1 Department of Chemical Engineering, Shahrood Branch, Islamic Azad University, Shahrood, Iran 2 Leibniz-Institut für Polymerforschung Dresden e.V., Hohe Strasse 6, D-01069 Dresden, Germany Abstract Nowadays, developing innovative solutions for environmental problems have turned into the major concerns of researchers around the world. Therefore, replacement of petroleum-based plastics with biodegradable polymers is one of the promising solutions. In this study, an entirely biodegradable multicomponent system based on poly(lactic acid) (PLA), starch and poly(caprolactone) (PCL) was prepared via the melt-mixing technique. To achieve a better compatibility among the components, hydroxyapatite nanoparticles (nHA) and triclosan were added to the above-mentioned ternary blend. PLA was the matrix to which starch was added as a filler making the final material more hydrophilic. On the other hand, PCL was added to enhance the blend toughness. Triclosan and nHA were also added to impart some properties such as antibacterial behavior and mechanical strength, respectively. It was found that the combination of nHA and triclosan resulted in a great level of compatibilization. Several samples containing 1, 3 and 5 wt.% of nHA were prepared, and then, characterized by scanning electron microscopy (SEM), and thermogravimetric analysis (TGA). The morphology results showed that addition of nHA enhanced the compatibility among PLA, PCL and starch phases. TGA results also showed that in different temperature zones, the samples exhibited a different thermal stability due to the complexity of the system. All in all, the sample containing 1 wt.% of nanoparticles was found to exhibit an optimum behavior.

Keywords: Poly(lactic acid); Poly(caprolactone); Starch; Morphology; Nanocomposite

S02-375

Elongation Thinning and Morphology Deformation of Nanoparticle-filled Polypropylene/Polystyrene Blends in Elongational Flow

Kong, Miqiu; Huang, Yajiang; Li Guangxian*

Abstract

Elongational thinning is observed in model polypropylene/polystyrene (PP/PS) blends filled with nanoparticles at nanoparticle loadings ≥3 vol.% and high strain rates, wherein the nanoparticle network that forms at rest is destroyed by the deformation. The elongational thinning is more obvious in blends with hydrophilic silica surfaces than with hydrophobic silica, apparently due to stronger interaction within the hydrophilic silica network and between PS and hydrophilic silica. Moreover, the elongational deformation of droplets is almost unaltered at lower silica loadings but nearly completely inhibited at higher loadings, owing to resisting the deformation by the enough enhanced elastic modulus of the PS matrix filled with high loadings of hydrophilic silica . In contrast, hydrophobic silica significantly boosts the deformation of droplets in elongation presumably because of the reduced interfacial tension due to the preferential distribution of hydrophobic silica at the droplet-matrix interface, relative to the hydrophilic silica which resides mostly in the PS matrix.

S02-380

Structural and electrochemical properties of PEO/PAN/graphene nano-fibrous blends

*Abdollahi, Serveh; Ehsani, Morteza; Morshedian, Jalil; Khonakdar, Hossein Ali**

Abstract

Lately, incorporation of the nano-size fillers mainly include carbon nanotubes and graphene nanosheets into the polymer electrolytes have received growing attention due to their unique mechanical, electrical, and thermal properties [1, 2]. In the present work, different weight per-cents of graphene Oxide nanosheets (GOs) [x=0.025,0.05,0.1, 0.5 wt.%] were incorporated into polyethylene oxide (PEO)/ polyacrylonitirle (PAN) nanofibrous membranes [PEO/PAN weight ratio : 75/25] via electrospinning process. Incorporation of very small amount of GOs (0.05 wt.%) enhanced ionic conductivity of PEO/PAN membranes remarkably from 3.7 mS/cm to 10.1 mS/cm. It could be due to the improved electronic conductivity of ion conducting poly-mer electrolyte and increased degree of amorphicity of the PEO matrix and thus formation of pathways for the charge carriers. On the other hand, upon adding 0.5 wt% of GO the tensile strength and Young's modulus of the composite membrabes increased sharply by 320.6 % and 128 MPa compared with neat PEO/PAN fibrous membarne respectively. Based on the high ionic conductivity and improved mechanical properties, PEO/PAN/GO membrane could be promisingly used as a polymer electrolyte. Keywords: graphene Oxide nanosheets, polyethylene oxide, polyacrylonitirle, membranes, elec-trospinning, ionic conductivity.

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S02-395

Insights on the efficiency of bio-based antioxidants in PLA/ABS blends

Rigoussen, Alan; Verge, Pierre; Raquez, Jean-Marie; Habibi, Youssef; Dubois, Philippe*

Abstract

Over the last years, interest toward bioplastics has grown and these materials are expected to gradually replace petroleum based plastics. Many efforts to study these bio-materials and optimize their properties were achieved. Nevertheless, their development is still a challenge according to their inherent weaknesses, such as poor processability, brittleness, or poor thermal and physical properties. Among them, polylactide (PLA) is one of the most interesting bio-based material according to its biocompatibility, bio-resorbability, renewable origin and biodegradability, but its weak impact properties and poor thermal/oxidative stability result in a limited applications range. To overcome the brittle nature of PLA, the melt-blending with poly(acrylonitrile–butadiene–styrene) (ABS), a polymer having good impact and thermal properties, is an efficient and easily implementable approach. However, as PLA and ABS are immiscible, the resulting blend has poor mechanical properties and the addition of a third component acting as compatibilizer could tackle this issue. Recently, we have demonstrated that cardanol, a naturally occurring phenolic compound, was acting as an efficient compatibilizer for PLA/ABS immiscible blends. Its antioxidant properties were involved in the grafting of the phenolic moiety onto ABS during reactive extrusion. According to that finding, several natural antioxidant compounds were considered to produce compatibilized blends being stable against oxidation.

S02-418

An Investigation of Linear Viscoelastic Behavior of PP/EVA/LDH nanocomposites by Using Dynamic Mechanical Analysis and Creep test

Mahdavi, Reza; Otadi, Maryam; Goodarzi, Vahabodin*

Abstract

In this work attempts polypropylene/ethylene vinyl acetate copolymer (PP/EVA) blends loaded with layered double hydroxides LDH nanoparticles were prepared by melt mixing process and their thermal and dynamic mechanical properties were determined. Detailed investigations on LDH dispersion state in the polymeric matrix were conducted by transmission electron microscopy. TEM investigations revealed that the LDH nanoparticles were mainly located within the EVA phase of the blend. Also, microstructure of blends studied by SEM showed that incorporation of LDH into the blends led to reduction of dispersed domain size attributed to reduction of interfacial tension due to the filler presence. Melting temperature of PP loaded with 5 wt% of LDH was increased up to 11 oC as compared to the neat PP. Addition of LDH and PP-g-MAH as compatibilizer to PP/EVA blend increased melting and crystallization temperatures determined by DSC. DMTA studies showed that addition of LDH into the blends had no positive effect on the storage modulus of nanocomposites while, their loss modulus were higher than that of the neat PP. Moreover, the beta transition temperature of PP phase in the blends loaded with LDH and compatibilizer was about 5 oC higher than the neat PP. Time-temperature superposition was applied to obtain viscoelastic master curves at different temperatures. Creep and recovery tests at various temperatures were done. Also, viscoelastic parameters of the nanocomposites at defined temperatures were obtained by applying of Burger and Weibull models. The creep compliance master curves of studied samples were also obtained which showed that compliance of neat polymer increased after 1667 h while that of nanocomposites containing 5wt.% of LDH showed significant reduction.

Keywords: polypropylene; Ethylene vinyl acetate copolymer; blends; Nanocomposites; layered double hydroxide (LDH); Dynamic mechanical properties