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ABSTRACTS

THE ROLE OF POLYMERS AND POLYMERS SCIENCE IN THE EVOLUTION OF NANOMATERIAL AND NANOTECHNOLOGIES

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ABSTRACT

Nanotechnologies (21st Century Technologies) prove a huge potential in changing society and life on all levels. The "nano" phenomenon is based on the generation of new properties of solid matter with decreasing size (below 100 nm) and shape changes on one, two or all three spatial dimensions in the "nano" domain (1-100 nm).

Around the 2000s, the synergetic convergence of various disciplines and fields of research and technology/engineering in the manufacture of advanced material systems and devices through high precision technologies ("Convergent Technologies") generated what are known today as nanoscience, nanotechnologies and nanomaterials (Fig. 1a) [1]. The “Convergent Sciences and Technologies” paradigm is based on the idea of taking over small material entities (starting with atoms and molecules) and assembling them rigorously controlled into larger components, the latter being able to be assembled into larger bodies up to the micro or macroscale (“convergent assembly”), systematically repeated in a hierarchical manner.

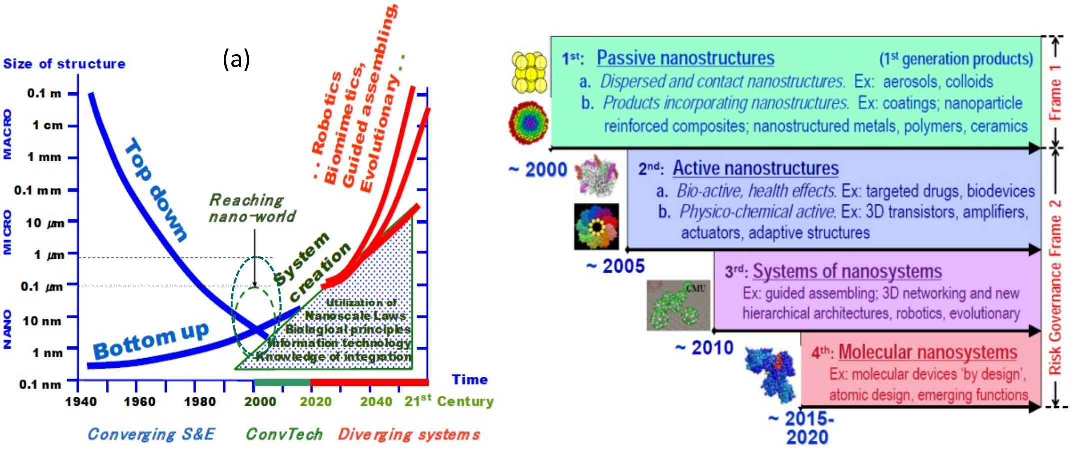

Fig. 1. The evolution towards the convergence of sciences and engineering fields (Converging S&E, 1940 ~ 2000), Development & Use of “Convergent Technologies” for the creation of “nanoscale” systems (ConvTech, 2000-2020) and Divergence towards new paradigms (approaches) for the realization of nanosystems with superior architectures for emerging applications (after 2020) (a). Chronological presentation of the four generations of nanoproducts resulting from nanotechnologies (b) [1]

Nanotechnology, defined by Guisberg (UK Royal Society) as the design, characterization, production and use of structures, devices and systems by controlling shape and size at the nanoscale, has so far led to four generations of nanomaterials (Fig. 1b) [1]. In the evolution of these generations of nanostructures and nanosystems, polymer science has led to the emergence of "molecular nanotechnology" (MNT) and "molecular manufacturing" (K. Eric Drexler) with a decisive role in the creation of "macromolecular nanosystems”of the 4th generation (“molecular machines”, “molecular robots”), similar to natural cellular structures (e.g. ribosomes, key elements in the biosynthesis of natural proteins essential for life [2]).

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Regarding polymers, it can be said that they have evolved in two directions: as a new generation of nanostructured organic compounds (I) and as key elements in the development of other classes of nanostructured materials (inorganic materials, hybrid materials, biomaterials) and of the chemical nanotechnologies in general (II). The presentation includes the classification of the two classes of nanostructured materials with polymers: nanostructured polymers (nanopolymers) (I) and polymers-based nanostructured materials (II).

As bottom-up approaches, chemical nanotechnologies (Nanochemistry) use material building blocks of nanometric dimensions with well-defined shapes (nanospheres, nanowires, nanotubes, nanowires, etc.) and perform their controlled assembly into micro / micro-objects at macroscale (3D), without external intervention (energy), based only on “specific” constraints (controllable molecular interactions) of self-assembly. The nanopolymers are among the most promising building blocks, which can be used as stand-alone elements or in more complex self-assembled architectures (hierarchical nanosystems). The presentation briefly focuses on the impact of “block copolymers” as nanopolymer templates, which come in many types and shapes, for synthesizing dimensional nanostructures (nanowires, nanorods, nanoribbons and nanofibers, nanolayer, nanosheets, dendrimers etc.) of metal, metal oxides, ceramic, polymer, graphene, or hybrid nanomaterials [3].

Recent progress in nanotechnologies uses natural and synthetic biocompatible/biodegradable polymers with important role in applications as flexible/transparent electronics, nano(bio)electronics, nonconventional energy, sensing, food industry, water treatment and biomedical field [4].

The presentation also shows some complex organic-inorganic hybrid nanostructured polymer systems resulting from our own experimental studies conducted in the Laboratory of Chemical Nanotechnologies of the Center for Nanostructures and Functional Materials in UDJG and in collaboration with our partners in the country and abroad.

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DETERMINING THE SURFACE ENERGY OF NANOPARTICLES BY PICKERING EMULSION POLYMERIZATION TECHNOLOGY

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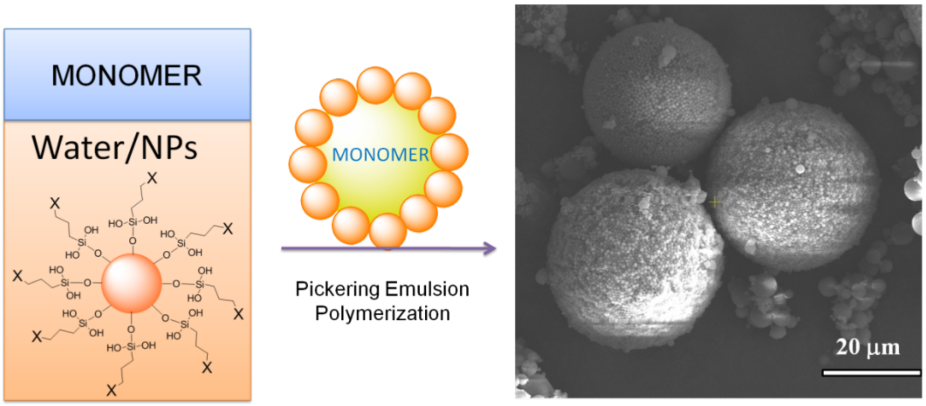
ABSTRACT

Knowledge of interfacial free energy interactions is necessary for understanding and modeling many surface and interface processes involving wetting phenomena such as preparation of suspensions and emulsions, painting, drug preparations and others. To date, several theories and approaches have been proposed, but the formulation of surface and interface free energy, in terms of its components, is still a very debatable issue.[1,2] In the present paper we have developed a new method for determining the contact angle and surface energy components of nanoparticles by using Pickering emulsion polymerization technology. This method first involves the creation of oil–in–water Pickering emulsion (the oil droplets consisting of a monomer such as styrene and other vinyl derivatives) stabilized by a series of functionalized silica nanoparticles (with differ in the polarity of their surface). Then, the Pickering emulsion was polymerized to attach the silica nanoparticles to the interface. In the next stage, their interfacial immersion depth is determined and subsequently the contact angle and the surface energy of the nanoparticles is calculated.



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ELECTROCHEMICAL SYNTHESIS OF *N*-SUBSTITUTED POLYANILINE WITH DIFFERENT MICRO/NANOSTRUCTURES FROM ACIDIC AND SLIGHTLY ACIDIC ELECTROLYTE SOLUTIONS

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ABSTRACT

Polyaniline also called “smart polymer”, is a versatile material because of its multiple applications conferred by its high stability and unique complex of properties. Among all polyanilines, the sulfonated ones possess unique properties, such as solubility in water or in aqueous bases, suppressed or not necessary anion doping during redox processes, extended redox activity for neutral and basic solutions, etc. which makes them very useful materials as sensing elements for sensors[1,2] and biosensors[3] and for some polymer processing techniques.

In the present study, we report the electrochemical synthesis of copolymers-based *N*-substituted anilines having sulfopropyl and ethylhydroxyl groups. The pH variation of the electrolyte aqueous solutions, from acidic to slightly acidic solution, and the influence of different molar ratio between monomers were investigated using electrochemical and surface morphology techniques. The polymer formation is a complex process which depends on many factors (e.g. the surface properties of the working electrode, (electro)polymerization parameters), while the assembly of the polymer chains may form various morphologies, like one-dimensional or two-dimensional micro/nanostructures. When using slightly acidic aqueous solution, nanospheres were obtained by cyclic voltammetry or controlled potential electrolysis, without any addition of steric stabilizer or surfactants, and this suggests that the growth mechanism evolved *via* a different path from that for polyaniline and its substituted derivatives. We have consistently changed the electrochemical parameters to control the size and distribution of particles. An increase in electrolysis time has led to an increase in the number of particle aggregations while the size of the individual particles slightly increases. Due to their high surface area activity, microspheres of these polyanilines may be useful in various applications like encapsulation, drug delivery, development of artificial cells, and protection of biologically active agents (e.g proteins, enzymes)[4,5].

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SYNTHESIS OF SUPRAMOLECULAR NETWORKS BASED OF POLYROTAXANES ARCHITECTURES

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ABSTRACT

Nowadays, considerable attention has been paid to development of new supramolecular networks based on polyrotaxane structures. Unlike, the classical polymer networks with fixed covalent junctions, these materials exhibit improved physical properties due to the pulleys like behavior [1]. This strategy opens new opportunities to obtain a wide variety of such supramolecular networks with a better tendency to organize into homogeneous surface morphology in the solid state that recommend them for a variety of applications, such as smart and stimuli-responsive materials, capacitors, sensors, actuators. As a continuation of our research interest in the designing of supramolecular networks, [2,3] this work outlines the results on synthesis and characterization of composite materials based on polyethylene glycol (PEG) polyrotaxane and polystyrene (PS) in semi-rotaxane architectures both encapsulated into hydroxypropyl-β-cyclodextrins (HPβCD) cavities, followed by their cross-linking with 1,6 hexamethylene diizocyanate (HMDI). The physico-chemical, morphological and dielectric properties of these materials have been analysed and compared to those of the pure cross-linked film. The schematic representation of the synthesis is presented in Error! Reference source not found.

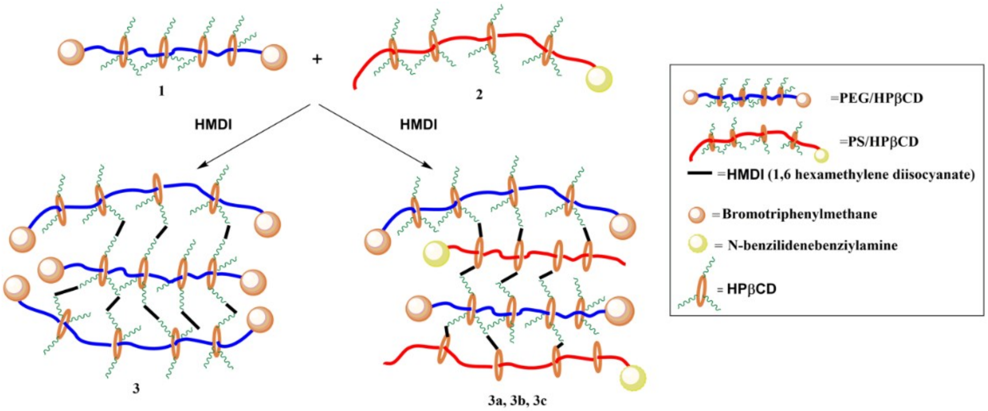

Fig. 1. Schematic representation of the composite materials synthesis

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POLYANILINE/ POLY(STYRENE-CO-TERT-BUTYL ACRYLATE) COMPOSITES: PREPARATION MORPHOLOGY AND SURFACE PROPERTIES

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ABSTRACT

Polyaniline (PANi) is one the most versatile semiconducting polymers owing to its unique advantages like good environmental stability, ease to prepare and reversible acid/base, doping/dedoping chemistry [1]. Therefore, much effort has been made to improve the major drawbacks, like lack of processability and solubility of the conducting PANi. Lately, polymeric materials such polystyrene, poly(vinylacetate), poly(vinylacohol) were used to synthesized composites with PANi. Polystyrene nanoparticles are frequently used as supporting materials for semiconducting polymers to improve their processability in solvents, and as surface doping agents [2].

The aim of this study is to improve the PANi processability by increasing its polarity by copolymerization with polar monomers and depositing it on supporting colloidal nanoparticles. Thus, we prepared a series of polyanilines/poly(styrene-co-tert-butyl acrylate) composite materials by chemical oxidative polymerization using five different fractions of aniline and sulfonated aniline, in the presence of poly(styrene-co-tert-butyl acrylate) colloidal nanoparticles (NPs). The concentration of NPs was kept constant. Typically, the *in situ* generated PANi polymer deposits as a shell on poly(styrene-co-tert-butyl acrylate) colloidal NPs, but with the increase in fraction of the polar sulfonated aniline compared to non-polar aniline, the semiconducting polymer deposits much less on the NPs. Further, we evaluated the sedimentation rate of obtained series of semiconducting composites, showing a substantial change in the polarity of the material, whereas the composites with the highest fraction of polar sulfonated aniline shows the slowest sedimentation rate. On the other hand, the presence of the NPs greatly increases the processability of PANi in water. The conductivity studies show that the improvement in polarity comes at the expense of decreasing conductivity, where the conductivity decreases monotonically in the series of semiconducting composites, with increase in the sulfonated aniline monomer content. Further, the prepared composites were characterized by various methods including FT-IR spectroscopy, UV-Vis spectroscopy, Zeta-potential and conductivity measurements, while morphological studies were carried out by scanning electronic microscopy (SEM).

The synthesis method that we used is simple in comparation with other techniques and the polyanilines/poly(styrene-co-tert-butyl acrylate) composite materials with improved processability in aqueous solvents could be deployed in many applications such sensors, drug delivery, supercapacitors, etc.

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PREPARATION AND SENSOR CHARACTERISTICS OF POLYIMIDES FILLED WITH IRON OXIDE TITLE

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ABSTRACT

The polymorphism of iron oxide particles (magnetite-Fe_3O_4 and maghemite-Fe_2O_3) has specific physical and chemical characteristics which make them good candidates in industrial applications. An advanced and new functional composite material, with impressing interplay at the boundaries between phases composition of iron oxide, is successfully obtained. The material consists of a semi-aliphatic polyimide (denoted PI-DOCDA) filled with iron oxide. The amount of iron oxide embedded in the polyimide matrix is varying between 5, 10 and 20%wt. All the materials are prepared at 300°C. The phase composition is demonstrated by X-ray diffraction analysis (XRD). Rietveld method is implied to quantify the presence of these two phases indexed as magnetite-Fe3O4 and maghemite-Fe_2O_3 (Table 1). Magnetic and electric properties of the resulted composites are also investigated. The magnetic information, such as remanent magnetization Mr, saturation magnetization Ms, and coercivity (H_c), are attained from the hysteresis loops of the samples. Magnetic properties are influenced by structural changes of the obtained materials and interphase of the fillers into matrix. The electrical properties are analyzed under different humidity conditions, demonstrating the applicability of the materials as sensors.

Table 1. Structural parameters calculated for PI-DOCDA/iron oxide composite prepared at 300 °C: lattice parameter for magnetite (a_{mgn}) and maghemite (a_{mgh}) crystalline phases; amount of crystalline phases for magnetite (Q_{mgn}) and maghemite (Q_{mgh}); and goodness of fit in Rietveld refinement (GOF)

PI-DOCDA/Fe_3O_4	**a_{mgn}**	**a_{mgh}**	**Q_{mgn}**	**Q_{mgh}**	**GOF**
5%wt	8.374(3)	8.346 (1)	87.7 (5)	12.3 (5)	1.25
10%wt	8.378 (2)	8.348 (4)	86.3 (5)	13.7 (4)	1.32
20%wt	8.370 (5)	8.346 (2)	82.8 (5)	17.2 (5)	1.22

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DIELECTRIC BEHAVIOUR OF PVP 360 AND PVA FOR THIN FLEXIBLE TRANSISTORS APPLICATION

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ABSTRACT

Altough there is much progress in the field of thin flexible transistor, major challenge for organic thin film transistors is the high operating voltage which is related to the dielectric gate from the structure of OTFTs. In this paper we present the electrical bahavior of PVP 360 (polyvinylpyrholidone) and PVA (polyvynil alchool) thin films deposited onto glass and PET/ITO (polyethylene terephthalate/Indium tin oxide) substrates. The polymer films with different thicknesses deposited from two concentration solutions using the spin coating method were characterized by optical microscopy and electrical measurements. For electrical measurements, graphite electrodes were used. The electrical behaviour of thin film polymers was measured in air by monitoring the variation of resistance when a constant voltage-V is applied in DC, both at room temperature (RT) and also from RT to 100 ^{0}C (Figure 1), using the Kiethley electrometer. Previously, the thermal behaviour of polymers was analized in air, from RT to 100 ^{0}C, using TGA Q 5000 IR TA and DSC Q20 TA equipments.

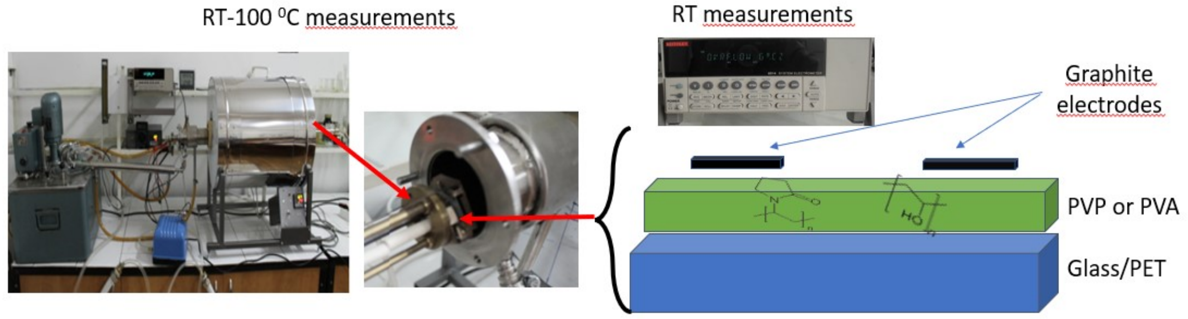

Fig. 1. Experimental set-up

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DYNAMIC PATTERNING OF POLYIMIDE FILMS USING ATOMIC FORCE MICROSCOPY TECHNIQUE

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ABSTRACT

With the advent of the atomic force microscopy (AFM), visualization, measurement and nanometer scale modifications of polymer samples became possible. Dynamic patterning using AFM is a less common technique through which a certain surface can be shaped by indenting it with a vibrating tip in the tapping mode, with predefined scan speed and oscillation amplitude, following an established design, composed by lines of arbitrary length and direction, with spacing even of a few nanometers without leading to edge irregularities. In this case, the advantage is that the imaging of the patterned surface can be made, with no unwanted alteration, without changing the scanning tool or the cantilever. Between the polymers that can be patterned at nanoscale, polyimides constitute a distinguished class due to their attractive mechanical, thermal, and electrical characteristics. In this context, three distinct polyimide films were patterned and a complex characterization of the obtained surface morphology through the texture and functional parameters was realized in order to determine if the obtained surface features can be adapted for applications where designing custom nanostructures with enhanced anisotropy is mandatory, such as fabrication of bio-analytical assays, guided cell growth, micro-fluidics, and liquid crystal alignment layers. Starting from the aliphatic/aromatic character of the monomers and the backbone flexibility, the effect of the diamine and dianhydride moieties on the characteristics of the pattern in the same AFM dynamic patterning conditions was established. Also, to pursue the impact of the patterning process on the cantilever's tip characteristics, for instance on the sharpness, degradation and contamination, a blind tip reconstruction of the AFM probe, before and after the experiments is presented.

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LAYERED POLYMER SHIELDING COVER WITH GRADED REFRACTIVE INDEX FOR SOLAR CELLS WITH ENHANCED LIGHT HARVESTING

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ABSTRACT

Optical phenomena occurring in upper layers of solar cells are of great impact when discussing the conversion efficiency [1]. In the attempt to replace the glass cover with other materials, few studies are focused on polymer materials as alternatives [2]. This work is focused on the investigation of the optical absorption and refraction processes which are taking place in the protective layer of the solar cell working in superstrate configuration. The shielding material is made of two transparent polymers with distinct refractive index. The correlation between refractive index dispersion and the optical losses is also examined. The amount of propagated light within each layer of the solar cell structure up to the active zone is analyzed. The presented data are of great relevance for modern design of protective polymer covers for solar cells with enhanced conversion efficiency.

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POLYMERS AND NANOTECHNOLOGIES FOR ENVIRONMENTAL REMEDIATION. A REVIEW

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ABSTRACT

Nanotechnology, one of the fastest developing areas of research with applications in a variety of fields can be the solution for many world problems, including water purification and water desalinization [1]. It is estimated that 829000 people die from unsafe drinking water and only in 2017, 220 million people required treatment for parasitic worms [2]. The second leading cause for death in children under 5 years old remains waterborne outbreaks [3].

One of the immediate applications of nanostructured polymers is in developing a new generation of filtration membranes for environmental and water purification. Increased efforts to eliminate pollutants and pathogenic contaminants of water have led researchers to explore different type of polymers nanostructuration and functionalization with photocatalytic and antibacterial agents.

Nano/microfiber membranes are one of the most important types of non-self-assembled nanostructured polymeric materials. This paper aims to present a review on the use of functionalized nano/microfibers-based membranes obtained through electrospinning. Some examples like cellulose acetate, polyacrylonitrile (PAN) (synthetic polymer) and polyvinyl chloride (PVC) membranes containing silver nanoparticles with anti-microbial activity will be discussed [4-5]. The use of polyvinyl butyral in combination with berberine hydrochloride via electrospinning show also antibacterial activities [5]. Designing durability into a product is the key. Successful fabrication strategy also relies in how to achieve the optimal characteristics in a renewable way. In this respect, nanosheet membranes can be made by constructing a molecular sive, layer by layer, crosslinking on nanoparticles [6]. In 1991 the term "Green chemistry" was proposed by Paul Anastas, paving the way towards applying the nanoscience but also assessing the consequences. The green chemistry concept allows for incorporation of sustainable processes, reducing waste, replacing hazardous substances used in the process and increasing sustainability [7].

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THE USE OF MICROWAVE AMINOLYTIC DESTRUCTION PRODUCTS OF POLYETHYLENE TEREPHTHALATE VIBRATING POLYMER COMPOSITION MATERIALS

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ABSTRACT

The aim of this work is to study the possibility of using the products of aminolytic destruction of polyethylene terephthalate (PET) and their derivatives in polymer composite materials with vibration-absorbing properties, which provide effective damping of vibrations of technogenic and natural origin in a wide temperature and frequency range.

The paper considers a modern method of recycling PET waste with a mixture of amino alcohols - monoethanolamine and triethanolamine, taken in two different ratios. As a result of the destruction reaction, terephthalic acid diamide (N, N'-bis (2-hydroxyethyl) terephthalamide) is formed. To accelerate the destruction process, microwave radiation of various powers of 200, 540 and 700 W was used. The optimal conditions for aminolytic decomposition of PET were determined: the time and power of microwave radiation with PET conversion up to 95% and the yield of the target product (terephthalic acid diamide) 80-85%. The destruction process was carried out according to a closed cycle of using reagents, without the use of catalysts and at atmospheric pressure, which to a certain extent reduces the energy consumption and increases the environmental friendliness of this method of PET decomposition. The aminolytic degradation product of PET (terephthalic acid diamide) was used as a monomer in the polycondensation reaction to obtain a new oligomer (terephthalic acid oligoesteramide). The degree of polymerisation (n) is in this case 7 to 11 (number of chain links).

The obtained oligomer and the PET degradation product were investigated as new components in elastomeric compositions based on chloroprene rubber and in compositions based on thermoplastic elastomers. It has been demonstrated that the introduction of an oligomer based on a PET degradation product reduces the viscosity of elastomeric compositions by 25-35%.

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RECYCLING OF CARBON FIBER LAMINATES BY THERMO-MECHANICAL DISASSEMBLY AND HYBRID PANEL COMPRESSION MOLDING

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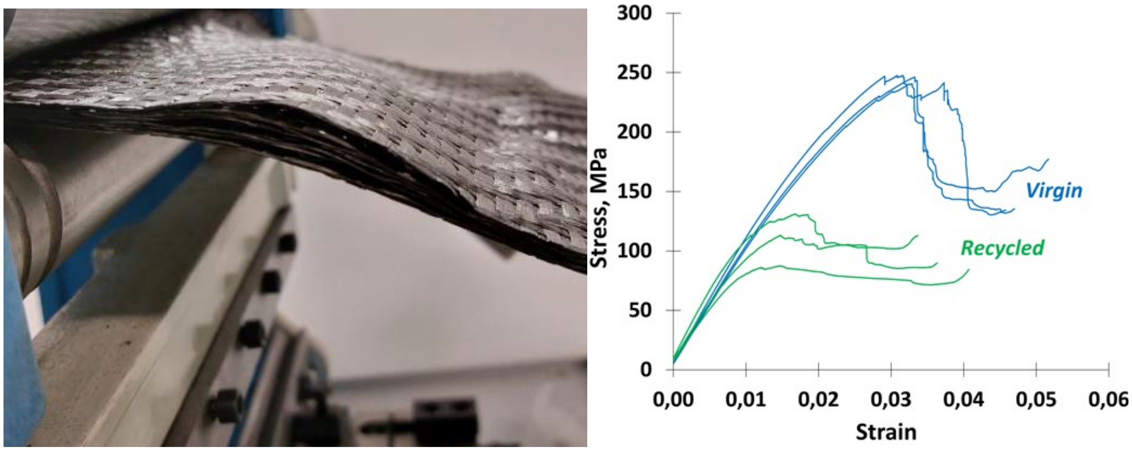
ABSTRACT

Composite recycling is a big challenge because of the difficulty of waste material re-processing and the very low residual value of secondary raw materials. Recent studies deal with thermal or chemical matrix evacuation with negative consequences in terms of emissions and energy consumption [1-3]. In this study, a novel technology for composite laminate recycling is proposed. The waste laminate is disassembled by roll bending after heating. Both woven fabrics and UD laminates can be decomposed. The resulting plies are re-laminated by interposing thermoplastic films, and compression molded. In the current study, a composite panel has been thermo-mechanically disassembled (Figure 1a) to produce a hybrid composite laminate with LDPE interlayer. Mechanical tests by bending have shown the optimal laminate agglomeration and its considerable mechanical properties (Figure 1b).



(a) (b)

Fig. 1. Thermo-mechanical disassembly (a) and bending tests on virgin and recycled samples (b)

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CRUCIAL PARTS IN A COMPOSITE-NANOCOMPOSITE: THE INTERFACES/INTERPHASES

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ABSTRACT

The key to achieving the best physico-chemical and mechanical properties of a composite, nano-composite or hybrid composite materials is to have a perfect control of the interface/interphase of the matrix/reinforcements. Three approaches are used:

(a) The chemical route which consists in making the reinforcement and the matrix compatible by a chemical treatment of the strengthening in adequacy with the chemical nature of the matrix,
(b) The second path, widely used in the industry, consists in creating indentations along the reinforcement by corona effect, etching or high temperature rotary embossing. These notches allow the resin to " hook " to the parts of the reinforcement and thus create the conditions for a better interface/interphase in composite manufacturing,
(c) The third and modern option is to work with aligned-carbon nanotubes A-CNTs to reinforce interlaminates (fuzzy-fiber reinforced polymers FFRPs or nano-stiched composites NSCs).

We will highlight and illustrate these phenomena with some applications taken from the automotive, nautical, aeronautical industries and additive manufacturing-3D printing technology.

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ENHANCEMENT OF THE MECHANICAL PROPERTIES OF ADDITIVE MANUFACTURED POLYMERIC PARTS BY USING DIFFERENT TYPES OF FIBRES

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ABSTRACT

Additive manufacturing (AM) also called 3D printing, is an emerging process in the manufacturing sector with increasing new applications in aerospace, prototyping, medical devices and product development, among others. The AM part's resistance is determined by the chosen material and printing parameters [1, 2]. Nevertheless, these materials without any modification have relatively low mechanical properties which means that the printed parts cannot be used for high-performance applications. There are various methods explored in the literature to enhance the original properties of the materials used for FDM processes (e. g. incorporation of nanoparticles within the material and the use of fibers or fabrics as reinforcements). The main objective of this work was to investigate the mechanical properties of AM polymeric parts (Polylactic Acid (PLA) and Acrylonitrile Butadiene Styrene (ABS)) reinforced by different types of fibers. Natural (curauá and jute) and synthetic (glass) fiber fabrics were laminated on the outer sides of the AM parts by using an epoxy resin. The reinforcement was applied to the AM parts as 1 and 2-layers for each fiber type. The mechanical characterization of the composites was performed through tensile and flexural tests in accordance with their respective ASTM standards. It was found that the addition of the reinforcement fibers improved the mechanical properties of the AM parts for both materials tested. In general, the glass fiber reinforced specimens presented better mechanical properties when compared to the natural fiber reinforced AM parts. The curauá fiber reinforced specimens presented improved performance when compared to the jute composites and matched the mechanical properties of the 1-layer glass fiber reinforced specimens. The failure modes significantly varied as a function of the material. The PLA specimens showed a brittle failure, while the ABS specimens presented delamination in the resin/printed part interface. Adding different fiber fabrics to 3D printed materials may be a promising innovation in order to improve their mechanical properties and these improvements might enable these materials to serve for high load bearing purposes.

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TENSILE PROPERTIES AND MANUFACTURING DEFECTIVES OF SHORT CARBON FIBER SPECIMENS MADE USING FDM PROCESS

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ABSTRACT

Once with the fourth industrial revolution, the Additive Manufacturing started to offer new possibilities of manufacturing, the Fused Deposition Modeling being one of the most used processes for fabrication. In this paper, the studied specimens are manufactured based on Fused Deposition Modeling (FDM) method, with a filament of short carbon fiber and polyethylene therephthalate (PET) matrix, with the variation of the layer thickness. For the resulted specimens the tensile properties are determined according to ASTM D638. The most advantageous results are obtained for the layer thickness of 0.15 mm, with failure strength of 58 MPa. Based on the stress-strain curves which are being presented in the paper, it also can be assumed that the material is brittle. The results of the mechanical properties are very similar for each group of specimens, which it can be assumed that the mechanical properties are homogenous due to the material quality and the machine performances. For all the specimens the rupture location is almost on the same area. Also, due to the difficulty of carbon fiber filament printing, the manufacturing defectives which appear during the manufacturing process are being detected, the most common manufacturing defectives being the material gaps from each specimen, which are being identified with Nikon T1-SM microscope. As failure modes, the most common failure criteria are being the delamination and the matrix cracks.

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SOME INSIGHTS ON CHEMICAL TREATMENT OF 3D PRINTED PARTS

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ABSTRACT

The substantial increase in the use of the FDM (Fused Deposition Modeling) process for the production of plastic parts in ever wider fields has led to the search for methods to improve the quality of the printed parts. In the case of ABS parts (Acrylonitrile Butadiene Styrene), one of the most common and used methods to improve surface quality is the process of acetone steam treatment, but the application of this method also brings more or less negative effects on the part. The main side effects when applying this method is the low breaking strength and loss of part details on the sharp edges. This paper presents a set of contributions on the relationship between surface quality and the level of detail of parts subjected to acetone steam treatment. In order to analyze the influence of the treatment on the details of the parts, a reverse engineering method was used in which a polyarticular arm FARO Edge 7.5 was used to scan the parts and reconstruct them. The study was performed on parts with 20% infill, grid type.

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SHAPE OPTIMIZATION OF TOPOLOGY INTERLOCKING ELEMENTS

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ABSTRACT

A Topology Interlocking Assembly is an arrangement of elements of a particular shape and arranged so that the surrounding elements constrain each element movement. The simplest Topology Interlocking configurations can be obtained by using one of the five platonic solids. Although the shape of interlocking elements is relatively simple, their arrangement into a structure is challenging without the help of a tray due to linear or point-like seating features. Furthermore, because of their shape and orientation, not all available surface area is used to achieve the interlocking behaviour. For this reason, the objective of this paper was to optimize the shape of the cubic element for interlocking assemblies by using topology optimization. In the optimization process, factors as assembly and manufacturing ease were considered. The resulting interlocking element has a similar load capacity with the unoptimized element but with lower mass, reduced volume, and easier assembly process.

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TENSILE STRENGTH OF THREADED RODS MADE BY 3D PRINTING OF POLYMERIC MATERIAL

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ABSTRACT

The extension of 3D printing processes for parts made of polymeric materials has highlighted the possibility of manufacturing threaded surfaces by such processes. In principle, the operation of a threaded joint implies tensile forces in the threaded rod. The dimensional characteristics of the threaded surface and some input factors in the 3D printing process can influence the tensile strength of the threaded rods made of polymeric materials. A factorial experiment was designed and materialized to identify an empirical mathematical model capable of highlighting the influence exerted by the dimensional characteristics of the threaded surface and some of the input factors in the 3D printing process on the tensile strength. Test samples made of polymeric materials were manufactured by 3D printing, subsequently subjected to tensile tests. The mathematical processing of the experimental results allowed the determination of a mathematical model that allows including the ordering of the factors taken into account in terms of the intensity of the influence that these factors exert on the tensile strength of the threaded rods.

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A STUDY ABOUT SOME MECHANICAL PROPERTIES FOR COMPOSITES REINFORCED WITH CORN COB POWDER

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ABSTRACT

In this paper we have created some composites reinforced with corn cob powder and the matrix from epoxy resin Resoltech 1050 with Resoltech 1058 hardener. For the composites manufacturing, we have used the manual casting technique. For the new manufactured composites, we have determined the mechanical properties from the tensile test according to ASTM D3039: Young modulus, breaking strength and elongation at break. We have also molded samples for the compression test according to ASTM D695-15 and we have determined the breaking strength. The tensile and compression tests were made on universal testing machines. In the end, we have determined also the dynamic mechanical properties for the studied material by clamping the bars at one end and leaving them free at the other end. At the free end we have placed a Bruel&Kjaer accelerometer which recorded the samples free vibrations. From the free vibrations recording and Euler-Bernoulli theory, we have determined the next dynamic mechanical properties: damping factor per unit mass and length, eigenfrequency, dynamic Young modulus, loss factor and dynamic stiffness. From the experimental results, we have obtained increased breaking strength values for the proposed material at compression compared to the tensile test. Compared to similar materials studied in the engineering literature, we have obtained increased compression breaking strength (for example, compared to the study from [1]). The mechanical properties, together with the vibration properties obtained for the studied composites, recommend them to be used for making reusable formworks for some construction elements, house decorations, table tops and so on.

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IMPROVED APPROACH TO DESIGNING THE VACUUM CHANNELS FOR ADDITIVELY MANUFACTURED THERMOFORMING MOULDS

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ABSTRACT

Some of the earliest plastics applications were performed by simply heating, bending and cooling a plastic sheet over a particular product or mould. Later, this process will be called thermoforming, but the steps of modelling a plastic sheet using this technology will remain the same even for modern equipment. The technologies considered in this paper are vacuum forming as a thermoforming process and Fused Filament Fabrication (FFF) as an additive mould manufacturing technology.

Vacuum forming uses only one mould at a time and, as the name might suggests, the process relies on a vacuum system. When air suction is applied, the heated plastic sheet will draw around the mould to create the desired shape. Consequently, the characteristic elements of such a mould are the vacuum channels or vacuum holes which traditionally are small diameter holes drilled through the mould body. The proper diameter of the vacuum hole should not exceed the thickness of the sheet that covers it. If the vacuum hole is too large, the sheet will thermoform into it and cause the appearance of marks (nibs or nipples) or rupture, as it draws. Currently, the smallest diameter holes that can be obtained through drilling, electrical discharge machining (EDM) or carbon dioxide lasers are 0.34 mm, 0.3 mm and 10 microns respectively.

The major advantage of using additive technologies is the freedom in design and the saving of material. Moreover, allowing the fabrication of extraction holes in the same process, will eliminate the need for post-processing. Through a systematic approach, this paper proposes a practical framework for creating custom-design efficient vacuum holes. By changing the inclination of vacuum channels and some printing parameters, smaller diameter holes of 0.35 mm have been obtained. Furthermore, different inner shapes and arrangements of the vacuum channels have been tested to not leave marks on the finished thermoformed product and to improve the air flow.

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COMPOSITES AND POLYMERS FAILURE PROCESSES IN TRIBOLOGY BY SCANNING ELECTRON MICROSCOPY

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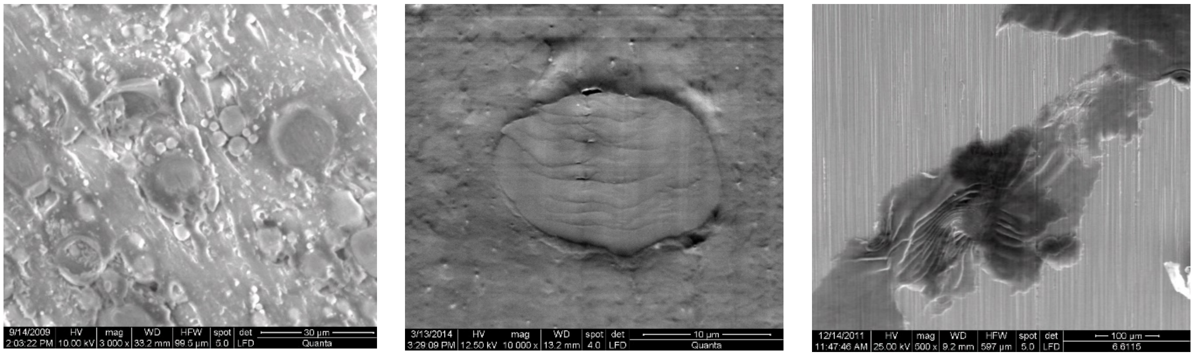
ABSTRACT

Using polymers, their composites and blends enlarge the field of tribological applications [1-4], but their specific failure processes need to be studied in order to improve the system behavior and durability. The aim of this research is to point out the help offered by scanning electron microscopy in analyzing the failure processes in these materials from the tribological point of view. SEM images and EDX analyses could reveal wear stages and the influence of working parameters on the material modifications. This paper presents several aspects in using SEM images for evaluating the specific failure processes in tribosystems using polymers or polymer composites against steel, a pair of materials more frequently used due to their good tribological behavior.



a) glass bead agglomeration by preferential wear of polymeric matrix (PA6) when sliding on steel (no gold coating) [2]

b) Wear and deformation of an short aramid fibers in a PA6 matrix (gold coating) [3]

c) adhesion process on steel surface sliding against a polymer blend PBT+PTFE [4]

Fig. 1. Aspects of failure/wear mechanisms characterizing polymeric composites sliding on

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MECHANICAL PROPERTIES OF ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE (TENSYLON) FROM TENSILE TESTS

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ABSTRACT

Results on mechanical properties of Tensylon composites at room temperature are presented. Single-ply (Figure 1) and two-ply samples, obtained from the ply-precursor sheet (of two orthogonal layers) have been subjected to: load till failure in traction, at different strain rates (below 10^{-1} s^{-1}) and cycles of successive loading and unloading and 5-minute stress relaxation period. The characteristic times of relaxation are evaluated, and the difference in values of Young modulus before and after the relaxation stage is established. A complex cyclic/relaxation test requires a visco-elasto-plastic model of Tensylon, and allows to quantify it [1, 2]. This model predicts the material behavior in other types of tests: for instance, it predicts strain rate independence of loading to failure in the considered strain rate range.

Cyclic tests fulfilled at a fixed strain rate suggest that Tensylon is an elastoplastic material without noticeable viscosity. A combined cyclic–relaxation test requires a visco–elasto–plastic description. The proposed model, additively including nonlinear viscoelasticity and plastic flow with strengthening, shows a satisfactory agreement with experimental data. It also agrees that the material is strain–rate–insensitive in the range 10^{-3}–10^{-1} s^{-1}.

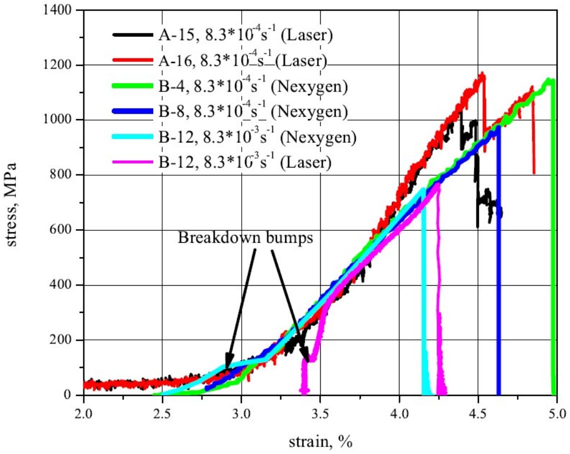

Fig. 1. Stress–strain curves of single–ply samples in tension along filaments direction, at constant strain rate until failure

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PROTEIN NANO- CAPSULES AND FIBERS AS VEHICLES FOR BIOACTIVE COMPOUNDS

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ABSTRACT

The development of food protein-based nano-architectures is one of the most promising and effective strategies to enclose and deliver bioactive compounds in functional foods and other nutraceuticals [2]. The high potentiality of proteins used for obtaining new biopolymers is particularly related to their natural nanocarrier ability for different bioactive compounds, especially those amphiphilic [1, 3]. Other advantages of proteins` use are due to their high nutritional value, excellent functional properties, good sensorial properties characterized by neutral flavor and taste, and their GRAS (Generally Recognized As Safe) status. However, the ability of certain proteins to induce an allergic response in susceptible individuals should be carefully addressed. Although proteins have relatively low barrier and mechanical properties, they can be formulated into polymers with low moisture migration, oxygen barriers, and appropriate tensile strength and flexibility. Animal proteins as whey proteins, casein and gelatin but also vegetal protein as zein and soy proteins` ability to form capsules and fibers is introduced in this presentation. Microencapsulation and nanoencapsulation but also fibers designed at micro and nanoscale have attracted lately a high level of interest for the encapsulation of different bioactive compounds into food. While microstructures refers to capsules or fibers with diameter higher than 1 μm, decreasing size below 1 μm means not only the increase of surface to volume ratio, but by reducing size below 100 nm, precision in regulation and release of the bioactive compounds is ensured. Methods to associate protein carriers with antimicrobial peptides, essential oils, polyphenols, vitamins, minerals, omega-3-fatty acids, probiotics etc. included in capsules and fibers and their applications in food and pharma are discussed.

The electrospinning and electrospraying of bioactive polymers and polymer blends have good prospective to improve functionality beyond what is known by the current encapsulation processes.

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