MACRO 2009

RECENT ADVANCES IN POLYMERIC MATERIALS

MARCH 9-11, 2009

Poster Abstracts of

10th National Conference of
The Society for Polymer Science, Chennai Chapter, INDIA

SPS

organized by
Department of Chemistry
Indian Institute of Technology Madras, INDIA

as a part of the golden jubilee celebrations of IIT Madras

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Morphology and mechanical properties of Poly Butylene Terepthalate/ Montmorillonite nanocomposites.

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Abstract:

Poly (Butylene Terepthalate)(PBT)/Organomodified montmorillonite (Cloisite 15A) nanocomposites with high degree of exfoliation of the nanoclay were successfully prepared by melt blending under optimized compounding conditions. The microstructure and the clay dispersion in composites were characterized by wide angle X-ray diffraction, while the phase morphology was characterized using Scanning electron microscopy. The mechanical properties of such as tensile modulus, strength and strain at yield investigated using a Universal testing machine.

The result of this study show these interactions of organic modification of MMT-15A clay and the PBT backbone are favorable leading to better dispersion of clay in the PBT matrix. The diffusion of the mobile PBT chain segments into the clay galleries leads to a peeling apart of the clay platelets resulting in an exfoliated morphology. The XRD traces of the various PBT/MMT-15A nanocomposites support the predominately exfoliated dispersion of clay.The SEM analysis of the nanocomposites indicate clay phase morphology of nanodimensions. These composites show pronounced increase in tensile properties and a modest increase in yield strength over the neat PBT. It is concluded that the large surface area of exfoliated clay nanoparticles and the enhanced interfacial contact between clay and PBT matrix, generated by the high aspect ratio of dispersed clay particle, notable improve the mechanical properties. This also indicates the better stress transfer at the interface between polymer matrix and clay particles. The yield strain in all composites decreases with increasing clay loading, indicating increasing brittleness for composites. This clearly suggests that the dispersion of clay in an exfoliated state is less detrimental for the ductility of the nanocomposites.

P - 02

Synthesis and Characterization of Metal Nanoparticles Doped Polyaniline by Interfacial Polymerization of Aniline using Metal Salt as Oxidant.

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Metal nanoparticles doped polyaniline nanocomposites have been synthesized by an interfacial polymerization of aniline, dimeraniline and tetraaniline using metal salts such as $HAuCl_4$, $Cu(NO_3)_2$ and $AgNO_3$ as oxidizing agent. The polymerization reaction occurs at the interface of toluene and water during mixing. The reaction mixture was allowed to stand for 4 days at room temperature under static condition. The organic phase becomes dark due to polymerization of aniline and its oligomers. The resulting metal nanoparticles doped conducting polyaniline nanocomposites were isolated and characterized with UV-VIS, FT-IR, XRD, SEM. and Cyclic Voltammetry.

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P - 03

Synthesis and Characterization of Water Soluble and "Click"able Monomers and Polymers based on 3, 4-Propylenedioxythiophene

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Polymers based on 3, 4-alkylenedioxythiophenes are known to be an important candidate for its wide application in electrochromic displays, sensors, as hole transport layer in OLEDs and anti static coating. In this direction, functional derivatives of hydroxymethylsubstituted 3,4 propylenedioxythiophene (ProDOT-OH) was synthesized. The flexible – OH group of ProDOT-OH can be further functionalized using different side chain which would lead to a water and organic soluble polymer. Alkylating with propane sultone resulted in water soluble ProDOT-sultone monomer. Solid state device out of Poly(ProDOT-sultone) showed fast switching speed. Secondly, substituting ProDOT-OH with propargyl group resulted in ProDOT-propargyl, which was then used for "click" chemistry and was functionalized with carboxylate, ammonium, glyme and alkyl side chains using the corresponding azides as "Click" partners. Oxidative polymerization of ProDOT-propargyl resulted in an insoluble material but still "click" chemistry could be performed on solid state using carboxylate salt and ammonium azide, which resulted in polyanion and polycationic systems. Electrochemically polymerized ProDOT-propargyl showed contrast of 75% which otherwise on chemical polymerization resulted in an insoluble material. To explore further "click" chemistry was performed on copolymer of ProDOT-propargyl and DihexylProDOT, resulting in anionic, cationic and neutral polymers depending upon the side chains. The yield and the specificity of the dipolar reaction make it an important and efficient route not only for the synthesis of small molecules but also for functionalization of polymers.

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P - 04

SELECTIVE PERMEATION OF ACIDS THROUGH POLYMERIC MEMBRANE

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Removal of acid from various industrial process streams needs to be addressed for the efficient separation of commercially important organic (acetic, lactic and citric acid) or inorganic acids (hydrochloric, sulphuric and nitric acid). The separation process needs to offer environmentally benign and techno-economically viable solution. Commonly used methods for acid separation are neutralization, distillation, ion-exchange, extraction, pervaporation, electrodialysis and perstraction with liquid membranes. They suffer from the drawbacks such as use of large amount of chemicals affecting purity of product, increasing environmental issues by generated waste, high energy requirements, low process economy, etc. Distillation and pervaporation can only be used for the separation of volatile acids. Acid separation by electrodialysis (ED) works on transport of ions through ion-exchange membrane from feed solution to another side of the membrane under the influence of electrical potential (1), which suffers from high energy requirement and selectivity issues.

Perstraction process works on the principle of selective transport of acid through chemically active membrane and stripping from the other side (2,3). Liquid membranes (based on tertiary amines and quaternary ammonium salts) are practiced in supported (SLM), bulk (BLM) or emulsion (ELM) form, for acid separation. The disadvantages of liquid membranes include bleeding, feed toxicities and contamination of process streams (4). In the present work, polymeric membrane bearing active functionality was evaluated for the transport of various acids; while using water as the stripping agent.

In case of organic acids, glucose was used as the representative of the small organic impurity present along with organic acid such as lactic and acetic acid. Both the lactic and acetic acid showed high flux (8.5 and 25 g/m2.h respectively) and appreciable selectivity (20.5 and 17 respectively) over glucose. In case of inorganic acids, H2SO4 and its selectivity over NaCl was determined by single component transport study. NaCl was used owing to its small molecular size. The flux of H2SO4 was found to be varying with concentration. The use of water as the stripping agent would allow recovery of acids as the product in the permeated stream; while selectivity over glucose or salt avoids product contamination. Thus, a single step process overcoming drawbacks of conventional methods is proposed.

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P - 05

Non-fluorinated Copolymer Emulsions for Durable Hydrophobic Finishing of Textiles

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In the recent years there has been an increased interest in the hydrophobic finishes and self-cleaning because of their wide-ranging importance in all parts of the textile market for clothing, home and technical textiles. The non-flouro copolymer emulsions containing one hydrophobic and a reactive monomer were successfully prepared at our lab, using emulsion polymerization technique. The process parameters during polymerization *i.e.* which affects the latex stability have been investigated and accordingly varied to obtain an emulsion with better stability. The copolymer emulsions were applied on to cotton fabric and the water repellency and the durability for the fabrics after vigorous washes were measured and compared. The comfort properties of the coated fabrics such as breathability and bending length were evaluated. It was found that there is no significant effect of finish add-on on the breathability and handle of the fabric. The water repellency tested on cotton fabrics displayed greater effectiveness with increase in reactive monomer content in the copolymer finish. The durability of the hydrophobic finish was found to increase with increase in the reactive monomer content of the copolymer.

Acknowledgement: The authors acknowledge partial financial support from the Department of Science and Technology, Govt. of India and Resil Chemicals P Ltd., Bangalore.

P - 06

STUDIES ON BIOMOLECULAR HYBRIDS OF CONDUCTING POLYMER AND RNA

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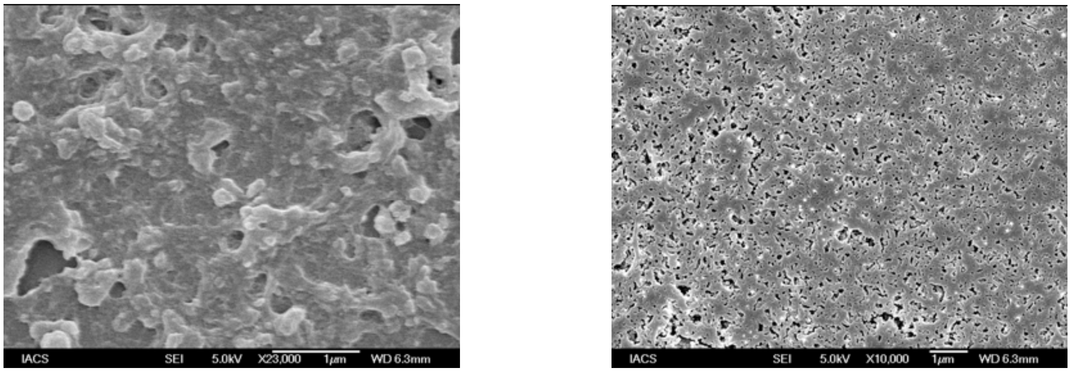
Abstract: Biomolecular hybrids of a conducting polymer and RNA are prepared at three different compositions by mixing aqueous solutions. The SEM micrographs (fig.1) indicate a change in morphology with composition of the hybrids. Three types of supramolecular interactions, viz. (i) electrostatic, (ii) H-bonding and (iii) π-π interaction, evident from FTIR spectroscopy, are present in the complexes The doping rate of biomolecular hybrids has been measured by UV-vis spectroscopy and pH study. The CD spectra indicate no change in biomolecular conformation during the complexation. The I-V characteristic curves of hybrids are semiconducting in nature.



W_{RNA} =0.75 **W_{RNA} =0.5**

Figure 1. SEM micrographs of biomolecular hybrids

Effect of Molecular weight on Miscibility and Orientation Function of PVC/PMMA Blend.

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Abstract:

The blends of poly (vinyl chloride) (PVC) in various proportions with poly (methyl methacrylate) (PMMA) were prepared by solution casting technique using Tetrahydrofuron (THF) as a common solvent. The miscibility, morphology and thermal properties have been studied .The miscibility of PVC/PMMA blend is controversial issue. Previous studies have drawn different conclusions. DSC data were found to be inadequate to describe whether the blend PMMA/PVC blends are miscible or not, possibly because of the small gap in their glass transition temperatures. Therefore, the miscibility also studied by dynamic mechanical analysis. The chain orientation behaviours of PVC and PMMA were studied by infrared dichorism method.

Up to 60wt% PVC concentration in the blend PVC showed negative values whereas PMMA showed independent positive values for its orientation function. FTIR results for PVC/PMMA indicate the possible interactions between the carbonyl group of PMMA and α-hydrogen of PVC. The SEM result shows phase separation in the blend.

By carefully observing literature, it has been observed that hydrogen bonding alone can not drive the system to miscibility. Along with intermolecular interaction many other factors like preparation temperature, solvent used, sample used play important role in miscibility. Molecular weight is an important aspect. The higher molecular weight of PMMA in lower concentration with large amount of PVC shows miscibility.

Synthesis of Polyaniline thin-films on dimeraniline head group monolayer assembly on glass and ITO surfaces.

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Dimeraniline functionalized carboxylic acid and disulfide can form a monolayer assembly on glass, ITO and gold nanoparticle modified ITO glass plates by immersing in the respective solutions (1mM in ethanol) for about 12 hours. The surface coverage and packing density of the monolayer was confirmed by UV-Visible and Cyclic Voltammetry studies. These monolayer modified surfaces acted as initiator for the growth polyaniline in presence of aniline and $(NH_4)_2S_2)O_8$ at 1:1 molar ratio under acidic condition . The rate of growth of polyaniline at different time intervals was monitored by UV-Visible spectral studies. The polyaniline modified surface was further characterized with SEM, FT-IR and Cyclic Voltammetry techniques.

Modification of Biodegradable Polymeric Nanofibers for Tissue Engineering Applications

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Abstract

Tissue engineering is the use of a combination of cells, engineering and materials methods, and suitable biochemical and physio-chemical factors to improve or replace biological functions at the injured site. The designing of a biomaterial which can mimic the three dimensional tissues *in vivo* is still challenging. Biodegradable Polymers are used for development of tissue engineering constructs in the form of sponges, films and macro porous scaffolds which do not influence the cell fate processes such as cell differentiation, migration and proliferation. Polymer nanofibers fabricated by electrospinning of a polymer solution has been drawing great attention for the tissue engineering applications. The electro spun materials have the nanofibrous morphology which is closest to the natural extra cellular matrix (ECM). The electro spun material is composed of three-dimensional networks of nanosized fibrous materials that mimics as extra celllular.matrix such as collagen, elastin and keratin. These polymers fabricated in the form of fibers in nanosize cause more favorable microenvironment for cells.

We prepared the PLGA/PPG nanofibers by elctrospinning technique. PLGA (85:15)/PLGA (75:25) nanofibers are hydrophobic and it can be minimized by addition of PPG to give better hydrophilitcity for cell adhesion for tissue engineering construct. The morphology of the electro spun fibers of composite of PLGA and PPG was observed using scanning electron microscopy (SEM).The contact angle of these nanofibers scaffold and protein adsorption and release studies on that scaffold have done.

The results proved that the small amount of Polypropylene glycol polymer to the Poly Lactic Glycolic acid (PLGA 85:15) improves drastically the hydrophilic of elctrospun nanofibers. The addition of small amount hydrophilic polymer to the biodegradable hydrophobic polymer increase the hydrophilic property and used for nanofiber based tissue engineering constructs.

Synthesis and Characterization of novel poly(ether – amide)s

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ABSTRACT:

A novel ether and aliphatic methylene linkage and a pendant cyclohexylidene moiety containing 1, 1 – bis [4-(4-carboxy methylene phenoxy) phenyl] cyclohexane (BCMPPC), was prepared through nucleophilic substitution reaction of 1, 1 –bis (4-hydroxy phenyl) cyclohexane and 4- fluoroacetophenone followed by Conrad Willgerodt reaction with Kindler variation using sulphur and morpholine and finally base catalyzed hydrolysis of intermediate thiomorpholide. (BCMPPC) was characterized by physical and spectroscopic methods. A series of eight novel poly (ether – amide)s was prepared from the (BCMPPC) and different aromatic diamines using Yamazaki's direct phosphorylative polycondensation. These poly (ether – amide)s were characterized by IR spectroscopy, solubility, viscosity, thermal analysis and X- ray diffraction studies. Inherent viscosities of poly (ether -amide)s were in the range of 0.27 to 0.41 dL / g indicating moderate molecular weight built -up. These polymers had better solubility in polar aprotic solvents such as N,N- dimethyl acetamide, N-methyl-2-pyrrolidone, dimethyl sulphoxide etc. Glass transition temperatures of these poly (ether – amide)s were in the range of 181 to 226 ^{0}C when analyzed by DSC under nitrogen atmosphere. Thermogravimetric analysis of these polymers showed no weight loss below 320 ^{0}C demonstrating excellent thermal stability. X- ray diffraction pattern of polymers suggested the amorphous nature. The structure -property correlation among these poly (ether – amide)s will be presented, in view of these polymer's potential applications as processable high temperature resistance materials.

High Performance Polymer Nanocomposites with Low Percolation

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Recently expanded graphite (EG) has been widely used as electrically conductive filler for electrically conductive polymer composites due to its many attractive properties. Electrically conducting polymer composites have shown potential applications in electromagnetic interference (EMI) shielding of electronic devices. In present work, EG and graphite flake (GF) filled high performance polymer matrix nanocomposite were fabricated by a simple method of dispersing EG in polymer matrix followed by hot compression molding at a temperature above melting point of polymer. The percolation threshold for polymer/EG was found much lower than that of polymer/GF. The degree of dispersion of EG or GF in matrix was investigated using scanning electronic microscopy. The thermal, electrical conductivity and dielectric properties of both polymer/EG and polymer/GF composites will be discussed.

A Comparative Study on the ATRP of *n*-docosyl acrylate with AIBN and BPO

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Abstract:

Well-defined poly(*n*-docosyl acrylate) (DA) with narrow molecular weight distribution have been synthesized by atom transfer radical polymerization (ATRP) of *n*-docosyl acrylate at 80 °C in N, N-dimethylformamide (DMF) using the carbon tetrabromide/$FeCl_3$/2,2′-bipyridine (bpy) initiation system in the presence of 2,2′-azobisisobutyronitrile (AIBN) and benzoyl peroxide (BPO) as the source of reducing agent. The rates of polymerization (R_p) for both the systems exhibit first-order kinetics with respect to the monomer, however peroxide initiated system shows slow rate of polymerization as compared to the azo-system. The effect of various reaction parameters on the molecular weight (MW) and molecular weight distribution (MWD) have been investigated. In contrast, in the reverse ATRP of *n*-docosyl acrylate the rate of polymerization has been significantly increased with BPO as the initiator. With the use of BPO as the initiator the MWDs are broader. The reverse ATRP initiated by peroxides behaves differently than that of the azo initiators. The resulting PDA that obtained in presence of AIBN and BPO systems has been compared for both the conventional and reverse ATRP. Poly(*n*-docosyl acrylate) has been characterized by different techniques such as GPC, DSC and NMR spectroscopy.

SYNTHESIS AND CHARACTERIZATION OF NOVEL OF POLYPHOSPHAZENE BASED ENERGETIC BINDERS

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The design of innovative weapon systems requires the use of explosive and propellant formulations having enhanced energy output and reduced vulnerability during storage and transportation. The current strategy is to synthesize energetic materials of improved performance, satisfactory insensitive munitions, comply with environmental aspects and reduce costs. Explosives such as RDX and HMX etc. possess high energy density and have crystalline morphology and high melting, which render them difficult to be shaped in explosive charges.

The energetic polymeric binders such as polyBAMO, polyNMMO, polyGLYN etc may be used in conjugation with high explosives such that the energy of the explosive itself is not overlay diminished by the presence of binder in the combined material. The difficulty with this approach is in obtaining energetic polymers, which when used as binders have an adequate combination of both desirable physical properties such as malleability and shock insensitivity, in addition to high energy density. Even the best energetic binders have energy densities that are significantly lower than that of the crystalline explosive material for which they are required to bind. This has the effect of reducing the energetic performance of the explosives. In an attempt to solve this problem, current practice is to use a high loading of explosive relative to binder which in turn diminishes the desirable physical properties of the binder/explosive mixture.Phosphazene based energetic polymers would be a good candidate for the above problem. Polydichlorophosphazene was synthesized and the chlorine in the polyphosphazene was replaced by the molecule having explosophoric functional groups [3] such as nitrato ($-ONO_2$) or nitro ($-NO_2$).

The polymers are characterized by nuclear magnetic resonance (NMR), infrared spectroscopy (IR), thermal analysis, and gel permeation chromatography (GPC) [3].

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SYNTHESIS AND CHARACTERIZATION OF NADIMIDE TERMINATED RESINS

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Abstract

Aromatic polyimides are one of the most stable and heat resistant polymer systems. PMR polyimides (most noticeably PMR-15) were prepared by polymerization of monomeric reactants, are high temperature polymers used as the matrix resins in fiber-reinforced composites for a variety of advanced aerospace applications. As composite materials, they possess certain unique characteristics, such as good solvent resistance, high temperature performance and outstanding mechanical properties. Twelve different nadimide end-capped oligomeric resins were prepared by reacting Endo-5-norbornene-2,3-dicarboxylic anhydride (Nadic Anhydride) with three different aromatic diamines namely bis(3,5-dimethyl-4-amino phenyl)phenyl methane (BAPM), bis(3,5-dimethyl-4-amino phenyl)-4'-methyl phenyl methane (BAMPM) and bis(3,5-dimethyl-4-amino phenyl)-4'-methoxy phenyl methane (BA4MPM) in 1:1 and 2:1 molar ratio to get mono- and bisnadimides, respectively. The mononadimides were chain extended with 3,3',4,4'-benzophenone tetracarboxylic acid dianhydride/pyromellitic dianhydride (BTDA/PMDA) in 2:1 molar ratio. Structural characterization of nadimide terminated resins was performed by elemental analysis, FT-IR, ^{1}H-NMR and ^{13}C-NMR techniques. All the mono- and bisnadimides are soluble in various organic solvents such as THF, DMAc, DMF and DMSO. The cure behavior of the mono- and bisnadimides was studied by using differential scanning calorimetry (DSC). Thermogravimetric analyses of all the cured nadimides were studied and their decomposition temperature and char yield are compared.

(**Keywords:** Addition polyimides, Nadimide terminated resins; High char yield; Thermal properties)

Characterization and Properties of Vinyl acetate-Butyl acrylate Copolymer Latex for Coating Application

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ABSTRACT

There are two types of coatings (1) that are solvent-based, i.e., that are reducible (soluble) by an organic solvent; and (2) that are water-based, i.e., that may be thinned or reduced by water. The specific properties of a coating will depend almost wholly on the specific properties of the binder and pigments used and on the proportions of one to the other. The organic coatings (solvent-based) contain 30-60% of volatile organic compound (VOC). The VOC content of water based coatings is appreciably lower than conventional solvent based coatings. Consequently water-based paints are less harmful to the environment than solvent-based paints.

Vinyl acetate (VAc)-Buyl acrylate (BuA) copolymer binder with different compositions was polymerized by semicontinuous emulsion polymerization method. The shear and peel strength of the resulting copolymers were investigated to evaluate its adhesion property. The result was interpreted in terms of different composition and temperature. The thermal properties were studied using Differential scanning Calorimetry (DSC) and Thermo gravimetric analysis (TGA). The mechanical properties also studied using Universal Testing Machine.

Keywords : copolymer, VOC, emulsion polymerization, coating

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SYNTHESIS AND CHARACTERIZATION OF NOVEL POLY(AMIDE-IMIDE)S

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ABSTRACT:

Poly(amide-imide)s are high performance materials and are well known for their high thermal stability but poor processability. It is highly desirable that these polymers be soluble in some organic solvents to facilitate processing, however they should retain resistance to common solvents during their use.

Present investigation deals with the synthesis and characterization of five new poly(amide-imide)s containing aliphatic spacer methylene linkage from novel dihydrazide. 2,5-Bis (4-hydrazino carbonyl methylene phenyl)-3,4-diphenyl thiophene (BHCMPDT) was condensed with pyromellitic dianhydride (PMDA) and 3,3',4,4'benzophenone tetracarboxylic dianhydride (BTDA) with view to improve their solubility without much sacrifice in thermal stability as compared to solubility and thermal stability of the poly(amide-imide)s derived from isophthaloyl dihydrazide (IDH) and PMDA / BTDA. Novel dihydrazide monomer (BHCMPDT) and intermediates were characterized by elemental analysis, IR, NMR and mss spectroscopy.

IDH derived co-poly(amic acid)s were soluble in DMAc and could be cast into tough film, however corresponding poly(amide-imide)s had limited solubility. Comparatively poly(amide-imide)s derived from only BHCMPDT had better solubility; possibly due to the introduction of the methylene linkages which may impart solubility improvement. The inherent viscosities of the polymers were determined at poly(amic acid)s stage in DMAc containing 5% lithium chloride at 30 ^{0}C. Poly(amic acid)s derived from BHCMPDT and PMDA / BTDA had viscosities in the range of 0.34 – 0.43 dL/g. Whereas poly(amic – acid)s derived from IDH and PMDA / BTDA were insoluble in DMAc.

These polymers were also characterized by IR spectroscopy which confirmed the complete transformation of poly(amic acid)s into poly(amide-imide)s and showed corresponding IR absorption bands to amide and imide groups stretching vibration. These poly(amide-imide)s showed the good thermal stability. Initial decomposition temperature for these polymers was in the range of 304 to 396 ^{0}C and showed 3 to 13 % weight residue at 900 ^{0}C. The structure property correlation for the series of poly(amide-imide)s synthesized is presented in detail.

Edible Oil Based Bioactive Metal Containing polymers: Preparation, Physicochemical and Biological Studies

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Abstract

Zinc containing coconut oil based polyesteramide resins Zn-CPEA-1 and Zn-CPEA-2 were synthesized by condensation polymerization reaction between coconut oil derived coconut fatty amide diol (HECA), Zn $(OH)_2$ and citric acid (Zn-CPEA-1) / tartaric acid (Zn-CPEA-2). The intermediates and the final products were characterized by FTIR, ^{1}HNMR,^{13}CNMR spectral studies. Standard methods were used to study the physiochemical properties. The thermal behaviour of the polymers were studied by using thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). Antibacterial investigations were carried out against both gram-positive and gram-negative bacterial species for the two polymers.

Keywords:

Zinc-containing polyesteramide resin; spectral studies; thermal behaviour; antibacterial investigations.

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Novel Fluorene-Based Thermally Stable Conjugated Polymer Containing Pyridine and Chromophoric Carbazole Groups

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Abstaract:-

A new diiodo monomer containing heterocyclic pyridine and carbazole groups was synthesized *via* Chichibabin reaction and used in the preparation of a conjugated polymer *via* Suzuki coupling approach. The polymer had high glass transition temperature at 191℃ and Td_{10} at 434℃ in nitrogen atmosphere. The pristine polymer exhibited the UV-vis maximum absorption at 355 nm and shifted to 420 nm after protonation. and the intensity of absorption depended on the concentration of acid. The polymer also showed electrochromic behavior under applied voltage. The emission color of the polymer film changed from blue (435 nm) to yellow (570 nm) when 2.5 V bias voltage applied. The polymer also exhibited write-once and read-many-times (WORM) polymer memory effect with tristable states.

Exprimental:

The diiodo compound, 4-(9-ethyl-3 -carbazole) -2,6-bis (4-iodophenyl) pyridine, containing pyridine and carbazole groups, was synthesized via facile Chichibabin reaction from 40-iodoacetopeheone and 9-ethyl-3-carbazolecarboxaldehyde. The structure was confirmed by elemental analysis, FTIR, and NMR spectra. The result of elemental analysis is consistent with the proposed structure.

The synthesis of the conjugated polymer containing pyridine and fluorene groups in the main chain and carbazole moieties in the side chain. The conjugated polymer was prepared from the diiodo monomer and 9,9- didodecylfluorene-2,7-diboronic acid via Suzuki coupling reaction, which was carried out in a mixture of THF and aqueous potassium carbonate solution (2 M) containing 0.6 mol % $Pd(PPh_3)_4$ under vigorous stirring at about 60 °C for 24 h. After purification and drying, the polymer PyCzPF was obtained as white color in 87% of yield. The chemical structure of the polymer was verified by FTIR, elemental analysis, and NMR spectra.

Result and discussion:

The thermal properties of the polymer were measured by DSC and TGA. The glass transition temperature of PyCzPF was 191°C, The high transition temperature may result from the rigid heterocyclic pyridine groups.

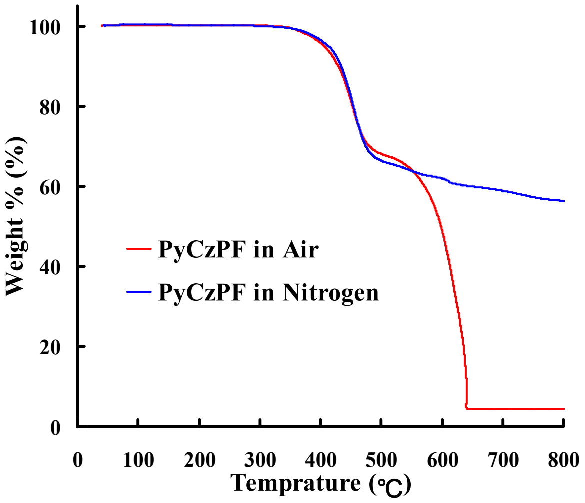

Fig 1. TGA spectra of PyCzPF in nitrogen and air atmospheres.

The polymer was measured by TGA in nitrogen and air atmospheres as shown in Figure 1. Two-step degradation was observed in the TGA spectrum in air atmosphere. The 1st degradation begins at about 411 ℃ and the 2nd degradation starts at about 480 ℃. The spectroelectrochemical analysis of the applied potential was increased from 0 to 2.5 V, the peak of characteristic emission of PyCzPF at 417 nm decreased gradually, while one new emission band grew up with maximum emission at the range of 490 to 595 nm due to the electron oxidation.

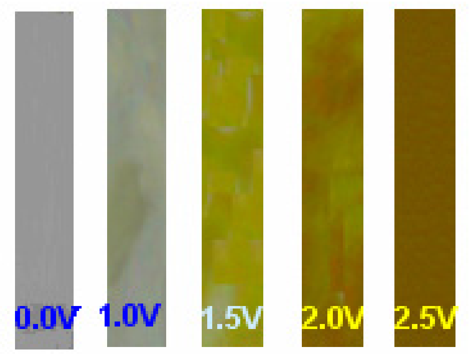

Fig 2. Film color changing of PyCzPF under different applied voltage.

The maximum emission peak is red shifted as the applied potential increased. The color changing of the polymer from neutral pale yellowish to brown under different bias voltages is shown in Figure 2. Protonation of PyCzPF in different HCl concentrations are shown in Figure 4. At low protonated concentration (lower than 0.1 M), the absorption bands are the same as pristine polymer. The absorption spectra in Figure 3(A) acid concentration was increased (higher than 0.1 M), it was apparent that the absorption at around 355 nm decreased and a new absorption band at 420 nm was formed gradually. The new band at 420 nm could be attributed to the protonated form structure. This phenomenon suggests that the absorption and emission of polymer with quaternized pyridine were obtained by the deposition of a drop of the polymer solutions onto a glass slide. The SEM micrograph of PyCzPF from THF reveals that the surface of the polymer is homogeneous with irregularly shaped granules that are neatly packed closely to one another Figure. 4(A). For comparison with the protonated polymer, we also prepared SEM samples in the same way from THF/ HCl (1.0 M) and THF/MSA (1.0 M) mixtures, as shown in Figure 4(B,C), respectively. The HCl protonated sample exhibited larger aggregates than the MSA-protonated sample. This is attributable to the interaction of PyCzPF and HCl or MSA, which resulted in aggregation of the polymer backbones. SEM micrographs of PyCzPF were measured at room temperature.

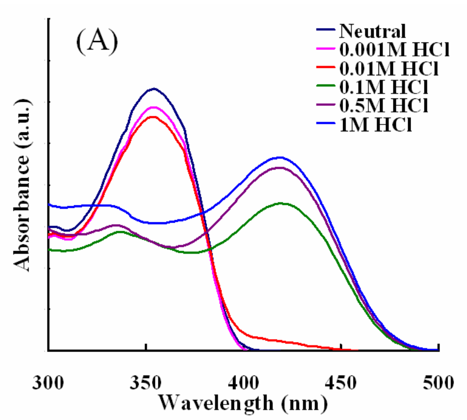

Fig 3. (A) Absorption of PyCzPF after protonation by different concentration of HCl..

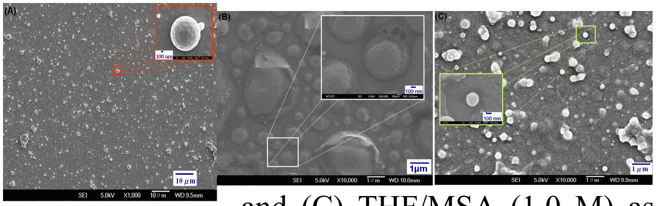

Fig 4. SEM images of PyCzPF with (A) THF as the solvent, (B) THF/HCl (1.0 M) as the solvent, and (C) THF/MSA (1.0 M) as the solvent. A drop of each polymer solution was deposited onto a glass slide.

Conclusion:

The polymer had high Tg at about 192℃ and Td10 at 437℃ in nitrogen atmosphere. After protonation with protic acid, the emission changed from blue 420 nm to yellow 540 nm was observed and the intensity of emission depended on the concentration of acids. The polymer also showed electrochromic behavior. The emission of the polymer under applied voltage exhibits red shift as higher bias voltage applied. The polymer also exhibited write-once and read-many-times polymer memory effect with tristable states.

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Process for Continuous Production of Electrospun Nano Fibers for Filtration Applications

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Abstract

Submicron size fibers (nanofibers) are easily produced with an electrospinning apparatus from polymer solutions of various polymers like poly(acrylonitrile), poly(vinyl alcohol), poly(caprolactone), etc. A basic electrospinning apparatus consists of three elements: an electrical generator (high voltage supply), a spinneret, and a grounded collector. The polymer in solution passes through the spinneret connected with the high voltage power supply, elongates in the form of a continuous filament within the electrostatic field, solidifies by the rapid solvent evaporation and finally deposits on the collector surface. Fibers were directly deposited in the form of random fiber webs with high area-to-volume ratio and small pore size on ordinary nonwoven filters of microfibers. The production rate of electrospun fibers with small diameter is usually very low which limits its use at commercial level. The production rate can be increased by use of multiple spinneret system. However, the electric field and mutual electrical interaction of multiple charged jets influence their path and results in nonuniform deposition. The major challenge with the multi-spinneret system is to eliminate the interference of surrounding polymer jets and obtain a uniform deposition. The present study describes a method of continuous and uniform deposition of naofibrous web over a filter media. Using the proposed method, nano filtration media could be produced at the rates of up to 7 m/min. The morphology and diameter distribution of the electrospun web was characterized by SEM and was found to have high quality fibres.

Acknowledgement: The authors acknowledge partial financial support from the Department of Science and Technology, Govt. of India and Purolator India Ltd., Gurgaon.

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Biocomposites of natural rubber : Effect of various biopolymers as fillers

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Abstract

Biocomposites of natural rubber blends were prepared using a variety of fillers obtained from renewable resources, by mastication technique on two roll mixing mill. The blends were characterized by mechanical properties and comparison was made with the conventional filler carbon black. The biopolymers exhibited an interesting trend and imparted strength to NR which was quite comparable to carbon black. Upto 30 phr of the fillers could be successfully incorporated leading to enhancement in the mechanical strength. The properties were found to vary with the type and ratio of filler viz. starch, cellulose, chitin and clay. The results were interpreted on the basis of morphology by SEM.

Keywords : natural rubber, chitin, starch, cellulose

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HDPE/PBT blends using ionomers as compatibilizers- mechanical, electrical and morphological studies

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Abstract

Most of polymer blends are immiscible and have heterogeneous phase, poor mechanical properties and unstable phase morphology, which cause melt fracture and non-uniformity in finished product. To overcome this problem reactively compatibilized HDPE/PBT blends have been prepared, using ionomers as compatibilizer. This involved the partial neutralization of an acid monomer with the metal salts containing ions like Na, Zn and Ca to produce ionic monomers. In the second step, the ionomer (ionic-graft-copolymer) were synthesized by solution grafting process using these monomers. These ionomers after being characterized by Fourier Transform Infrared Spectroscopy (FTIR), Melt Flow Index (MFI) and X-ray Energy Dispersive Spectrometry (EDS) were used to study the compatibilizing effect on polymer blends of HDPE/PBT .

These compatibilized blends were characterized for mechanical properties like tensile strength, % elongation, hardness and impact, electrical properties like insulation resistance, arc resistance, comparative tracking index, dielectric strength, etc. Thermal analysis was carried out using DSC and TGA techniques. Torque analysis was carried out to support the compatibilization principle, where as phase morphological studies were carried out using Scanning Electron Microscopy (SEM). Uncompatibilzed HDPE/PBT (80/20) showed a tensile strength of 24.8 MPa where as on compatibilizing it with an ionomer the strength increased to 27.56 MPa. The details of the results obtained will be discussed in this presentation.

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THERMOREVERSIBLE GELATION OF PVDF AND ITS COPOLYMERS IN PHTHALATES: THERMODYNAMIC AND SMALL ANGLE NEUTRON SCATTERING STUDIES

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Thermoreversible gelation of poly (vinylidene fluoride) (PVDF) and its copolymers has been studied in phthalates with varying aliphatic chain lengths as a function of concentration and temperature. Gelation kinetics, structure, morphology, and thermodynamics of PVDF gels have been investigated. Gelation rates have increased with increasing aliphatic chain length of diesters. PVDF phase diagram and compound formation have been studied with various phthalates as solvents. Small angle neutron scattering (SANS) have been conducted for PVDF and its copolymers showing their nanostructure after fitted the data with the Debye-Bueche model and Ornstein-Zernike model. The gelation mechanisms have been investigated by using energy minimization programme. The dipole-dipole interactions are increasing with increasing aliphatic chain length of phthalate solvent.

ELECTROMAGNETIC SHIELDING MATERIALS FROM POLYSTYRENE-POLYANILINE BLEND: PREPARATION AND PROPERTIES

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ABSTRACT

Recently electromagnetic interference shielding materials are receiving enormous attention due to the extensive use of microelectronic devices, computer housings,etc in our daily life. High conductivity and high dielectric constant of the materials contribute to high EMI shielding efficiency. Conductive polymer composites are widely used due to their light weight, corrosion resistance, easy and flexible processibility. Among the conducting polymers, polyaniline and its analogues have been studied most extensively because of their good environmental stability, unique doping mechanism and conductivity variation with radiation frequency. Moreover, conducting polymers have added properties compared to metals, they not only reflect but also can absorb electromagnetic waves. However, due to the poor thermo-mechanical property and poor solubility in common solvents, hampered the commercial utilization of these polymers very seriously. On the other hand, conductive blends of PANI with conventional thermo plastics can have the combined electrical properties of the conducting polymers and the mechanical features of the thermo plastic matrix. However, it is known that the polymerization of a monomer in a polymer matrix is a useful approach for the intimate mixing of the two components which is not possible by conventional solution or melt blending. The percolation threshold concentration for the onset of electrical conductivity can be reduced by preparing the conducting polymers in the nanometer regime.

Nanostructured EMI shielding materials were prepared from electrically conducting blends based on polystyrene-PANI by insitu polymer matrix assisted emulsion polymerisation at room temperature. The correlation between the percolation threshold concentration, morphology and dielectric property,electromagnetic shielding efficiency, mechanical property of the conducting filler in PSP and PSPS blends were discussed. Electrical conductivity measurement showed conducivity 4.6×10^{-2} S/cm. Dielectric loss and dielectric constant measured as 9.9 and 18.5 at the percoaltion threshold concentration The change in morphology on the onset of percolation threshold concentration studied by optical microscopy and scanning electron microscopy. The EMI SE measurent studied in the frequency range of 8 – 12 GHZ observed to be 40 to 60 dB.

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Synthesis, Characterization and corrosion protection properties of Poly (N – Vinyl Carbazole – Co-Glycidyl methacrylate) on low nickel stainless steel.

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[b]Department of Chemistry, Periyar University, Salem, India.

Abstract

The copolymer from different feed ratios of N – Vinyl Carbazole and Glycidyl methacrylate has been synthesized using free radical solution polymerization technique and characterized using FTIR, H^1-NMR and ^{13}C NMR spectroscopy. The thermal stability of the copolymers were studied using thermogravimetric analysis (TGA) .The corrosion behaviour of low nickel stainless steel specimens dip coated with different composition of copolymers have been evaluated by potentiodynamic polarization and electrochemical impedance spectroscopic (EIS) method. These electrochemical properties were observed in 0.1 M H_2SO_4 medium. The polarization and impedance measurements showed different corrosion protection efficiency with changes in composition of the copolymers. It was found that the corrosion protection properties are owing to the barrier effect of the polymer layer covered on the low nickel stainless steel surfaces. However it was observed that the copolymer obtained form 1:1 mole ratio of N-VC and GMA exhibited better protection efficiency than other combinations.

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High refractive index of transparent acrylate polymers functionalized with alkyl sulfur groups

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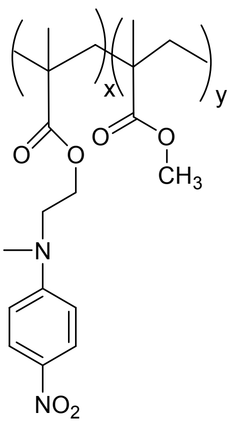
ABSTRACT

Acrylate based polymers have received special interest from researchers because of their outstanding optical performance. Several hetero atom containing acrylate monomers were synthesized to generate high refractive index from acrylate polymers with high transparency and good processing performance of thin films. A series of polymethacrylates were successfully synthesized by thermal radical polymerization and thermal and optically characterized. The prepared copolymers film exhibited high refractive index with a range of 1.77~1.81 at a visible light. The refractive indices were highlighted with each homopolymer giving a range of 1.77~1.81. Which was predicted by extrapolation wavelength dispersion of the index was expressed with Abbe's number and must polymers presented around 20, while they were transparent at measured wave lengths. All polymers was thermally stable up to ~ 250 ^{0}C and exhibited glass transition around at more or less than 100 ^{0}C. This article deals with the synthesis and radical polymerization of methacrylic monomers and their optical properties including refractive indices and low dispersion, optical transparency, and mechanical properties. Our work aimed to obtain synthetic resin having both high refractive index and good processing performance. The refractive index of materials can be increased by incorporating polarizability of substituent groups such as nitro, and sulfur substituents into novel polyacrylates.

Keywords: Optical materials, ophthalmic lens, high refractive index.

Polymer synthesis:



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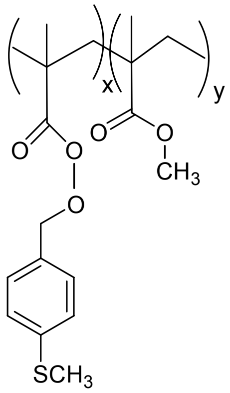

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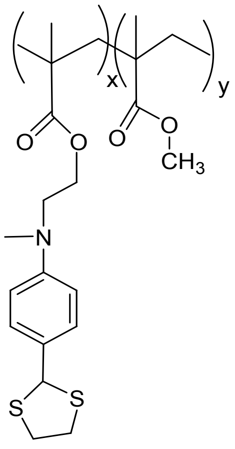

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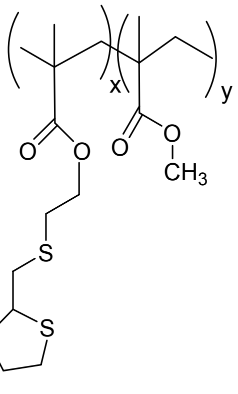

4

pH Sensitive IPN microspheres of Poly(hydroxy ethyl methacrylate-co-Acrylic acid) for controlled release of Metformine hydrochloride

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ABSTRACT

pH-Senensitive novel poly(hydroxyethyl methacrylate-co-acrylic acid) copolymeric microspheres crosslinked with N,N-methylene bisacrylamide (MBA) have been prepared by free radical emulsion polymerization using varying amounts of hydroxyethyl metharaylate, acrylic acid and MBA. Metformine hydrochloride (MH) was loaded into these microspheres during in situ polymerization in vitro release of Metformine hydrochloride has been studied in terms of microspheres. The microspheres were characterized by Fourier transform infrared spectroscopy differential scanning calorimetry, X-ray diffactometer. The release of MH, diabetes drug from these microspheres was studied in pH 1.2 and 7.4 media. Microspheres consists of hydroxy ethyl methacrylte, while poly(acrylic acid) provides pH-sensitivity to the microspheres. The system developed in this study showed a pH-sensitivity for the release of MH, which was attributed to the diffusion controlled release of the drug through the surfaces of microspheres that undergo disintegration after release, disintegration upon the chemical composition of microspheres and pH of the medium.

Synthesis of SnO_2 nanofibers by electrospinning technique and their applications in gas sensors

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ABSTRACT

SnO_2 nanofibers have been synthesised by using a cost effective, simple wet chemical solution with electrospinning technique. The effect of variation of processing parameters, diameter of the nanofibers, composition have been optimised by employing high resolution scanning electron microscopy, and transmission electron microscopy techniques. Nanofibers synthesised at room temperature and subjected to annealed at low temperatures have exhibited high mechanical strength. X-ray diffraction (XRD) and scanning electron microscopy (SEM), Atomic force microscopy and X-ray photoelectron spectroscopy techniques have been employed to characterise structural, morphological and elemental composition of the as deposited and annealed nanofibers. A case study has been presented, where pure SnO_2 nanofibers were used as benzene, aldehyde, ammonia, ethanol gas sensing elements whose selectivity and sensitivity has dramatically changed when compared to previously investigated Polypyrrole and SnO_2-polypyrrole nanaocompsites nanofibers. Preliminary results showed enhanced gas sensitivity, faster response and lower gas detection limit than that of the pure polypyrrole and SnO_2-polypyrrole nanocompsite fibers. These nanofibers are opening up unique opportunities for fundamental physics and high-performance devices also the nanowires could be used to create electronic devices for small, ultra fast computers and memories.

Keywords: Sol-gel process, eelctospinning technique, nanofibers, gas sensing, X-ray diffraction,. X-ray photoelectron spectroscopy

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P - 28

Eu^{3+} Doped Silver-PMMA Nanocomposite: Synthesis, Charecterization, and their Optical Properties

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ABSTRACT

A new europium doped silver-polymer nanocomposite was synthesized by *in situ* addition of the silver nitrate and europium nitrite to the PMMA in DMF solution. The rare earth doped silver-polymer photoluminescent material was obtained. A light brown solution in its UV-Vis absorption spectrum showed suface plasmon resonance absorption bands between 410 to 450 nm. Infrared detector was used to demonstrate the structure of the polymer. The thermal properties of the composite were analyzed by DSC, and TGA. XRD was used to analyze the influence on the crystalline property of the polymer. Morphology and distribution and size of silver were obtained from SEM and TEM, respectively. The fluorescence intensity of the nanocomposite solution and film was analyzed by fluorescence spectrum. The influence on the emission intensity of polymer with different compositions was studied. The result showed that emission intensity of the polymer was changed with different concentration of the rare earth ion in synthesizing the compounds. The concentrations quenching appeared when the concentration of rare earth complexes arrived at some value.

Recent years, metal nanoparticles are gaining more attention due to their significant surface plasmon resonance property and one can tailor the surface plasmon resonance peak maximum and bandwidth by controlling the size and shape of these particles. Apart from this, the host which holds nanoparticles also plays a crucial role to alter the surface plasmon resonance position and band width. Incorporating nanoparticles in polymer host gaining potential significance in technological applications, especially as advanced functional materials like optical limiters, sensors, hydrogen storage systems and microwave absorbers. The polymer characteristics like glass transition temperature, crystallinity, free volume content, etc., have been altered by the incorporation of these nanofillers[1-3].

Acknowledgement

Authors gratefully acknowledge the support by Korea Research Foundation (Grant No. KRF-2007-J00903).

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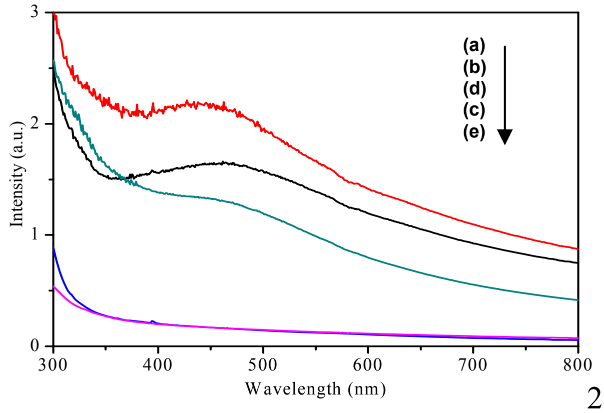

Figure 1 :UV-Visible absorption spectra of (a) PMMA-Eu-Ag (0.0250) (b) PMMA-Eu-Ag (0.0125) (c) PMMA-Eu (d)PMMA-Ag(0.0250) (e) PMMA.

Studies on Cellulose acetate and Poly(phenylsulfone) Blend Ultrafiltration Membranes and their Application Studies

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Abstract:

Ultrafiltration membranes are largely being applied for heavy metal ion separations from aqueous streams. Cellulose acetate(CA) and poly(phenylsulfone)(PPSU) based membranes are prepared in the absence and presence of the polymeric additive, polyethylene glycol, PEG 600, in various compositions. The effects of polymer blend composition and additive concentration on compaction, pure water flux, membrane hydraulic resistance and water uptake have been investigated to evaluate the performance of the membranes and the results are discussed. Surface and cross sectional morphologies of membranes were also analyzed using scanning electron microscopy (SEM). Toxic heavy metal ions such as Cu^{2+}, Ni^{2+}, Cd^{2+} and Zn^{2+} were separated by the blend membranes using polyethyleneimine (PEI) as polymeric ligand. The rejection and permeate flux efficiencies of the blend membranes are compared with pure cellulose acetate membranes. The percent separations of metal ions in the feed and the permeate streams by an atomic absorption spectrophotometer (Perkin – Elmer 2380).

Keywords: Ultrafiltration, Poly(phenylsulfone), Cellulose acetate, blend membranes, PEG 600, metal ion separation, Polyethyleneimine

Organic/Inorganic composite membranes for fuel cells

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Abstract

Zirconium dioxide as inorganic compound was chosen to prepare the composite membranes for fuel cell. The composite membranes of sulphonated polystyrene ethylene butylene polystyrene (SPSEBS) up to 10 wt% zirconium dioxide content were prepared. The composites were characterized using FTI R, XRD, SEM, AFM, TGA and DSC. The proton conductivity of the composite membrane was measured using impedance spectroscopy. The composite membranes had better thermal stability than SPSEBS membrane. The addition of well dispersed zirconium dioxide to polymer solution decreases the membranes conductivity. Impedance measurements indicate that proton conductivity decreases when thickness of the composite membranes increase. In terms of water uptake, it was found that it decrease with the thickness. A good adhesion between inorganic domains and the polymer matrix was confirmed through morphology studies.

Key words: composites, electrolyte membrane, fuel cells.

Antibacterial Silver Nanoparticles Embedded in Semi Interpenetrated Hydrogel Nanocomposite: Synthesis, Characterization and Evaluation of Antibacterial Property of Nanocomposites

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Abstract

Design of consistent and eco-friendly procedure for synthesis of silver nanoparticles is an significant forward in the field of application of antibacterial bio-nanotechnology. One among the available options hydrogel templates is highly useful to achieve this goal. In the present investigation, we have investigated semi-IPN hydrogel silver nanocomposites (SIHSNC) in which the size of silver nanoparticles is ~ 2-3 nm. The synthesis process was quite convenient, fast and directly can be used for antibacterial and wound dressing applications. All the nanocomposite aqueous solutions were showed absorption peaks at 420nm in UV-visible spectrum corresponding to the plasmon absorbance of silver nanoparticles. X-ray diffraction (XRD) spectrum of the SIHSNC exhibited 2θ values matching with silver nanocrystals. Transmission electron microscopy (TEM) images of nanocomposites represent discrete silver nanoparticles through the gel networks in the range of 2-3 nm. The developed nanocomposites were evaluated for antibacterial application on E-coli.

Keywords: Silver nanocomposites, semi-interpenetrated hydrogel, hydrogel, antibacterial activity, wound dressing, nanoreactors.

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Poly(ε-caprolactone)-Based Hyperbranched Polyurethanes prepared via A_2 + B_3 approach and its Shape-memory Behavior

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Chennai 600 025, India.

ABSTRACT

Novel hyperbranched shape-memory polyurethanes based on ε-caprolactone were prepared via $A_2 + B_3$ approach with different molecular weights (M_w); the molecular weights ranged from 7.2×10^4 g/mol to 32.3×10^4 g/mol. The hard segment content was varied minimally and the B_3 monomer was also varied. The polymers were characterized by GPC, DSC, DMA, WAXD and shape-memory test. The crystallinity calculated from DSC and WAXD data indicated that the highly branched architecture does not affect the crystallization of these polymers. More interestingly the E′ ratios of hyperbranched polymers were found to be significantly high compared to the linear analogue. As a consequence, hyperbranched polymers show 100% more shape-recovery rate compared to their linear counterpart. Antimicrobial susceptibility tests confirmed, that these polymers have good antimicrobial activity which is an essential requirement of medical implantations.

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POLYANILINE/CARBON NANOTUBE GEL NANOCOMPOSITES

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Thermoreversible gel nanocomposites of dinonylnaphthalene disulfonic acid (DNNDSA) doped polyaniline (PANI)/multiwalled carbon nanotubes (MWCNTs) has been prepared from solvent casting method from formic acid medium.[1] A three dimensional fibrillar network and a reversible first order phase transition characterize the systems as thermoreversible gels (Figure1). TEM pictures indicate that MWCNT are mixed well with PANI-DNNDSA gel with some wrapping and the behavior of the mixing/wrapping is varying with MWCNT content in the gel. The thermal stability of the polymer chain increases with increasing MWCNT concentration into the gel. The storage modulus (G') also increased with addition of MWCNT to the gel and its relative increase is larger in 20-40^{0}C temperature region. The highest increase (141%) of G' is observed for GNC0.5 at 40^{0}C. The π band-polaron band transitions show a red shift and the dc conductivity increases two orders of magnitude over that of the PANI-DNNDSA gel with the addition of MWCNTs. The current-voltage characteristic curves are Ohmic in nature and the current increases appreciably with increasing MWCNT concentration. The GNCs are also characterized by scanning electron microscopy (SEM), differential scanning calorimetry (DSC), WAXS and FTIR. These GNCs of PANI are easily processible due to its thermoreversible nature and viscoelastic nature.[2,3]

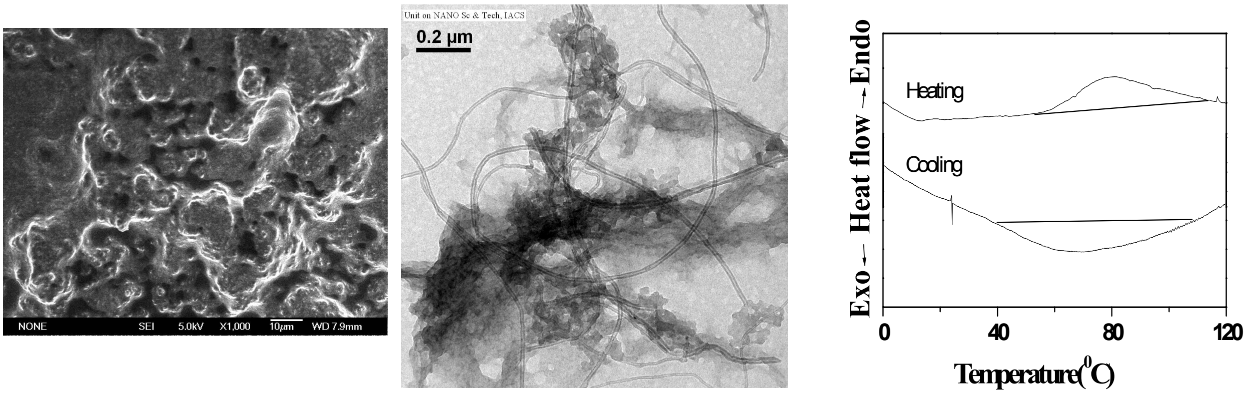

Figure-1: SEM, TEM and DSC micrographs of GCNC 1.

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New approaches towards the synthesis of donor-acceptor type foldamers using Michael addition polymerization

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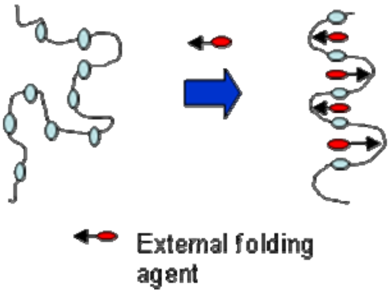
Gellman[1] first used the term *foldamer* to describe "any polymer with a strong tendency to adopt a specific compact conformation", which was further elaborated upon by Moore and co-workers in a review.[2] But the term "*foldamer*" largely refers to those oligomers where the folded conformation is one of the various possible conformations, and the position of the folding-unfolding equilibrium greatly depends on several extrinsic variables, such as acid base interaction, hydrogen bonding, solvophobic and solvophilic interactions, charge transfer interaction, metal ion complexation, temperature etc.

Several weak non-covalent interactions have been successfully utilized to control the solution conformation of oligomeric systems. We have chosen to focus on the design of an external folding agent to induce folding of a high molecular weight polymer via a two-point interaction. While Rotello's[3] efforts utilize a single point interaction and results only in formation of random aggregates, Suhrit et al.[4] have shown that a two point interaction can lead to folding. The conceptual design for folding the flexible synthetic macromolecules can be visualized as depicted below. This type of truly flexible synthetic macromolecules can be made to fold under influence of several interactions. The objective of the present work is to generate polymers containing simple donors via Michael addition polymerization, such that the linker includes a protonable tertiary amine functionality. Such systems have the potential to interact with specifically designed acceptors containing an acid group via acid-base interaction that could then lead to enhanced C-T interaction and yield a folded structure, as schematically shown below.



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Proton conducting composite membrane from sulfonated poly styrene ethylene butytlene poly styrene and boron orthophosphate for fuel cell

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Abstract :

A composite membrane for proton exchange membrane fuel cell application was fabricated by blending sulfonated poly (styrene ethylene butylene) poly styrene (SPSEBS) with boron orthophosphate (BPO_4). The effect of boron phosphate and relative loading are discussed. These effects include IEC, water uptake, methanol permiability and proton conductivity. The results showed that the proton conductivity of the composite membrane at room temperatute increased with reduction of BPO_4. Thermal stability and morphology structure were also studied by DSC, TGA and SEM analysis.

Key Word: Membrane, blend, fuel cell

Acnowledgement:-

The authors would like to thanks the BRNS, India for funding this project 2007/36/08-BRNS/597 dated 27.06.07.

Phosphonic acid functionalized organic-inorganic nanostructured polyelectrolyte membrane for fuel cell application

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Recently, there has been considerable interest for the development of polyelectrolytes membrane as a key component in the most promising electrochemical devices for convenient and efficient power generation such as polymer electrolyte membrane fuel cells (PEMFCs) and direct methanol fuel cells (DMFCs). Between both types of fuel cells, DMFC offers reasonably high fuel energy density, readily stored and available liquid fuel, and ease of refueling with direct electro-oxidation of methanol at moderate temperatures. Nafion® perflurosulfonic acid copolymers are state-of-art membranes for DMFC and hydrogen/air fuel cells due to their high conductivity, good mechanical and chemical stability. However, there is much interest in alternative polyelectrolytes membranes because of Nafion's reduced performance above 80 ^{o}C, significantly high methanol crossover and its high cost. Fluorine-free materials with comparable properties to Nafion are one of the directions in the development of cheaper polyelectrolytes.

Organic-inorganic nanostructured composites constitute an emerging research field, which has opened the possibility of tailoring new materials because they combine in a single solid both the attractive properties of a mechanically and thermally stable inorganic backbone and the specific chemical reactivity and flexibility of the organo functional groups. Additionally very less effort had been rendered to study the effect of functional groups on inorganic segments covalently bonded with organic segment. A material with covalently/chemically bound acidic groups would be desirable for preventing this phenomenon. In addition, under strong oxidative fuel-cell conditions, the stability of the sulfonic group in the membrane is uncertain, and thus more inert phosphonic acid group could improve the stability and conductivity.

In this abstract we describe the preparation of organic-inorganic nanocomposite polyelectrolytes membrane based on a new monomer precursor, bis(4-γ-aminopropyldiethoxysilylphenyl)sulfone (APDSPS), has been synthesized and cross-linked poly(vinyl alcohol) (PVA)-APDSPS composite polyelectrolyte membranes with phosphonic acid functionality were prepared by acid catalyzed sol-gel method. Cross-linking was carried out by gluteraldehyde to achieve micro-tailoring in hydrophobic domain for polyelectrolyte membranes impervious to methanol. These membranes were designed to possess all the required properties of proton conductive membrane, namely reasonably swelling, good mechanical, dimensional and oxidative strength, flexibility, low methanol permeability along with reasonable proton conductivity due to bridged aromatic sulfone between functionalized silica. From the estimation of selectivity parameter, 60% APDSPS composition among the PVA-APDSPS composite membranes showed highly suitable polyelectrolyte membrane, which suitability increased with the temperature.

Synthesis and Characterization of Shape Memory Bismaleimide Resins

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Abstract:

Maleimide–end capped poly(tetramethyleneoxide) (BMI-PTMO) was synthesized by reacting maleimidobenzoyl chloride with hydroxy–telechelic poly(tetramethyleneoxide) (PTMO). The polymers were characterized by FTIR, GPC, TGA and DSC. This compound was blended with a resin system constituted by o,o'-diallyl bisphenol A (DABA) and 2,2'-bis 4[(4-maleimidophenoxy)phenyl]propane (BMIP) and its cure characteristics were evaluated . The carbon fabric laminate of this resin system showed Shape Memory properties. The composites were evaluated by dynamic mechanical thermal analysis and Shape Memory property was determined by bending test. The dependency of the Mechanical and Shape Memory properties on the resin composition and resin/reinforcement ratio of the Elastic Memory Composites (EMCs) was examined.

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Synthesis, characterization and degradation studies of acid-labile polyketals prepared via a novel melt polymerization

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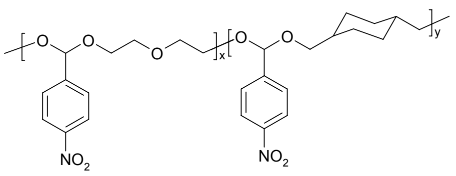
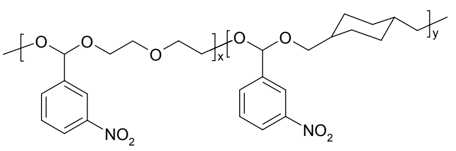
Polyketals and polyacetals are a class of polymers that could degrade under mildly acidic conditions.[1-2] Recently Murthy and coworkers have developed an interesting ketal-exchange methodology for the preparation of polyketals and have demonstrated their importance in the context of degradation-induced drug delivery vehicles. We have, over the past decade, explored a transetherification polycondensation process that is carried out under melt polymerization conditions. One feature of this process is that the monomers need to be rendered resistant to electrophilic aromatic substitution either by per-substitution or electronic deactivation. This ensures that side reactions that can lead to the formation of insoluble crosslinked products are precluded. Bearing this in mind, we extended this transetherification melt-condensation process for the preparation of polyacetals by the use of a simple dimethylacetal of an electron deficient aromatic aldehyde, such as p-nitro benzaldehyde, along with an aliphatic diol. The process entails melt-condensation of the two monomers at 150°C in the presence of a mildly acidic catalyst, such as pyridinium camphorsulphonate. Using this approach, we prepared a series of polymers, whose structures are depicted below, wherein two variations have been made: a) the aldehyde component was changed from 4-nitro- to 3-nitrobenzaldehyde and b) the amounts of two diols, namely diethylene glycol and 1,4-cyclohexane dimethanol were varied. The first variation is expected to modulate the intrinsic hydrolysis rate of the acetal linkage, while the second is expected to change the hydrophilicity of the matrix thereby controlling the accessibility of the acetal linkage to the aqueous acid during the degradation studies. The presentation will discuss the synthesis and degradation studies of the various polymers thus prepared.





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Environmentally Benign Process for Bulk Ring Opening Polymerization of Lactones Using Iron and Ruthenium Chloride Catalysts

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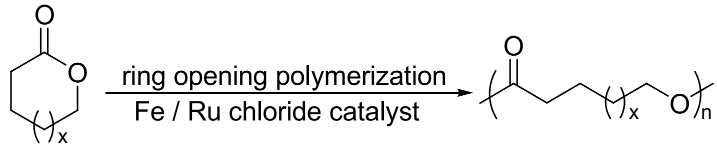
In the recent years, the increasing need to search alternative polymeric materials to those based on non-renewable petroleum resources, along with the desire to produce environmentally benign biodegradable plastics has provided active impetus towards the polymerization of cyclic esters.[1] Aliphatic polyesters have been implicated for biomedical applications such as delivery medium for the controlled release of drugs and biodegradable surgical sutures.[2] Polylactones have potential utility for such applications as a result of their permeability, biocompatibility and biodegradability. One of the convenient strategies in synthesizing these polymers is the ring opening polymerization of the corresponding cyclic lactone monomers or functionally related compounds.[3]

$FeCl_3{\cdot}6H_2O$, $RuCl_3{\cdot}H_2O$ and $FeCl_2{\cdot}4H_2O$ are found to be bulk polymerization catalysts for the ring opening polymerization of ε-caprolactone, δ-valerolactone and β-butyrolactone. These polymerizations can be significantly enhanced by conducting them in the presence of appropriate amounts of different alcohols. The major initiation pathway in the polymerization is found to proceed via the activated monomer mechanism and depending on the nature of the alcohol used, poly(lactones) with different end groups can be synthesized. Such polymerizations constitute an economical process, employing readily available inorganics as catalysts and do not necessitate solvents. The overall system is green and eco friendly.



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SYNTHESIS AND CHARACTERIZATION OF NOVEL RADIOPAQUE POLYURETHANE FOR MEDICAL APPLICATIONS

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Polymeric biomaterials are increasingly being used for medical applications such as cardiovascular implants, prostheses, orthopedic implants, wound dressings and controlled release devices. It would be advantageous if these implants could be accessed in a non invasive manner so as to evaluate the performance. A relatively new and perhaps more promising approach for non-invasive evaluation of the performance of a biomaterial is to impart radiopacity to such materials. Conventional polymers cannot be detected by commonly used imaging techniques like X-ray and ultrasound because they contain elements such as C, H, O and N which exhibit both low electron density and low specific gravity. Therefore research on methods for increasing the average electron density and the specific gravity of polymers by incorporating heavy elements would lead to the development of novel radiopaque polymers. In the present investigation, a new class of radiopaque polyurethane was synthesized and characterized. Radiopaque polyurethane (RPU) was synthesized by following a two step process. In the first step, the chain extender 2,3- diiodo-2- butene-1,4 diol was prepared by a method which approximated the method of Merianos and John [United States Patent 4087451]. In the second step, 4,4'- methylene bis(phenyl isocyanate), polypropylene glycol (of molecular weight 1000) and chain extender were reacted in the molar ratio 2.2:1.2:1. The RPU thus obtained was characterized by FTIR spectroscopy, thermogravimetric analysis, differential scanning calorimetry, gel permeation chromatography and X-ray opacity. Blood compatibility and cytotoxicity of the RPU was evaluated. The RPU was thermally stable, blood compatible, non-cytotoxic and highly radiopaque. These iodine-containing polyurethanes may have potential biomedical applications.

GREEN NANOCOMPOSITES FROM MALEATED POLYCAPROLACTONE/SOY PROTEIN ISOLATE BLEND WITH ORGANOCLAY: PREPARATION, CHARACTERIZATION AND PROPERTIES

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New biobased, eco-friendly nanocomposites were prepared from maleated Polycaprolactone/soy protein isolate blend (50/50 wt/wt) with organo-modified clay by melt compounding. The XRD, TEM, tensile, DMTA, and rheological properties of the nanocomposites were investigated. X-ray diffraction and transmission electron microscopy analysis revealed that the intercalated nanocomposite is formed and the silicate layers of the clay are uniformly dispersed at a nanometer scale in the polymer matrix. There is a great enhancement in tensile and dynamic mechanical properties of the nanocomposites. Rheological study revealed that the nanocomposite exhibits strong shear thinning behavior and clay particles form network in the melted state of the composites.

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ISOMANNIDE BASED NLO ACTIVE MAIN CHAIN CHIRAL POLYURETHANES WITH AMIDO DIOL CHROMOPHORES

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ABSTRACT

The work deals with the synthesis of smart polymeric materials with high second order optical response functions which are having potential applications in telecommunication, optical computing and data storage. The paper discusses the synthesis of polyurethanes having main chain chirality and main chain push-pull (donor-acceptor) chromophoric moiety. Toluene diisocyanate, isomannide (chiral diol) and the amido diol chromophores obtained by the ring opening of caprolactone by diamino alkanes (ethane, butane and hexane) were used for the present synthesis. The noncentrosymmetric (both charge asymmetry and spatial asymmetry) environment were attained by the incorporation of the chiral units and donor-acceptor building blocks in the main chain and hence induce a helical conformation in the macromolecular chain.

A series of polyurethanes were synthesized by varying the chiral-chromophore composition. The amido diol chromophores used in the present study are N, N'- ethane- 1, 2- diyl bis (6-hydroxy hexanamide), N, N'- butane- 1, 4- diyl bis (6-hydroxy hexanamide) and N, N'- hexane- 1, 6- diyl bis (6-hydroxy hexanamide). The corresponding chromophores were obtained by the ring opening of caprolactone by using the diamines, diamino ethane, diamino butane and diamino hexane respectively. The influence of chromophore and their spacer effects on thermal and nonlinear optical properties of polymers were studied. The synthesized monomers and polymers were characterized by FT-IR, NMR and UV spectral methods. The nonlinear optical properties were studied by using the Powder Techniques and thermal properties were determined by TG/DTA analysis. The specific rotations of the polymers were measured by polarimetric techniques.

Micro Encapsulation of coconut oil For Thermo Regulation

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Abstract

Phase change materials which store, release or absorb heat when they change their phase, can be used to maintain the temperature of any active component such as electronic heat sinks, medical wraps, etc. This study deals with the microencapsulation of coconut oil with melamine formaldehyde resin by insitu polymerization, and their characterization. Since coconut oil is abundantly available and of low cost compared to many hydrocarbons that are widely used as PCM, it can be used to regulate immediate environmental temperature where, increase in weight of the component is not critical. The microcapsules containing coconut oil were produced with good encapsulation efficiency, high core content and high thermal stability. The surface characteristics of the capsules were investigated using scanning electron microscopy and thermal properties of capsules were determined using TGA and DSC. The DSC results showed that the enthalpy of microcapsules was reasonably high at 60kJ/kg.

Acknowledgement: The authors acknowledge partial financial support from the Department of Science and Technology, Govt. of India and Pluss Polymers P Ltd., Gurgaon.

Synthesis, characterization and bactericidal activity of certain co polyesters

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Abstract

Chalcone the precursor of flavanoids and isoflavanoids is associated with several biological activities and is also found to exhibit diverse pharmacological activity[1,2].Recent progress in the synthesis of high molecular weight polyesters reveals that they are found to possess wide biomedical and ecological applications which have made them technologically important. In this review four new co polyesters were synthesized by the condensation of two diols namely,4,4'- di(2-hydroxy ethoxy)chalcone and 2,5- di(4-hydroxy benzylidene) cyclopentanone with adipoyl, suberoyl, azelayl and sebacoyl chloride respectively by solution polymerization method. The structure and repeat unit in the four co polyesters were confirmed from FTIR, ^{1}H NMR, and ^{13}C NMR spectral data. The thermal properties of the four co polyesters were investigated by DSC technique. The presence of antimicrobial pharmacophores in both the diols used enhances the bactericidal activities of the co polyesters which were studied using disc diffusion method.

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NOVEL SULPHONATED POLY(ETHER ETHER KETONE)/ POLY (VINYLIDENE FLUORIDE) ELECTROLYTE MEMBRANES FOR FUEL CELLS

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Fuel cells are considered as the best alternatives to the present conventional engines for keeping the environment clean for tomorrow’s generation. In our current study, we investigated blend membranes of sulphonated poly(ether ether ketone) (SPEEK) and poly(vinylidene fluoride) (PVDF) for a possible application as electrolyte membranes in fuel cells. The ion exchange capacity, water and methanol absorptions, durability were evaluated and found to be satisfactory. From the FT-IR analysis, the interaction between the two polymers was understood. The thermal suitability was found to be excellent as determined by TGA. The mechanical properties were appreciable and was obtained by UTM and DMA. The SEM pictures revealed a uniform blend without any pores. The crystallinity of the blend was analysed by means of XRD. The methanol permeation studies was also carried out to determine the applicability of the blend membranes in DMFC. The proton conductivity was found to be promising as obtained by impedance spectroscopy.

Keywords: SPEEK, PVDF, Blend Membranes, Proton Conductivity.

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Cholesterol -End Capped Fluorescent Amphiphilic Block Copolymer: Synthesis, Characterization and its Interaction with Biomolecules.

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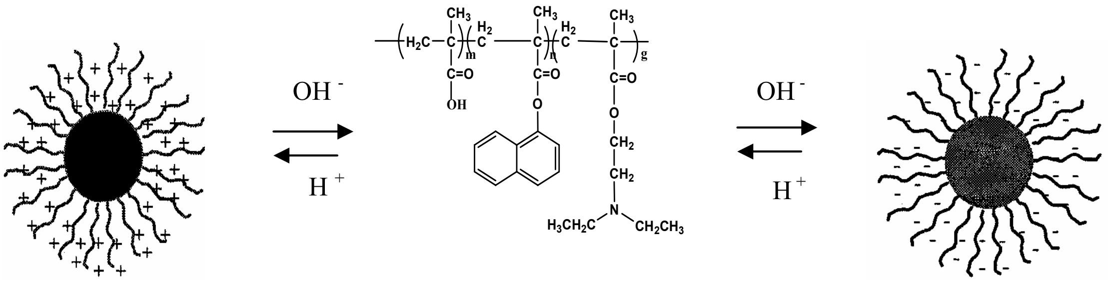
Abstract:

Novel fluorescent amphiphilic block copolymer [1] poly(styrene – b – acrylic acid) [P(S–b-AA)], poly(methyl methacrylate–b-dimethylaminoethyl methacrylate-co-napthyl methacrylate) P(MMA-b-DMAEMA-co-NMA)] , poly(styrene-b-t-butyl acrylate-co-napthyl methacrylate) P(S-b-t-BA-co-NMA) were successfully synthesized by atom transfer radical polymerization (ATRP) method [2], using CuBr as the catalyst and N, N, N, N, N – pentamethyldiethylene triamine as the complexing agent. The initiator was prepared by reacting cholesterol and 2 - bromoisobutyrl bromide [3]. The polymers were characterized by GPC, ^{1}H NMR, IR and UV spectroscopies. It was observed that as the polymerization time increased, both the conversion and the molecular weight increased linearly with time [4]. The florescence properties of the polymers prepared were recorded. Amphiphilic block copolymers have been used extensively in pharmaceutical application ranging from sustained released technologies to gene delivery. The fluorescent block copolymers interact with biomolecules like DNA and anti-viral drugs, which can be monitored by fluorescent studies [5]. The block copolymers formed micelles in aqueous phase and this was also investigated.

Keywords: ATRP, living radical polymerization, fluorescent polymers, amphiphilic Copolymer, DNA.



PMAA-core micelles @ pH 2

PMAA-b-PNMA-co-PDMA fluorescent zwitterionic diblock copolymer

PDMA- core micelles @ pH 10

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Synthesis and Characterization of Metal Nanoparticles Doped Polyaniline by Interfacial Polymerization of Aniline using Metal Salt as Oxidant.

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Metal nanoparticles doped polyaniline nanocomposites have been synthesized by an interfacial polymerization of aniline, dimeraniline and tetraaniline using metal salts such as $HAuCl_4$, $Cu(NO_3)_2$ and $AgNO_3$ as oxidizing agent. The polymerization reaction occurs at the interface of toluene and water during mixing. The reaction mixture was allowed to stand for 4 days at room temperature under static condition. The organic phase becomes dark due to polymerization of aniline and its oligomers. The resulting metal nanoparticles doped conducting polyaniline nanocomposites were isolated and characterized with UV-VIS, FT-IR, XRD, SEM. and Cyclic Voltammetry.

Synthesize and characterization of liquid crystalline polyesters containing α, β-unsaturated ketone in the main chain

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Thermotropic main chain liquid crystalline polyesters containing α, β-unsaturated ketone moieties in the main chain were synthesized from 2,6-bis[4-(3-hydroxypropyloxy)-3-methoxybenzylidene]cyclohexanone (BHPMBCH) and aliphatic and aromatic diacid chlorides. The diol precursor, (BHPMBCH) was synthesized from 2,6-bis(4-hydroxy-3-methoxybenzylidene)cyclohexanone (BHMBCH) and trimethylene bromohydrin as a spacer. Solubility of the polymers was tested in various solvents. The molecular structure of the monomer and polymers was confirmed by elemental analysis, FTIR, UV-Visible and ^{1}H, ^{13}C-NMR spectral analysis. Thermal properties were studied using TGA and DSC. The thermogravimetric analysis data revealed that the polymers are stable up to 120°C and starts degrading. Thermal stability varies with the type of acid chlorides used. Molecular weight of the polymers was determined by GPC. The inherent viscosity of the synthesized polymers was studied by Oswald viscometer. Crystallinity of the polymers was studied by X-ray diffraction. Condensed phase structure of polymers was investigated using hot stage polarized optical microscope. In addition, photocrosslinking properties of the polymer chain was studied using UV spectroscopy.

Keywords : Liquid crystalline polymer, Polymer synthesis, Photocrosslinking.
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Studies on Synthesis and Characterization of Bismaleimido phenylphosphine oxide benzoxazine and its polybenzoxazine-bismaleimide polymer alloys

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Abstract

A new flame retardant polymer alloy was prepared by mixing typical bismaleimido phenyl phosphine oxide benzoxazine with a distinctive bismaleimide, 4,4'-bismaleimidodiphenyl methane by various weight ratios followed by thermal treatment up to 240 ºC via addition and ring opening self-polymerization. Bismaleimido phenylphosphine oxide benzoxazine was synthesized from *p*-hydroxyphenyl maleimide, paraformaldehyde by using characteristic bis(3-aminophenyl)phenylphosphine oxide. The synthesized benzoxazine was then mixed with bismaleimide to yield polybenzoxazines-bismaleimide polymer alloys. The structure of benzoxazines was characterized by FTIR, ^{1}H and ^{13}C NMR spectra. The curing behaviour and glass transition temperature of benzoxazine and its mixing with bismaleimide was investigated by DSC and IR measurements. These analyses showed that the obtained polybenzoxazines-bismaleimide alloys possess co-cross linked polymer networks through the formation of ether linkage between the hydroxyl groups of polybenzoxazine and the double bond of bismaleimide. Thermal stability of the polymer alloys was investigated by TGA. The degradation temperature and the char yield of phosphorus containing benzoxazine and bismaleimido benzoxazine were higher which further increased with increasing the concentration of bismaleimide compared to the homopolymers showing that the flame retardancy is also improved by alloying. Dynamic mechanical analysis (DMA) revealed that the polymer alloys also exhibit much higher glass transition temperatures and storage modulus by increasing the bismaleimide content than those of each homopolymer due to the formation of co-cross linked structure.

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Functionalization of Polymeric Substrates Using Atmospheric Pressure Cold Plasma

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Abstract

Low pressure plasma can be used to impart different functionality by the nano-scale modification of any polymeric materials by either plasma etching or depositing of a suitable material as thin layer. However, atmospheric pressure plasma would be more promising for such applications from the point of view of ease of operation and industrial application, if challenges related to generation of active species and their stability could be solved.

In this study, plasma reactions were carried-out in an indigenously developed atmospheric pressure cold plasma reactor by optimizing different plasma parameters. Both hydrophilic and hydrophobic surface functionality could be imparted on various polymeric substrates. Hydrophilicity of hydrophobic polymeric textile substrates such as nylon and polyester could be increased significantly after plasma treatment in the combination of gases. As a result of this, water spreading time of a droplet (37 μl) over a pre-defined area of nylon fabric decreased from 540 s in untreated sample to 1.1 s in plasma treated sample. For polyester samples the change was from 700 s to 6.8 s. On the other hand, hydrophobicity of hydrophilic polymeric textile substrates could be improved by reacting fluorine based precursor under plasma. In the plasma modified hydrophobic sample, a water drop of 37 μl took more than 1 hour to get absorbed by the fabric, compared to control sample where it took less than 1 second. The modified sample showed water contact angle of 148^0. The surface characteristics of the samples were investigated using SEM, AFM, XPS and ATR-FTIR.

Key words: Atmospheric Pressure Plasma; Polymer; Hydrophilic; Hydrophobic; Textile

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Synthesis and characterization of polybenzimidazoles based on diaminobenzidine (DAB) and aliphatic dicarboxylic acids

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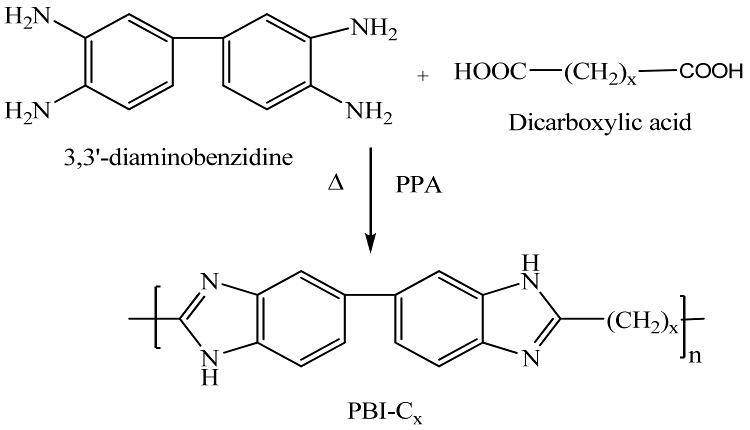
Abstract

A series of polybenzimidazoles (PBI) were synthesized by solution polycondensation of *3,3′*-diaminobenzidine (DAB) with aliphatic dicarboxylic acids (with varying -CH_2-groups) in order to incorporate flexibility in polymer backbone. Polyphosphoric acid (PPA) was used as a solvent which also acts as dehydrating agent. The duration of reaction were optimized individually and was found to be lesser than that for the PBI based on isophthalic acid [Iwakura (1964); Kumbharkar (2006)]. The ease of the reaction and high viscosity of obtained PBIs were indicative of high reaction rates of aliphatic dicarboxylic acid than that of aromatic ones.



Where, x = 2, 4, 5, 6, 7, 10

Figure 1. Synthetic route to polybenzimidazoles

The solubility of these PBIs was evaluated in common solvents. The dense membranes were prepared by solution casting method using 2 % (v/v) solution in formic acid. Physical and thermal properties were determined to evaluate effect of added flexibility in PBI backbone. TGA analysis showed good thermal stability in the range of 400-500°C. Wide angle X-ray diffraction (WAXD) proved the amorphous nature of polymers.

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Development of Structure Modified Sulfonated Polyether Ether Ketone for Solid Polymer Electrolyte Application

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Abstract

Development of proton exchange membrane based on polyaryl ether ketones is done for use as solid polymer electrolyte for fuel cell application. Sulfonated polyether ether ketone (sPEEK) membranes are considered promising alternative to the perfluorinated polymers due to some important advantages such as low cost and high temperature stability. Sulfonation of poly ether ether ketones (PEEK) beyond certain limits causes excessive swelling of the membrane due to the presence highly polar SO_3H groups. sPEEK with 50 mol% sulfonic acid was found to dissolve in hot water. It is necessary to retain the dimensional stability of the polymer in hydrated conditions for application in fuel cells.

This study presents the structural modifications carried out by different means to control the swelling characteristics and proton conductivity of PEEK. Tertiary butyl substituted PEEK polymer was utilised for sulfonation in strong acid medium. Membranes were prepared using the sulfonated polymer and tested for sulfonic acid content, proton conductivity and water uptake. The results showed that the substituted PEEK improves the swelling resistance and allows sulfonation to an extent of 88% resulting with proton conductivity of 1.34×10^{-2} Siemens/cm. In another method, crosslinks were introduced in the PEEK by reacting with phenyl sulfone in a high boiling solvent. The stoichiometry was varied to optimise the extent of crosslinks. The polymer was analysed chemically and spectroscopically. The resultant polymer was sulfonated using strong acids. Membranes prepared with the sulfonated polymer showed excellent swelling characteristics with 80% sulfonation and a proton conductivity of 1.5×10^{-2} Siemens/cm. The results show that considerable improvement in swelling characteristics and proton conductivity could be achieved for PEEK based solid polymer electrolyte membranes by proper selection of substituent groups and also by structural modification of the polymer.

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Polymers for electronics

SOME NOVEL POLYANILINE-MULTIWALLED CARBON NANOCOMPOSITES IN PREPARATION AND CHARACTERIZATION.

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With their unique electronic and mechanical properties, carbon nanotubes are from great interest for the fabrication of new classes of advanced materials. Here, especially composites based on polymers and nanotubes offer the possibility to obtain materials with superior properties. Polyaniline, a particular conducting polymer with a high application potential, is a promising candidate to synthesize such nanotube composites with improved structural or functional characteristics. Some substituted Polyaniline- Multi Walled Carbon Nanotubes (MWCNT) composites have been synthesized by "in situ" polymerization process in acidic medium. Aniline molecules were absorbed onto and then polymerized on the surfaces of multiwalled carbon nanotubes (MWCNT). The composites have been characterized by, FTIR, SEM, TGA and XRD methods. The electrical conductive properties of the composites have also been investigated. The X-ray diffraction analysis at low angles the difractogram of the PANI/MWNT materials show the highly pronounced oscillating structure of the primary doped PANI with oxidation degree of 0.5. The Raman's spectroscopy reveals that the electronic behavior of the composites in the concentration range between 20 and 50 wt% very significantly from one of its constituents. It becomes very clear that the overall structure of MWCNT plays a critical role in the formation of true material composites.

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Effect of Various Salts such as Sodium Chloride, Magnesium Sulfate, Sodium Citrate, Di-sodium tartrate 2-hydrate on the Thermo Reversible Sol-gel Transition Temperature of Methylcellulose-Polyethylene Glycol (PEG) Binary System.

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ABSTRACT:

The effect of various salts such as Sodium Chloride, Magnesium Sulfate, Sodium Citrate, Di-sodium tartrate 2-hydrate on the reversible sol-gel transition temperature of methylcellulose (MC) - poly ethylene glycol (PEG) binary system was studied with the aim to get the reversible sol-gel of methylcellulose at physiological temperature (37°C) for biomedical application. The gelation temperature of 1% methylcellulose was 59°C. When PEG (6000) was added with varied concentration from 2% to 10% and MC was kept constant at 1%; the reversible sol- gel transition temperature was lowered from 59°C to 54°C. To reduce the sol-gel transition temperature of MC, further different salts were added in the binary system where the concentration of MC (1%) and PEG (10%) were kept constant. The concentrations of different salts were varied from 1% to 5% and it was observed that the reversible sol-gel transition temperature was further lowered and some of these ternary systems formed gel at physiological temperature i.e. 37°C. Therefore, the proper combination of PEG and salt can reduce the gelation temperature of MC up to physiological temperature for biomedical application.

KEY WORDS: methylcellulose, reversible sol- gel transition temperature, physiological temperature.

The luminescence study of Lead sulfide nanocrystal-Polyhydrazide/ 1,3,4 polyoxadiazole composite

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The composites are prepared by in-situ method; the particles are allowed to form in the monomer solution with the formation of polyhydrazides. The cyclization of the polyhydrazides is done by vacuum heating at 320-350^{o}c. The polymer-PbS composites are found to soluble in amide solvents and can be cast into films. The inherent viscosity of the polymer ranges from 0.19-0.45 dL/g. Polymers/composites are characterized by FTIR, 1H NMR spectroscopy, SEM analysis and XRD analysis. The luminescence property and the thermal behaviour of the polymer nanocomposites show significant changes and are found to be advantageous over the virgin polymers.

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Vegetable Oil Based Polyester/Clay Nanocomposites

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Abstract

Polyester has been synthesized from monoglyceride of *Mesua ferrea L.* seed oil with phthalic anhydride and maleic anhydride based prepolymer followed by esterification with trimellitic anhydride using DMF as the solvent. This vegetable oil based polyester was used as a matrix to prepare polymer clay nanocomposite by solution technique. The system was cured by using conventional MEKP, styrene and Co-octate curing system at 150 ^{O}C. The prepared nanocompositse were characterized by FTIR, XRD and SEM studies. The rheological properties like viscosity, storage modulus and loss modulus were also measured by CVO 100 rheometer of the nanocomposite before curing. The TGA was done to study the thermal behavior of the nanocomposites. The mechanical properties like tensile strength, impacts, scratch hardness, gloss, elongation at break and chemical resistance in different media were investigated for the prepared nanocomposites. The results showed that the properties of nanocomposite are much better than the pristine polyester.

Keywords: Polyester, Vegetable oil, Thermal behavior, clay nanocomposite.

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PREPARATION AND CHARACTERIZATION OF STARCH- CLAY BIONANOCOMPOSITES FOR FOOD PACKAGING APPLICATIONS.

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In the recent years there has been a growing interest in the use of biodegradable polymers for packaging materials in order to reduce the environmental pollution caused by plastic wastes. Starch is known to be completely biodegradable in soil and water and to be one of the most effective packing materials because it is a cheaply resourced material and has very fast biodegradability. In this present research program nanocomposites films were prepared by homogenously dispersing organo clay with thermoplastic starch (TPS) via polymer melt processing techniques. The structural and mechanical characteristics of the nanocomposites were investigated. Moreover, food contact tests with some vegetables and stimulants have been performed in order to study the possibility of utilizing these materials in the food packaging sector. In fact, plastic materials are not inert and, where direct contact between the packaged product and the plastic container occurs, there can be migration of substances into the product. The dispersion of the organo clay/ Cloisite 30B in the TPS hybrids was also characterized by using wide angle X- ray diffraction (WAXD) and transmission electron microscopy (TEM). It was observed that the TPS/ Cloisite 30B nanocomposites showed higher tensile strength and thermal stability, better barrier properties. The effect of clay contents on the tensile, dynamic mechanical and thermal properties as well as the barrier properties of the nanocomposites were also investigated.

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Metal ion adsorption by polystyrene supported schiffs base derived from salicylaldyde and oxy dianiline

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Abstract

A polystyrene supported schiffs base derived from salicylaldehyde and (4,4'diamino diphenyl ether) [oxy dianiline] ODA was prepared, starting from chloromethylated polystyrene (2% divinyl benzene cross linked), and used for metal ion pick-up from aqueous solution. The complex formation of resin ligand with Cu(II) and Zn(II) was studied under the optimum conditions, which were first determined by using a low molucular weight analog of the resin ligand. Adsorption of metal ion, rate of adsorption, effect of eluent on desorption were studied. The complexes were characterized by I.R. spectroscopy.

The resin has a remarkably high capacity for Cu(II), 0.47 m mol/g, at pH 8. Maximum adsorption was observed for Cu(II) in presence of 0.1 mol NaCl, for Zn(II) in presence of 1.5 mol NaCl. The adsorbed metal ion could be easily and rapidly stripped by using 2M HCL. The resin was stable to acidic medium of stripping and was recyclable.

Studies on Flame Retardant Polymer Blends based on Urethane-Epoxy Systems

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Abstract

Polyurethanes have been synthesized by reacting a novel phosphorous containing polyol with different diisocyanates like toluene diisocyanate and isophoron diisocyanate and have been employed as a modifier for epoxy resin which has similar phosphorous moiety in the back bone structure. The polyol is a product of castor oil and tris-(m-hydroxy phenyl)phosphate by transesterification reaction. The polyol, polyurethanes and epoxy resin have been characterized by chemical, physical and instrumental analysis techniques. The polyurethanes and epoxy resin have been blended in different proportions. Films have been prepared by casting process using suitable curing agent. The same formulations have also been used for the coating of different substrates like wood, wood composite and metal. The effects of polurethanes on the properties of epoxy resin have been found out by evaluating various flame retardant, mechanical and chemical resistance properties.

Synthesis and Characterization of Photocrosslinkable Epoxy Resin containing Dibenzylidene Cyclohexanone

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A dual functional epoxy resin was synthesized by solution polycondensation of 2,6-bis(4-hydroxy-3-methoxy benzylidene)cyclohexanone with epichlorohydrin. Epoxy content was determined by pyridinium hydrochloride method. It was observed that the epoxy content vary with diol-epichlorohydrin ratio. The synthesized epoxy resin was characterized systematically by UV, FT-IR, ^1H and ^{13}C – NMR spectroscopic techniques. Thermal characterization of synthesized epoxy resin was carried out by TGA and DSC under nitrogen atmosphere. The photosensitive property of the epoxy resin in solution state was investigated by Ultraviolet spectroscopy. It was observed that on exposure to UV light the epoxy resin undergoes photocrosslinking reaction. The photocrosslinking proceeds through the dimerization of olefinic chromophore present in the main chain of the polymer via $2\pi + 2\pi$ cycloadditon reaction. The effects of solvents and epoxy content on the photocrosslinking ability of the epoxy resin were also studied. Photopolymerizing ability of the epoxy resin was studied using a photoacid generator.

Keywords: Epoxy resin, Photocrosslinking, Photopolymerisation, Photosensitive polymers.

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Ultrafiltration membranes prepared from blends of Cellulose Acetate and Sulfonated Styrene Acrylonitrile copolymer

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Abstract

Modification of membrane materials helps minimize fouling and thus facilitates their large scale applications. Sulfonation is a versatile route to polymer modification that is especially suitable for aromatic polymers. The sulfonation of hydrocarbon polymers for functionalization bearing -SO_3H groups is the most suitable method to produce hydrophilic polymers and thereby membranes. Polymeric membranes of hydrophilic type are a class of materials with increasing interest in both laboratory research and industrial practice.

Hence, styrene Acrylonitrile copolymer (SAN) was functionalized by sulfonation before blending and ultrafiltration membranes were prepared based on blends containing Cellulose acetate (CA)and sulfonated styrene Acrylonitrile copolymer (SSAN) in various blend compositions with N-N'-Dimethyl Formamide as solvent by phase inversion technique.

Thus, partially charged hydrophilic membranes prepared from blends of cellulose acetate polymer and sulfonated copolymer were subjected to ultrafiltration characterizations such as compaction, pure water flux, water content, and membrane hydraulic resistance. All CA/SSAN blend membranes had substantially higher pure water flux, water content, and reduced hydraulic resistance compared to the pure CA membrane and the results are discussed.

Further, the morphology of the novel asymmetric polymeric membrane prepared in our laboratory was also analyzed through Scanning Electron Microscopy. The prepared membranes exhibited the typical asymmetric structure and fully developed macro pores.

Polymers in health care

POLY LACTIDE/ MONTMORILLONITE NANOPARTICLES FOR CONTROLLED DELIVERY OF ANTICANCER DRUG PACLITAXEL.

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This research program describes the preparation of paclitaxel-loaded PLA/MMT nanoparticles by the emulsion/Solvent evaporation method. MMT can provide mucoadhesive capability for the nanoparticles to cross the GI barrier (Gastro intestinal). MMT is also a potent detoxifier, which belongs to the structural family known as the 2:1 phyllosilicate. MMT could absorb dietary toxins, bacterial toxins associated with gastrointestinal disturbance, hydrogen ions in acidosis, and metabolic toxins such as steroidal metabolites associated with pregnancy. MMT was incorporated in the formulation as a matrix material component, which acts as a co-emulsifier in the nanoparticles preparation process. The drug loaded PLA/MMT nanoparticles were found to be spherical in shape. The TG analysis, surface morphology and in-vitro drug release profile of the PLA/MMT nanoparticle have been evaluated. Adding MMT component to the matrix material appears to have little influence on the particle size and the drug encapsulation efficiency. The drug release pattern was found to be bi-phasic with an initial burst followed by a slow, sustained release and not affected by the MMT content. The results indicate that MMT can significantly enhance the nanoparticle cell interaction. This novel formulation by PLA/MMT nanoparticles for oral chemotherapy seems to be feasible

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Synthesis and Characterization of Copolymers of N-Phenyl Methacrylamide with Glycidyl Methacrylate

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Abstract:

Copolymers of N-phenyl methacrylamide and glycidyl methacrylate of different compositions were synthesized by free radical solution copolymerization of the monomers in dimethylformamide using benzoyl peroxide as the initiator at 70^0C. Solubility of the copolymers was tested in various solvents. The molecular structure of the copolymers was elucidated by infrared and proton nuclear magnetic resonance spectroscopy. Copolymer composition of the copolymers was determined from the corresponding ^{1}H NMR spectra by using the intensities of aliphatic and aromatic protons present in the copolymer. Finemann – Ross and Kelen – Tudos are employed to determine the reactivity ratios of the monomers. The intrinsic viscosities of the copolymers of GMA and PMA were determined using Ubblehode viscometer. The thermal transitions of the copolymers were determined using differential scanning calorimetry and thermo gravimetric analysis.

Key Words: N-Phenyl methacrylamide; Glycidyl methacrylate; Free radical solution copolymerization; Thermal properties; Reactivity ratios.

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Study on the effect of carboxylated nitrile rubber on the properties of high performance epoxy adhesive

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ABSTRACT

Epoxies dominate the field of structural adhesives due to their better wetting ability, superb mechanical properties and good chemical and temperature resistance. However fully cured epoxies have the limitation of brittleness and in order to overcome this limitation, extensive research has been carried out to toughen epoxies by incorporating a reactive elastomers such as amine terminated butadiene acrylonitrile rubber (ATBN), carboxyl terminated butadiene acrylonitrile rubber (CTBN) etc.

We modified a room temperature curable triglycidyl p-amino phenol phenol epoxy novolac resin based adhesive with solid XNBR (carboxylated nitrile rubber) and studied the effect of XNBR on different physico-mechanical properties of the adhesive. XNBR concentration was varied from 2.5 to 7.5 % by weight. Optimum lap shear strength (Al/Al) was found with 5% by weight of XNBR. Inclusion of larger amount of XNBR reduced the shear strength leading to more flexibilization. DSC study showed that the on increasing reactive rubber content glass transition temperature decreased. Thermal analysis was also carried out to study the effect of XNBR on the thermal stability of the adhesive. The morphology for the XNBR modified systems was evident from the scanning electron micrographs (SEM).

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NANOCOMPOSITES FROM SOY PROTEIN ISOLATE CROSSLINKED WITH FURFURAL FOR CONTROLLED RELEASE OF CEFADROXIL

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ABSTRACT

Soy protein isolate, a potential alternative to petrochemical based polymer, has been cross-linked with furfural and blended with an organoclay Cloisite 30B. The nanocomposites have been characterized by using spectral, thermal, XRD, and morphological studies. The water absorption properties of the nanocomposites have also been reported. These cross-linked nanocomposites have been developed with an aim to be used as controlled release matrices and tissue engineering applications. The degradation pattern of the cross-linked product has been monitored by TGA method. A computerized **LOTUS** package method developed by us has been used for evaluating the kinetic parameters. The degradation mechanism of the nanocomposites has been discussed in the light of the computed kinetic parameters. The cross-linked nanocomposite has been blended with Cefadroxil and the in-vitro release of the drug has been evaluated.

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Recyclable Efficient Heterogeneous Catalyst from Gel Nanocomposite

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Abstract:

Metal nanoparticle embedded porous heterogeneous catalyst is developed from the nanocomposite route (figure-1). The catalytic activity of the dried porous nanocomposite is evaluated for two oxidation and one reduction reactions in aqueous medium. The recyclability was tested by reusing the same catalyst for three times for the same reactions. The effect of NP size and the effect of porous binder compared with that of bulk polymeric binder on catalytic activity are also tested. Smaller the NP size, greater is the catalytic activity and the catalytic activity is 2-2.5 times greater in porous polymeric binder than that of bulk (sintered) polymeric binder. The catalytic activity of the porous catalyst is also compared with that of exiting catalysts for reactions under similar reaction conditions and it has been observed that the porous catalyst enhances the reaction rates dramatically.

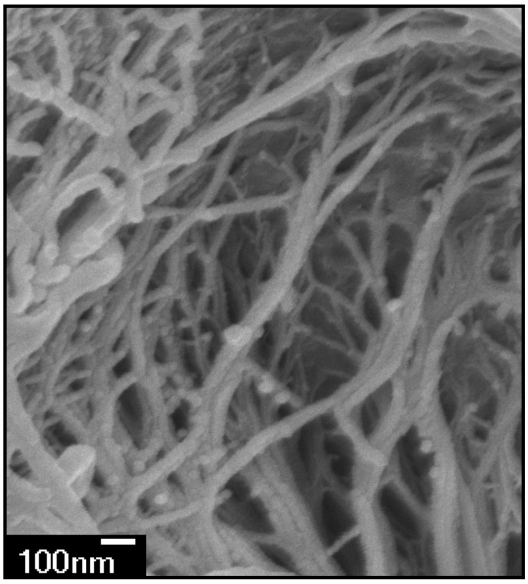

Figure-1: SEM image of the heterogeneous catalyst.

CONTROLLED DELIVERY OF GENTAMICIN SULFATE FROM POLYCAPROLACTONE–CHITOSAN CAST MATRICES

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In the present research program, PCL/ Chitosan (PC) (80:20) were loaded with the amino-glycoside antibiotic, gentamicin sulfate (GS) using the precipitation casting technique by suspension of powder in the PCL/ Chitosan solution prior to casting. The formulation of GS loaded microsphere matrices were prepared by powder suspension method with cooling stage and drug precipitation method. The TG analysis, SEM, XRD and the biodegradability tests of the composites have been investigated. Improvements in drug loading from 1% to 7% (w/w) and distribution in the matrices were obtained by pre-cooling the suspension to 4 ^{o}C. Gradual release of approximately 80% of the GS content took place in 11 weeks. The pattern of GS release from the PCL/Chitosan matrices into PBS at 37^{o}C generally consisted of an initial burst phase during the first 24 hours followed by gradual drug release.

Amino-glycoside antibiotics such as Gentamicin sulfate and Streptomycin are effective against a broad range of gram negative and some gram negative organisms including Staphylococci and Enterobacteriaceae. They act by penetrating the outer cell wall and disrupting the cytoplasmic membrane, leading to the potential lethal event. Staphylococci such as *S. aureus* and *S. epidermidis* are the most common pathogens associated with osteomyelitis and cardiovascular implant infections. The *S. epidermdiis* inhibition assay revealed clear zones around GS-loaded MPCM (Microporous PCL-Chitosan matrices) after 24 hour incubation at 37^{o}C but not in the control plates containing drug-free matrices, demonstrating that GS is released with retained activity after formulation. Microporous PCL-Chitosan matrices produced by precipitation casting may therefore provide a useful vehicle for local antibiotic delivery in cases of musculoskeletal, ocular infection and bone substitution.

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Forsterite based polymer-ceramic composites for microelectronic packaging applications

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Abstract

The dielectric properties and coefficient of thermal expansion of Diglycidyl ether of bisphenol A (DGEBA) and Polytetrafluoroethylene (PTFE) composites of forsterite (Mg_2SiO_4) have been studied at 1 MHz and 7GHz for their applications in microelectronic packaging. The dielectric constant and dielectric loss of the composites increased with the increase in the forsterite content. The measured dielectric constant (ε_r) values were compared with the effective dielectric constant calculated using different theoretical models. The observed dielectric constants were in agreement with that calculated using effective medium theory. Coefficient of thermal expansion decreased with the forsterite content. Although surface modification of forsterite particles did not show any significant change in the dielectric properties of the composites, the modification resulted in a significant reduction in the coefficient of thermal expansion from 96 ppm/^{o}C to 33 ppm/^{o}C for the DGEBA composite at 40 vol% ceramic content and from 99 ppm/^{o}C to 52 ppm/^{o}C for the PTFE-forsterite composite at 60vol% ceramic content.

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Melt Processable Copolyesters Derived From Isosorbide, Siloxane and Terephthalic Acid

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ABSTRACT

Long term problem for mankind is warming of the climate and exhaustion of oil resources. One answer (of course not the only one) is the production and application of materials from renewable resources. In the field of polycondensates only few difunctional monomers are available which can be produced at sufficiently low costs. One of these monomers is isosorbide (anhydrosorbitol) which is technically produced in large quantities from glucose. Hence it is the only relatively inexpensive diol which is based on renewable resources and is not based on oil or coal chemistry.

Furthermore, the isosorbide possesses an interesting combination of useful properties. First, incorporation of isosorbide into polymers containing alkane or aliphatic ether building blocks will raise the glass transition temperature (Tg). Second, isosorbide is a rather thermostable monomer and its polymers may be heated for a short time to 300^{o}C without decomposition and even without significant racemization (or epimerization). Third, isosorbide is a chiral building block which is insensitive to racemization under acidic or basic conditions. This situation has prompted numerous research groups to study syntheses and properties of various types of homopolymers and copolymers based on isosorbide.

Copolyesters including aliphatic diols such as isosorbide are of great interest to the chemical industry because such aliphatic diols can be produced from renewable resources, namely sugars, rather than from petroleum feed stocks as for most presently used diol monomers. Therefore, it would be desirable to have an efficient method to produce high quality, random polyesters or copolyesters from isosorbide.

In the present work, we have prepared a series of new melt processable copolyesters derived from a renewable resource material i.e. isosorbide by melt polymerization of isosorbide, eugenol end capped siloxane and diphenyl terephthalate in the presence of a catalyst. The effect of eugenol end capped siloxane was studied on the properties of copolyesters derived from isosorbide and diphenyl terephthalate. The isosorbide copolyesters were characterized by FTIR and ^{1}H NMR spectroscopy, solution viscosity, differential scanning calorimetry, thermogravimetric analysis and X-ray diffraction.

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Phthalonitrile Terminated Oligoimides for High Temperature Applications: Synthesis and Characterization

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Abstract

Prepared from the reaction between aromatic dianhydride diamines and 4-(aminophenoxy) phthalonitrile. The reaction of 3,3' 4,4'- benzophenonetetracarboxylic dianhydride and a diamine, bis-[4-(4'- aminophenoxy)phenyl]sulfone/ 1,5-bis-(4-aminophenoxy) naphthalene followed by reaction with 4-(aminophenoxy)phthalonitrile yields the corresponding oligoimides. The reaction was carried out through the one-pot, two step imidization method. The average molecular weight of the oligoimides can be controlled by varying the mole ratio of dianhydrides and diamine added. The prepared compounds were characterized by FT-IR and NMR spectral techniques and Gel permeation chromatographic (GPC) analysis. The average molecular weights and polydispersity (PDI) index values of the oligoimides are in the range of 3193- 6787 and 1.025- 1.298, respectively. Cure behavior of the oligoimides was studied by DSC analysis with 5 wt% of aromatic diamine, 4,4'-diaminodiphenyl sulfone (DDS) curing agent. The oligomeric phthalonitrile monomers were converted into cross-linked network structure by three step thermal curing process at elevated temperatures. Thermo gravimetric analysis shows that the fully cured polymers exhibit superior thermal, thermo-oxidative stabilities. The percentages of residual weight retention at 800°C are in the range of 49.83-52.56%. Overall, such materials could be extremely useful for high temperature applications.

Keywords: phthalonitrile, oligoimides, GPC analysis, cure studies, thermal properties

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Thermal and morphological properties of siloxane modified tetra glycidyl epoxy – clay nanocomposites

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Abstract

The organic-inorganic hybrid involving hydroxyl terminated polydimethylsiloxane modified epoxy, filled with organo-modified flurohectorite clay of various percentages (1 to 5 wt %) were prepared via insitu polymerization using γ-amino propyltriethoxysilane as coupling agent in the presence of dibutyltindilaurate catalyst. The reactions involved during the curing process between epoxy and siloxane were confirmed by FTIR. The results of differential scanning calorimetry and dynamic mechanical analysis show that the glass transition temperatures of the clay filled hybrid epoxy systems are lower than that of neat epoxy. The data obtained from the thermal studies indicated that improved thermal stability was due to the incorporation of nano clay into siloxane modified epoxy hybrid systems. The morphologies of the siloxane containing epoxy-clay hybrid systems show heterogeneous character, due to the partial incompatibility of hydroxyl terminated polydimethylsiloxane. Scanning electron microscopy indicates the phase separation, induced by the polymerization, occurs in the hydroxyl terminated polydimethylsiloxane modified epoxy hybrids to yield spherical particles of siloxane-rich phase, which are uniformly dispersed in the continuous epoxy matrix. Microstructures of nanocomposites were ascertained from X-ray diffraction and transmission electron microscopy. The formation of exfoliated structure of organoclay was confirmed from the X-ray diffraction pattern and shows interlayer spacing between 3.42 Å and 8.50 Å. Hybrid epoxy nanocomposites containing higher percentage composition of organo modified flurohectorite clay contents (up to 5 wt %) display more pronounced improvements in thermal properties and moisture resistance than corresponding unmodified epoxy matrices.

Keywords: Flurohectorite clay, thermal stability, morphology properties.

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DEVELOPMENT OF NON-HALOGENATED FLAME RETARDANT FOR ELECTRICAL APPLICATIONS

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Reactive type of flame retardants are inserted into the chemical structure and the chemical bond enhances the flame retardant molecule in the resin matrix rendering it more difficult to migrate from products in the environment. Phosphorus based flame retardants are nonhalogenated, eco friendly and have better properties. The use of nylon for electrical applications is restricted mainly because of its inadequate flame retardant behaviour. Thus nylon is modified with phosphorus moiety by reacting phosphorus diamine with Adipic acid to get phosphorus-modified nylon. Thermal stability and flame retardancy of unmodified nylon and phosphorus modified nylon were evaluated by means Thermo gravimetric analysis (TGA), Differential Scanning Calorimetry (DSC) and UL94 vertical burning tests and char residue tests. From the results, incorporation of phosphorus into the nylon enhances the thermal stability and flame retardancy.

POLYANILINE BASED SENSOR FOR DETECTION OF LINDANE

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Conducting polymers are versatile material for development of biosensors. Polyaniline, in particular, is widely used for biosensing due to its ease of synthesis and stability. In this paper we report a polyaniline based sensor for detection of Lindane. Lindane is a popular agricultural insecticide. But it is found to be neurotoxin and also a carcinogen, hence banned in several countries. Due to the low water solubility of Lindane, it is a persistent pollutant and remains dispersed in soil for several years. Hence detection of Lindane in ground water, beverages and milk is important.

We have developed a polyaniline based electrochemical sensor for detection of Lindane. Polyaniline was deposited on gold interdigitated electrodes by electropolymerisation. Genetically engineered *E. coli* cells which can degrade Lindane were used as the bio- recognition element. These *E. coli* cells were entrapped in the polyaniline matrix and lindane was sensed at the modified electrode using pulsed amperometry. The amperometric current was found to increase with increasing Lindane concentration. The modified polyaniline electrode was able to detect Lindane even at very low concentrations (5-500 ppt).

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POLYDIACETYLENE THIN FILM BASED OPTICAL SENSOR FOR DETECTION OF GLUCOSE

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Polydiacetylenes (PDA) and its derivatives are known to exhibit biochromatic properties and hence are used for development of optical biosensors [1, 2]. PDA can form self assembled films which exhibit color changes from blue to red upon external stimuli like pH, mechanical stress etc.

In this paper, we report a polydiacetylene based optical sensor for detection of glucose. Thin films of long chain diacetylene were deposited by Langmuir-Blodgett technique. The enzyme glucose oxidase was covalently immobilised on the diacetylene films. The monomer film was then polymerised using UV radiation. This resulted in a blue coloured sensor film. The polymer film was dipped in glucose solution of varying concentration (0.1-5 mM) and the optical absorbance of the film was recorded. On binding of glucose to the glucose oxidase enzyme, the conformation of the enzyme changes which leads to stress in the polymer structure, resulting in a colour change of the film to red. The polymer film gave a good colorimetric response to glucose in this concentration range.

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SYNTHESIS AND CHARACTERISATION OF TETRA GLYCIDYL FLAME RETARDANT EPOXY RESINS

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Abstract:

Two new types of tetraglycidyl epoxy resins containing phosphorus oxide and nitrogen groups in the main chain were synthesized. The structures of the new type of epoxy resins were confirmed by infrared (IR) spectroscopy, ^{1}H nuclear magnetic resonance (^{1}H-NMR) spectroscopic techniques. Curing of the newly synthesized phosphorus tetraglycidyl epoxy resins along with conventional tetraglycidyl-4, 4'-diaminodiphenylmethane (TGDDM) were done with 4,4'-diaminodiphenylmethane (DDM). The thermal stability and flame retardant properties of the newly synthesized phosphorus resins were compared with conventional tetraglycidyl-4,4'-diaminodiphenylmethane (TGDDM) epoxy resin. Their reactivities were measured by differential scanning calorimetry (DSC). The thermal stability and weight loss behaviour of the cured polymers were studied by means of thermal gravimetric analysis (TGA). Data resulted from this study indicate that new types of tetraglycidyl epoxy resins exhibit superior thermal stability and flame retardancy and the results are discussed.

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Sulfonated polyurethanes as corrosion inhibitor for mild steel in acidic medium

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Polyurethanes has been tested as corrosion inhibitor for mild steel in acidic medium after sulfonating it with 1,3 propane sultone. The presence of sulfonate group was confirmed by ^{1}H NMR and FTIR. The inhibiting action of the polymer on the corrosion of mild steel has been investigated by various corrosion monitoring techniques, such as weight loss, polarization resistance, potentiodynamic polarization and electrochemical impedance spectroscopy (EIS). The results of the investigation show that polyurethane is an excellent inhibitor and attains a maximum value of 94 % at 100 ppm at 25˚C. The inhibition efficiency was determined at different concentrations of inhibitor, solution temperature, immersion time and pH of the solution. It has been found that inhibition efficiency increases with increasing inhibitor concentration, solution temperature, immersion time and with decreasing pH of the solution. The adsorption behaviour of the polymer follows Langmuir isotherm. Scanning electron microscopy (SEM) has been applied to identify the surface morphology of the mild steel both in the presence and absence of the inhibitor molecules. The SEM micrograph reveals that the surface was strongly damaged in the absence of inhibitor and a good protective film was formed on the mild steel surface in the presence of the inhibitor.

Modeling of drug release from various collagen scaffolds for treatment of infected dermal wound

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Natural polymers such as collagen, Gelatin and elastin have been used as one of the materials in the scaffolds for wound healing. This biomaterial have the capacity to regenerate tissue effectively and mimics the extra cellular matrix at the site of injury, and degraded by enzymes such as collagenase in the damaged site .The antimicrobial agents incorporated in collagen biomaterials help to stabilize the collagen biomaterial and also to decrease the infection in wound. The sustained release of antimicrobial agents at the wound surface provides a prolonged antimicrobial activity to eradicate pathogens rapidly. In design of wound dressings, burst release is prepared and followed by controlled release of drug to eradicate wound pathogens and support for tissue regeneration. The significance of burst release has been ignored in the design of controlled drug delivery systems for infected dermal wounds. Burst release of drugs occurs in a very short time compared to the entire release process, it has not been specifically investigated in most work and we have given burst release for various collagen scaffold .The purpose of the present study was to develop and characterize the various collagen scaffolds loading with ciprofloxacin and its release profiles. According to the following equation,

$$\frac{M_t}{M_\infty} = Kt^n + \alpha$$

We predicted and developed zero orders and first orders release collagen dressings for infected dermal wound.Invitro antibacterial studies of these collagen dressings shows effective antimicrobial activity against wound pathogens. The result concludes collagen dressings with burst release followed controlled release may effectively regenerate highly infected soft tissue.

Silicone Impregnated Ceramic Foams: Microstructure, Mechanical properties and arc jet evaluation

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Abstract

Silicone impregnated ceramic foam composites (SICOMP) for possible application in the thermal protection of reentry vehicles were developed by using ceramic substrates (90% porous amorphous silica) impregnated with silicone and modified silicone resins. Density of SICOMP samples varied from 0.45 to 0.55g/cc. The thermal performance and ablation characteristics of SICOMP were investigated in terms of the back wall temperature in a simulated re-entry environment using arc jet analysis. The tiles were subjected to a heat flux of 20-30W/cm^2 under a simulated shear load of 100Pa. The effect of resin impregnation as a means of strengthening the silica tiles and improving their performance as thermal protection system (TPS) was studied by evaluating the mechanical, thermal and thermo-physical properties of the composites. Microstructural analysis was carried out to investigate the distribution of polymeric matrices in the foam composite both before and after heat load application. Arc jet studies proved that these novel systems were potential candidates for re-entry thermal protection systems.

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Synthesis and thermotropic liquid crystalline behavior of cholesterol linked gum acacia

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Abstract

Monocholesteryl monosuccinate derivatives of gum acacia (GA-ChMS – 1 and GA – ChMS – 2) were prepared by reacting gum acacia with cholesteryl monosuccinate in the ratio of 1:2 and 1:0.67 mole, repectively. They were characterized by infrared spectroscopy, polarizing optical microscope coupled with microheating stage and differential scanning calorimetry. Both the polymers displayed thermotropic liquid crystalline behavior on heating as well as cooling, GA – ChMS – 1, when observed under crossed polars using polarizing optical microscope, show birefringence just prior to melting. On cooling the melt, a cholesteric phase was observed at about 87^{o}C, which changed to smectic phase at about 60^{o}C. The thermotropic behavior of GA-ChMS – 1 observed under optical microscope was further substantiated from differential scanning calorimetry. The DSC scan of heating run revealed two endotherms, one at 90.8^{o}C attributed to crystal – liquid transition and another at 94^{o}C attributed LC – isotropic liquid transition. The cooling run showed two exotherms at 91.4^{o}C and at 53.5^{o}C, which were ascribed to isotropic – cholesteric and cholesteric – smectic transitions, respectively. GA-ChMS – 2 showed the similar behavior.

Ecofriendly Polyurethane Nanocomposites for Prosthetic Applications

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Abstract

The growing problem related to finding available landfill areas for the final disposal of non-degradable polymers gives rise to the development of biodegradable polymers and blends, able to fulfill the new environmental requirements regarding the effective management of post-consumer waste.

Polyurethanes (PU) derived from polyols like propane-diol, butane-1, 4-diol and polyethylene glycol, etc. have been used for prosthetic application, but these materials are not degradable and cause environmental pollution upon disposal after their intended use. Degradable polymers like PCL, PLA, and poly vinyl alcohol have been extensively used, but these materials are costly and not easily commercially available. Hence, there is a need to develop eco-friendly plant-based degradable polymers from agricultural feedstock to meet the requirements. is an economic & environmental necessity rather than academic curiosity.

Therefore, in the present research programme, a degradable PU derived from castor oil is used as the base material for manufacture of prostheses. The polyurethanes have been prepared by condensing castor oil with different isocyanates like toluene diisocyanate, diphenylmethane diisocyanate, hexamethylene diisocyanate and isophorone diisocyanate changing the NCO/OH ratio. To enhance the tensile and other dynamic and mechanical properties along with processibility, PU-nanocomposites are prepared using organoclay. This represent the preferred way to produce a substantial improvement in the mechanical properties of a polymer matrix as compared to conventional composites because of the use of very low filler contents with great impact on properties for better prosthetic application. Characterization is done by FTIR, TGA, XRD, SEM, testing for tensile properties, Impact, Storage Modulus and biodegradation and the results are encouraging. Molded products, with excellent required properties, are to be tested with 500 patients. Their biomedical applications are under investigation.

Thermal and Spectral Characterization of a novel copolymer Melamine-Silicic Acid-Thiourea.

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The novel condensed copolymer MSTU (Melamine-Silicic Acid- Thiourea) is prepared in stochiometeric ratio 3:3:1 w/w in ethanol medium. It has been characterized with elemental, spectral (IR, UV and ^{1}H NMR) and thermal analysis. These analysis indicates the replacement of hydroxyl groups of silicic acid and formation of a copolymer. No band in a region from 3448 cm-1 infers replacement of –OH groups of silicic acid.

The thermal characterization (TGA, DTA and DSC) confers the linkage of silicic acid and the formation of MSTU copolymer.

The elemental, spectral and thermal data of the copolymer MSTU are correlated with their structural evidences and compatibility. Such materials may open a futuristic door for conducting and metal scavenging polymers.

Development of Poly(acrylamide)/Poly(ethyleneglycol) semi-IPN hydrogel silver nanocomposites for antibacterial applications

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Abstract:

In the present investigation, we have developed smaller size and finer distribution of semi-IPN silver nanoparticle hydrogels based on Poly (acrylamide) -Poly (ethylene glycol) by insitu reduction of Ag^+ ions in the presence of $NaBH_4$ as a reducing agent for the purpose of biomedical applications. The formation of silver nanoparticles have been confirmed by using with ultraviolet visible (UV-Vis) spectroscopy,X-ray diffraction (XRD). The morphology of nanoparticles was characterized by scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The antibacterial effect of silver nanoparticles was investigated against gram positive and gram negative bacteria.

Keywords: Silvernanoparticles, Poly (ethyleneglycol), biomedical applications,
Antibacterial activity, Gram positive and Gram negative.

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Phase Transfer Catalysis: Kinetics of polymerization of ethyl methacrylate using water soluble potassium peroxy disulfate in the presence of monosited phase transfer catalyst

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Phase transfer catalysis is an efficient and powerful tool in many areas of chemistry. Phase transfer systems characterized by the presence of at least two phases and at least one interfacial region separating the phases. Reactions taking place in such systems usually involve transfer of an anionic reactant from its normal phase to reaction phase. The present work dealt with free radical polymerization of ethyl methacrylate using water soluble potassium peroxydisulphate as an initiator and propiophenoneheptyldimethylammonium bromide used as phase transfer catalyst. The polymerization reactions were carried out in air free atmosphere and unstirred conditions at constant temperature of 60±1ºC in ethyl acetate/ water biphase media. The role of concentration monomer, initiator, phase transfer catalyst and variation in temperature and aqueous phase on R_p were discussed. Based upon the results obtained a suitable mechanism has been proposed for the polymerization reaction. The prepared polymer characterized by spectral studies.

Key words: Phase transfer catalyst, Free radical polymerization, Kinetics, Mechanism

Synthesis and Characterization of Soluble and Low Dielectric Constant Silsesquioxane Polyimides

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Abstract

Silsesquioxanes are inorganic-organic hybrid consist of rigid, crystalline silica-like core that is perfectly defined spatially (0.5-0.7 nm). These are compounds with general formula $(RSiO_{1.5})_a(H_2O)_{0.5b}$, where R is a hydrogen atom or organic group and a and b are integer numbers (a = 1,2,3,…; b = 0,1,2,3, …), with $a + b = 2n$, where n is an integer (n = 1,2,3, ..) and $b \le a + 2$. Novelty in the present work is to synthesise and characterize highly soluble linear aromatic and aliphatic polyimides with silsesquioxane core as a pendant group using ring opening metathesis polymerization for low dielectric properties with a view to make polymeric membranes for gas separation.

Key words: Polyimide, soluble, low dielectric constant, and nanocomposites.

Synthesis and characterization of poly 4-Benzyloxyphenylmethacrylate) and its copolymers

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Abstract

The monomer 4-benzyloxyphenylmethacrylate (4-BOPMA) was synthesized by reacting 4-bewnzyloxy phenol dissolve in methylethylketone (MEK) with methacryloyl chloride in the presence of triethylamine. The homopolymer and various copolymers of 4-BOPMA with butylmethacrylate (BMA) were synthesized by the free radical polymerization in MEK at 70 ±1˚C in nitrogen atmosphere using benzoylperoxide as initiator. The homo and copolymer were synthesized by various spectral techniques like IR, 1H-NMR, 13C-NMR spectroscopic techniques. The molecular weights of the polymers were determined by Gel permeation chromatography. The glass transition temperature of polymers was determined by differential scanning colorimeter. The thermal stability of the polymers were performed by thermo gravimetric analysis in inert atmosphere. The monomer reactivity ratios were determined using conventional linearization methods such as Fineman-Ross, Kelen Tudos and extended kelen Tudos methods.

Key words: 4-benzyoxyphenylmethacrylate; butylmethacrylate; reactivity ratios;1H-NMR; 13C-NMR;

Electronic Properties of Conducting Polymer- Ag Nanocomposite Thin Films: Influence of Nanoparticle Size and Density

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Abstract:

A tailor made synthesis of mono-dispersed, size controlled, highly populated and highly stable Ag nanoparticles in organic medium containing poly (o-methoxy aniline)(POMA) has been done through an interfacial redox process with an aqueous $AgNO_3$ solution. The nanoparticles are free from excess oxidant and external stabilizer particles. The POMA (EB) concentration tailors the size of nanoparticles. Particles of three different sizes and different densities are prepared. Different current-voltage (I-V) behavior depending on the size and density of nanoparticles is observed in the thin films of POMA-Ag nanocomposites. If the nanoparticle size is large (diameter = 21.9 ± 1.7 nm), and the density is low (density $=2.6 \times 10^{14}$/ sq.m.), they exhibit switching behavior. And if size is lower (8.9 ± 0.8 nm) and density is very high (60×10^{14} /sq.m.), they exhibit rectification property. Possible reason of rectification and switching characteristics is discussed from the retention of charges in larger size Ag nanoparticles when transferred from POMA chains under the application of electrical bias.

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POSS reinforced cyanate ester - epoxy nanocomposites: Characterization of Thermal, Dielectric and Morphological properties

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Abstract:

A nanoporous octa-functionalized polyhedral oligomeric silsesquioxane (POSS) reinforced cyanate ester-epoxy nanocomposites were prepared *via in situ* co-polymerization of cyanate ester (CE) with epoxy resin in the presence of octaaminophenyl silsesquioxane (OAPS). Two types of cyanate esters, bis(4-cyanophenyl)propane (CE-1) and bis(4-cyanophenyl)sulfone (CE-2) were used. The organic-inorganic hybrid nanocomposites containing up to 20 wt% of OAPS were obtained. The reactions involved between epoxy, cyanate ester and OAPS were investigated by FTIR studies. Differential scanning calorimetry (DSC) and dynamic mechanical analysis (DMA) showed that the glass transition temperature (T_g) of the nanocomposites were higher at the lower POSS concentration (≤ 3 wt%) level than the neat CE-epoxy systems. When compared with the neat CE-epoxy systems, the increased rubbery plateau modulus with increasing concentration of POSS (upto 20 wt %) ascertains the nanoreinforcement effect of OAPS with CE-epoxy resins. Data resulted from thermogravimetric analysis, indicates that the POSS containing CE-epoxy nanocomposites displayed the high ceramic yields, suggesting the flame retardant behaviour of the materials was improved. The increasing concentration of OAPS into CE-epoxy networks exhibited the decreasing trend in the values of dielectric constant than those of neat CE-epoxy systems. Due to the presence of polar sulfonyl group in the CE-2, the CE-2/epoxy/OAPS nanocomposites possess higher T_g, char yield and dielectric constant than those of the CE-1/epoxy/OAPS nanocomposites. The X-ray diffraction (XRD) analysis indicated that the molecular level reinforcement of OAPS cages occurred in CE-epoxy nanocomposites. The homogeneous dispersion of POSS cages in the CE-epoxy matrices was evidenced by scanning electron microscopy (SEM) which further confirmed that the POSS molecule has become an integral part of the organic-inorganic inter crosslinked network systems.

Synthesis and Characterization of Resorcinol based cyanate ester- Epoxy – Organomodified Montmorillonite clay hybrid nanocomposites.

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Abstract

The interpenetrating network matrices of epoxy and resorcinol based (1,3-dicyanto benzene) cyanate ester and cured by diaminodiphenyl methane (DDM). The epoxy modified with5,10 and 15wt%(by weight) of cyanate ester and cyanate ester-organomodified clay hybrid nanocomposites were characterized using differential Scanning Calorimeter (DSC) ,Thermogravimetric analysis (TGA) ,and mechanical properties such as, tensile strength, flexural strength and unnoteched izod impact test were studied. The cyanate ester-epoxy-organomodified clay was incorporating (1-5wt %) into organic matrix, the dispersion throught the cyanate ester of a montmorillonite with octadecylamine (ODA) results in the formation of hybrid materials. The organic based inorganic oxides significant improvement in orgnomodified clay hybrid nanocomposites system. The morphology of the epoxy and cyanate ester systems were also studied by scanning electron microscopy(SEM) and transition electron microscopy (TEM) for cyanate ester-organomodified clay nanocomposites.

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Nano-silver based durable antibacterial finish for textile

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Abstract

Now-a-days, there is a good deal of demand for the fabrics having functional/speciality finishes in general but antimicrobial finishes in particular to protect human being against microbes. The application of antimicrobial textile finishes include a wide range of textile products for medical, technical, industrial, home furnishing and apparel sectors. For thousands of years silver has been used as a healing and anti-bacterial agent by civilizations throughout the world. Silver nanoparticles, a noble metallic nanomaterial, can be used as antibacterial materials, antistatic, biosensor materials, etc. Many commercial grade antimicrobial products are available today, often do not lead to durable antimicrobial finishes and lose their functions after laundering or wearing. Also many of these products are not ecofriendly and are being phased out. Nano silver being non-poisonous, non-allergic to human skin, can give durable antibacterial finish to the fabrics. A novel nano-silver based antibacterial finish has been developed and its activity and durability were evaluated in comparison to popular commercial antimicrobial non-silver based finish like Resil's Ultrafresh NM-V2, & silver-based finish Ultrafresh Silpure. Our finish showed 99.9% activity for cotton and 99% activity for silk even after 30 laundry washes which were significantly higher than existing commercial finishes. The samples were analysed for their appearance also.

Acknowledgement: The authors acknowledge partial financial support from the Department of Science and Technology , Govt. of India and Resil Chemicals P Ltd., Bangalore

Anionic Polymeric Membrane as an Effective tool for alkaline fuel cell applications

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Abstract

Now-a-days anion exchange membranes (AEMs) are considered with more attention due to their versatile application in fuel cells and other emerging fields. AEMs from poly (styrene ethylene butylene poly styrene) (PSEBS) were prepared via. Chloromethylation and subsequent amination followed by ion exchange with aqueous hydroxide solution. These AEMs showed high hydroxyl conductivities and rather low methanol permeability. The reaction products were characterized by FT-IR and thermal analysis. The hydroxyl conductivity of the membrane was measured by Impedance spectroscopy. The ion exchange capacity (IC), water uptake and swelling behavior were also analyzed.

Key words: Anion exchange membrane; fuel cells; hydroxyl conductivity

Mechanical properties and Transport Behaviour of Chitin Whiskers (CW) Reinforced Carboxylated Styrene Butadiene Rubber Latex (XSBR) Nanocomposites

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Abstract

Nanocomposites were successfully prepared using a colloidal suspension of chitin whiskers (CW) as reinforcement in carboxylated styrene butadiene rubber latex (XSBR) by water evaporation method. The chitin whiskers were prepared from commercial crab shell chitin powder by acid hydrolysis. Atomic force microscopy (AFM) was carried out to see the size and structure of chitin nanowhiskers and scanning electron microscopy (SEM) and atomic force microscopy (AFM) were used to study the nanocomposite morphology. The mechanical properties of nanocomposites like tensile strength, tear strength, tensile modulus and elongation at break were measured. Transport parameters such as diffusion coefficient, sorption coefficient and permeation coefficient were also calculated from water diffusion studies and all of them showed a decrease with filler loading. The result indicates that there exist a strong interaction between chitin whiskers and XSBR latex by the hydrogen bonding. The properties of the nanocomposites were strongly affected by the concentration of chitin whiskers in the rubber matrix. This has been explained on basis of the network formation of chitin whisker in XSBR latex.

Keywords

Nanochitin whisker, nanocomposites, tensile properties, diffusion, morphology.

Studies on the size distribution of particles in the combustion plume of MIP de orbit motor propellant.

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Abstract

The moon impact probe (MIP) de orbit motor of Chandrayan I mission is fired to propel the MIP on to the moon surface. Since the main orbit faces the nozzle exit of the de orbit motor during the de orbit phase, there is a possibility of exhaust plume impinging on the main orbiter resulting in contamination of the main orbiter elements. Hence the size and size distribution of particles in the exhaust plume of the de orbit motor is of great concern. In this contest, the particle size distribution of the combustion products of AP/HTPB propellant composition containing 2% Aluminium is studied in detail. The preparation of the combustion products is achieved using the modified quench bomb collector. The particle size distribution of the combustion residue was measured using Malvern laser scattering particle size analyzer -Master Sizer 2000. The size distribution of combustion residue of this propellant indicated the presence of particles in the size range of 0.1 micron to 100 microns. The different size distributions –length, volume and sieve size distributions - and cumulative and differential size distribution curves of the combustion residue are presented.

***HTCR, VSSC**

Morphology and Thermal Characterization of Poly (L-lactic acid) nanocomposite blown film

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Abstract

Poly (L-Lactic Acid)/nanoclay (Cloisite 30B) composites blown film developed by melt blending were investigated. Three types of PLA nanocomposites contaning 1wt%, 3wt% and 5wt% of nanoclay were compounded in a co-rotating twin screw extruder, to study the effect of the concentration on nanostructure and physical properties of blown films. During compounding and film blowing processing condition like temperature, rpm, feed rate, air pressure and nip roll speed were optimized. Crystallite growth behavior of pure PLA and nanocomposite samples were investigated by Polar optical light micrograph (POLM). The spherulite growth rates were increased relative to the bulk in nanocomposite and also with annealing time. Wide angle X-ray diffraction (WAXD) and Transmission electron microscopy (TEM) were used to determine the degree of intercalation, or exfoliation and nanostructure level of nanocomposites. XRD data showed complete exfoliation at lower nanoclay content. On increasing the nanoclay % the exfoliated and partially intercalated structure were obtained. Differential scanning calorimetry (DSC) has determined that the cold crystallization and melting point temperatures were influenced by the presence of nanoclay. The thermogravimetric analysis (TGA) showed increase in the decomposition temperature for all of the nanocomposites. Mechanical properties of the nanocomposites showed that the % elongation is increasing up to 3 wt% of clay whereas in case of tensile strength and modulus both, the properties are increasing only up to 1 wt% of the nanoclay compare to the neat samples.

Processing and Nanoscale Dispersion: An Approach for Structural Characterization of Polymer–Clay Nanocomposites

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Abstract

Particle spatial dispersion is a crucial characteristic of polymer composite materials and this property is recognized as especially important in nanocomposite materials due to the general tendency of nanoparticles to aggregate under processing conditions. This study focuses on the degree of dispersion and structural development of organomodified MMT clay (OMMT) during processing of polypropylene clay nanocomposites. For this, PP (2, 11 & 35 MFI), PP-g-MA and Cloisite 15A were melt blended in a DSM microcompounder at a specific speed and temperature. The compositions were optimized by using design of experiment (DOE) software. The clay was modified with Methylene Blue (MB) and the adsorbed dye content in the clay gallery was estimated by using uv-spectrophotometric method. FTIR and XRD also supported the modification of clay. The average particle size of the organoclay and dyed clay was determined by using Particle Size Analyzer. The effect of residence time and molecular weight of the PP matrix on the clay dispersion were studied. Dispersion and exfoliation of the clay in polymer matrix was investigated from the area under the torque versus time plot. It was also supported by XRD, SEM, TEM and DSC analysis. Offline dielectric and fluorescence spectrophotometric study also yielded quantitative information about the extent of clay dispersion, intercalation and exfoliation in the polymer matrix. Change in dielectric constant and dielectric loss with both frequency and temperature yielded quantitative information about the extent of clay exfoliation and intercalation in the polymer matrix. The fluorescence data of MB-PP-clay nanocomposites further corroborate this phenomenon.

The influence of filler type and concentration on the properties of solid rocket motor case insulation

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Abstract

The solid rocket motor (SRM) case is protected from the enormous heat developed during the propellant firing by means of flexible rubber insulation with specific characteristics such as strength, flexibility, thermal erosion resistance and moisture resistance. The performance of the insulation system demands modification for using with different types of propellants. For example, ISRO uses a copolymer of acrylonitrile and butadiene as the SRM case insulation where the propellant consists of hydroxyl terminated polybutadiene (HTPB) and toluene diisocyante (TDI). The properties required for an insulation system can be obtained by manipulating the composite variables. The present study highlights the different types of fillers and filler concentrations on the performance and properties of SRM case insulation. Two types of silica fillers, conventional silica and treated fumed silica, are tried at different concentration levels. These systems have been evaluated for their thermal, mechanical and moisture absorption characteristics. The filler type and concentration are found to have considerable influence on the performance of the material. It is expected that the composition in which the change in filler type from conventional silica filler to treated fumed silica may give improved moisture resistance, which is a critical parameter for the performance of the insulation system.

Polymer-Grafted Multiwalled Carbon Nanotubes through Dehydropolycondensation

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Abstract

In recent years, extensive research is focused on surface modification of carbon nanotubes mainly to enhance their chemical compatibility and dissolution properties. Polymer grafting of multiwalled carbon nanotubes (MWCNTs) and the biocompatible polymers (L-lactic acid based homo and copolymers) are of special interest due to their potential for biomedical application and also due to the environmental concern. In the present study, multiwalled carbon nanotubes were functionalized chemically to attach carboxylic functional groups on the surface. L-lactic acid and L-lactic acid based copolymer were anchored to the surface of MWCNTs by ester linkage using dehydropolycondensation reaction. The grafted polymeric materials were characterized by using FT-IR, TGA, ^{13}C CP/MAS NMR, SEM, TEM and AFM techniques. The electronic transport and thermal properties have also been investigated. The DSC study of the grafted PLA homopolymers and copolymers highlights that the presence of MWCNTs in the grafted polymer have the effect of inducing crystallization and plasticizing the polymer matrix. The observed activation energy of PLA-g-MWCNTS was higher than that of PLA/ MWCNTS, which focuses that grafted polymers was more stable than the composite.

Mechanical preparation of cellulose microfibrils and its Characterization

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Abstract

The cellulose microfibril from short staple cotton is an interesting new material that constitute strong reinforcement in polymer composites due to their network formation characteristics. Cellulose microfibrils can be prepared by mechanical disintegration of cotton fibers. The lateral dimension of the fibrillated cellulose is in the order of 10-100 nm and the length can be in the micrometer scale. The present work involves kier boiling & bleaching of the raw cotton fibers for removal of dirt and waxy materials and then passing through refiner for fibrillation. The cotton fibers with 0.3%, 0.5% and 1% consistency was passed through lab disc refiner (Universal Refiners Ltd. India) up to 30 passes. The increasing number of passes increased the percentage of fibrillation. Quinine sulfate labelled microfibrils revealed the uniform web like structure under fluorescence microscope. The average diameter of the microfibrils is found to be 100 nm as analyzed by Scanning electron microscopy. Further characterization of fibrils by XRD, FTIR and TEM is in progress.

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Renewable Resource Approach for Conducting Polymer Nanomaterials

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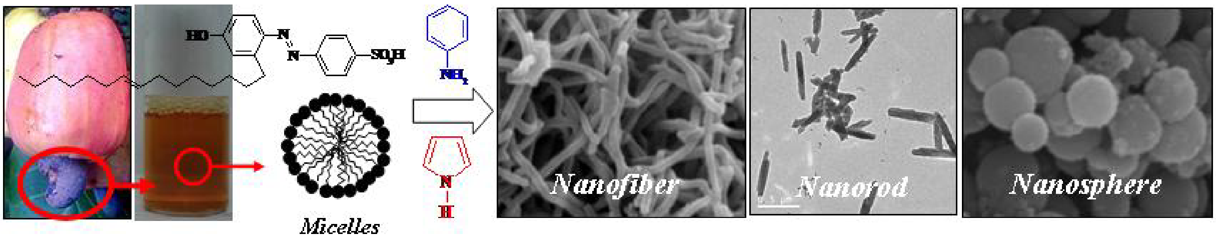
Morphology control of conducting nano-materials with specified dimensionality has been realized as important task for good performance of their chemical, electrochemical and optoelectronic devices. Since the fast depletion of fossil resources in earth is becoming a major concern, the research activities interconnecting both renewable resources and advanced conducting nano-materials have tremendous opportunities for fundamental and applied research. We have developed a renewable resource amphiphilic surfactant molecule to fine tune size, shape, and properties of polyaniline, polypyrrole and polypyrrole-co-polyaniline nano-materials. The sulfonic acid surfactant developed is existed as spherical micelles in water and upon adding aniline (or pyrrole), the micelles self-organized to form micrometer sized cylindrical or spherical assemblies. The oxidation of these soft templates filled with monomer in water produced nanofibers and nanospheres, respectively. Random co-polymerization of pyrrole and aniline with varying amount of either of the monomer resulted in morphology change from sphere to rod to fiber or vice versa. The mechanistic details of the nanomaterials formation was investigated by dynamic light scattering and electron microscopy to trace the factors which control the morphology of the resultant nanomaterials. The amphiphilic nature of the dopant solubilises the nanomaterials in water and polar organic solvents that enabled us to characterize the polymer nanostructures by NMR and FTIR studies. The UV-vis studies of nanomaterials in water showed the highly doped conducting nature of the nanomaterials. The wide angles X-ray diffraction studies confirmed the improved ordering in nanomaterials due to penetrating nature of amphiphilic dopant molecule. The optical and solid state properties of the nanomaterials were found highly dependent on the types of template and polymerization routes. We have proved that precise control of soft template is very much essential for conducting polymer nanomaterials synthesis and depending on how the reactants are self-organized and polymerized in water under normal conditions.



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Comparative study of thermo mechanical behaviour of SPEEK and SPEEK/PES blends for fuel cell membrane applications

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Abstract

Ionomers which are having potential applications as polymer electrolytic membrane (PEM) for fuel cell are required to sustain at extreme thermal and mechanical regimes. Membranes are prepared by blending sulfonated poly (etheretherktone) (SPEEK) and poly (ether sulfone) (PES) using N-methyl-2-pyrrolidone (NMP) solvent. SPEEK membranes of different degree of sulfonation (DS) were prepared. Blend membranes were prepared by using SPEEK of DS 71% with varying blend ratios of SPEEK and PES (50/50 to 100/0). Ion Exchange capacity (IEC), proton conductivity and thermo mechanical characterization were done for the blend membranes. A comparative study was carried out with SPEEK of different DS also.

Keywords: Sulfonated PEEK; PES; Ionomer blend; Proton conductivity; DMTA.

NANOSTRUCTURED ELECTRO-MAGNETIC FUNCTIONAL MATERIALS FROM INORGANIC ORGANIC HYBRID GUEST- HOST SYSTEM.

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ABSTRACT

Nanostructured electro-magnetic materials have attracted considerable attention for their potential applications in various fields such as electromagnetic interference (EMI) shielding, antistatic coatings, chemical sensors, transducers, rechargeable battery, and corrosion protection coatings.[1-5] Nanostructured electro-magnetic polyaniline- magnetite-clay composite (PCMC) having core-shell morphology was prepared by the oxidative radical emulsion polymerization of aniline in presence of Iron-polycation intercalated clays (PHIC) as magnetic precursors. Formation of self-assembled aggregates of nanostructured magnetite-polyaniline with core-shell morphology was manifested by the studies made by FT-IR, XRD, SEM and TEM. Electrical and magnetic properties of these materials were investigated at room temperature. Materials exhibited saturation magnetization of 47 memu/g , coercivity 13.9 Oe and retentivity of 2.6 memu Electrical conductivity measurement exhibited positive variation from 0.003 S/cm → 0.015 S/cm → 0.205 S/cm → 1.06 S/cm → 1.05 S/cm on increasing the amount of PHIC. The prospects for the direct application of this material is for the development of processable electromagnetic interference shielding materials having high mechanical strength and thermal stability with electro-magnetic properties for high tech applications from low cost materials.

Effect of compositional variations of propellant on the size distribution of particles in the combustion plume.

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Abstract

Aluminised solid propellants are extensively used in various stages of the polar and geosynchronous satellite launch vehicles. The exhaust plume of these propellants contains large amount of aluminium oxide droplets. The size and size distribution of these droplets can have large influence on the impulse efficiency, combustion stability and environmental effect. The quantity of slag accumulated during the solid motor firing has got direct correlation with the size and size distribution of particles in the exhaust plume. In the present study an attempt was made to study the effect of variation in propellant composition on the size distribution of particles in the exhaust plume. The combustion residue of two HTPB solid propellant compositions, with varying concentrations of aluminium, were prepared using modified Quench Bomb Collection Technique. The representative samples of the combustion residue were collected using a slurry sampler and analysed for particle size distribution using Malvern Laser Scattering Particle size Analyser. The particle size distribution as well as the size distribution pattern were found to vary with change in propellant composition. The composition with higher aluminium content was found to yield higher concentration of lower size particles in the exhaust plume.

Studies on formulations of Polymer Bonded High Energy Materials and their applications to Launch Vehicles

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Polymer Bonded Explosive (PBX) is a type of explosive composition which consists of high energy materials cast in polymeric / energetic binder systems. These binders are used to bind the energetic materials into the polymeric matrix which decompose endothermically under the influence of thermal stimuli. They are powerful like the currently available explosives and can withstand thermo mechanical abuse to some extend without decomposing rapidly, so that it could be cast into desired configurations. PBX, unlike the conventional melt cast high explosive, shows no shrinkage on curing and is rather insensitive to impact forces or accidental detonation, which makes them very attractive for aerospace applications. The cast PBX is suitable as an explosive element for cutting and severance of structures of launch vehicles.

Studies were carried out to look into various formulations of polymer bonded explosives with respect to their application to launch vehicles. Explosives such as RDX, PETN, HMX, HNS and binder systems like HTPB-TDI, NCO terminated polyol prepolymer-castor oil, Viton etc. were studied. The various compositions were characterised by its rheological, mechanical and thermal properties, process conditions and explosive properties such as velocity of detonation, sensitivity of friction etc.

Effect of variation in NCO/OH ratio, effect of addition of wetting agents and catalyst were also studied. Based on these studies, composition was finalised and the initiating boosters were processed. The reliable initiation studies were also carried out.

With these a suitable polymer bonded high energy materials can be chosen for specific requirements in future launch vehicles depending on the requirements like application temperature , sensitivity and moldability. The paper describes the various trials carried out to arrive the final formulation to cast the boosters and their functional performance.

Hydroxyl Functionalized Polyaniline Nanospheres for Sensing Bio-analytes

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Polymeric conducting nano-materials are a topic of current interest because of their potential application in biological and chemical sensors, electronic and optical devices etc. Among them polyaniline nano-materials have gained significant interest due to their easy synthesis; simple non-redox doping/dedoping chemistry based on acid/base reactions, and environmental stability. Here, we report a synthesis of novel polyaniline nano-spheres bearing mono and bis-hydroxyl functional groups to trace the molecular interactions at the nano-surfaces through Vitamin C sensing. Two new aniline monomers were synthesized via tailor-made approach and polymerized to produce soluble and uniform polyaniline nano-spheres. The structures of the monomers and polymers were characterized by NMR, FT-IR, Mass techniques and the morphology of the nano-materials was analyzed by SEM and TEM. The mechanistic aspects of the nano-materials formations were analyzed by FT-IR and dynamic light scattering techniques. Vitamin C was employed as an analyte to trace the molecular interaction at the nano-sphere surface and study the influence of nano-surface functionalization on the sensing ability of bio-molecules. The bis-hydroxyl functionalized polyaniline nano-spheres were found to show efficient molecular interactions towards vitamin C whereas nano-spheres with mono-hydroxyl group or un-substituted nano-fibers failed as sensing materials. In nut shell, in the present investigation, we have proved the importance of surface functionalization of polyaniline nano-materials, exclusively nano-spheres, using bis-hydroxyl groups for improved molecular interactions at the nano-surfaces with bio-molecules such as vitamin-C. These functionalized nano-materials are novel and find application in sensing other chemical and biological moieties.

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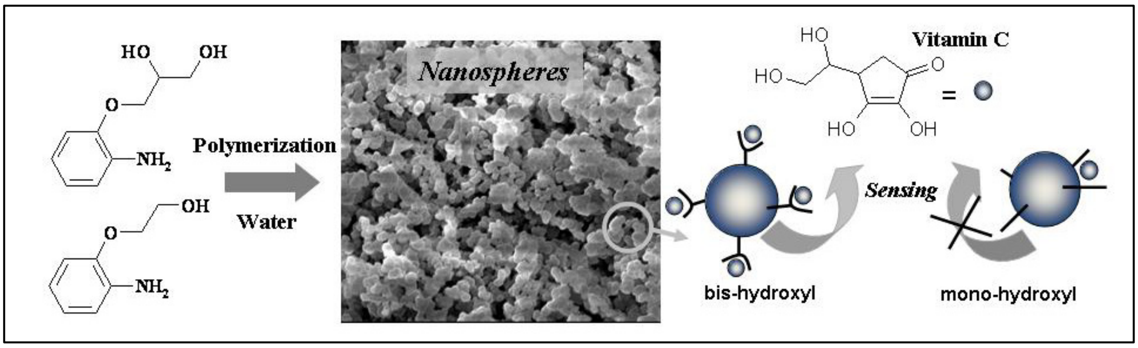

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Carbon Nanotube Embedded HTPB-Based Polyurethane Networks: Mechanical, Thermal and Microscopic Studies

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Abstract

Carbon nanotube are reported to give enhanced performance for hydroxyl terminated polybutadiene (HTBP)-based propellant formulation by way of improved combustion charcateriisrics, lower ignition delay and better mechanical properties. The present paper discusses the incorporation of Multiwalled Carbon nanotube (MWCNT) (unfunctionalized and –OH functionalized) in HTPB network. The formation of urethane linkage between the –OH functionalized CNT and tolylene diisocyanate (TDI)/isophorone diisocyanate (IPDI) were separately ascertained by FT-IR. CNT and HTPB –urethane composites were characterized by FT-IR and HRTEM. The CNT dispersed HTPB system was cured with two different diisocyanates viz,TDI and IPDI leading to a polyurethane network. The CNT content in the elastomer was varied from 0 to 0.3% by weight. Mechanical and thermal properties of the systems were evaluated. It is observed that there is nearly two fold increase in the tensile strength of the system with elongation properties remaining unaffected. Functionalisation with –OH group was conducive in better dispersion leading to superior mechanical properties for the urethane networks. Optimum mechanical properties were obtained for a CNT loading of 0.2% by weight. Thermal stability of the CNT-filled system also was superior. Incorporation of CNT also resulted in enhanced thermal conductivity as expected. The CNT containing urethane networks were characterized by HRTEM.

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A study on crystallization behavior of PP/LDH nanocomposites

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Abstract

The isothermal crystallization kinetics and melting behavior of polypropylene/layered double hydroxide (PP/LDH) nanocomposites prepared via melt intercalation method were investigated by using differential scanning calorimeter, polarizing optical microscope (POM) and X-ray diffraction (WAXD). The results show that the crystallization behavior of PP depended significantly on LDH content and crystallization temperature. The crystallinity of the nanocomposites decreased with the increase of the filler content, indicating that the LDH layers dispersed in the PP matrices confined the PP chains and hindered the crystallization of the PP chains. The Avrami equation successfully used to describe the isothermal crystallization kinetics of PP/LDH hybrids, indicates heterogeneous nucleation of PP. The POM photographs showed that the spherulites of the PP/LDH nanocomposites were greatly decreased in size as LDH was introduced. The WAXD results showed that the addition of LDH decreased the crystalline size D_{hkl} of the polymer. Subsequent melting endotherms exhibited increase in melting temperature of PP/LDH hybrids due decrease in crystallization time of the PP. On the other hand, the crystallization rate increased dramatically with the increasing of LDH content. Overall results signify that LDH at nano meter level acted as nucleating agent and accelerate the overall crystallization process.

Keywords: Polypropylene nanocomposites; layered double hydroxide; isothermal crystallization; melting behavior.

Preparation and structural Characterization of Nylon 4

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Nylon 4 of molecular weight around 25,000 was successfully synthesized by the ring opening polymerization of 2-pyrrolidone and it had been well characterized by NMR spectroscopy. Thermal behaviour of the synthesized sample was studied using differential scanning calorimetry and thermo gravimetric analysis. It was found that the melting of the nylon 4 is followed by degradation. The crystalline transition in nylon 4 was monitored by high temperature wide-angle X-ray scattering (HTWAXS). The X-ray diffraction pattern of nylon 4 sample precipitaed 1,4 butandiol during heating from room temperature to melting was shown in Fig.1.The room temperature diffraction pattern showed the strong two characterestic reflections at 2θ = 20.45° and 24.24° corresponding to *d*- spacings 0.43 nm and 0.37 nm respectively.While heating from room temperature, as shown in Fig. 2, these two reflections corresponding to the *α*- phase converged and but above 180°C the d-spacings did not show any appreciable change inicating that the structure transformed into a high temperature *α*- phase. The samples melted in the high temperature *α*- phase. Such a behaviour was exhibited by nylon 610 and nylon 612. Interestingly nylon 4 crystallized from trifluoroacetic acid (TFA) showed typical γ phase at room temperature.

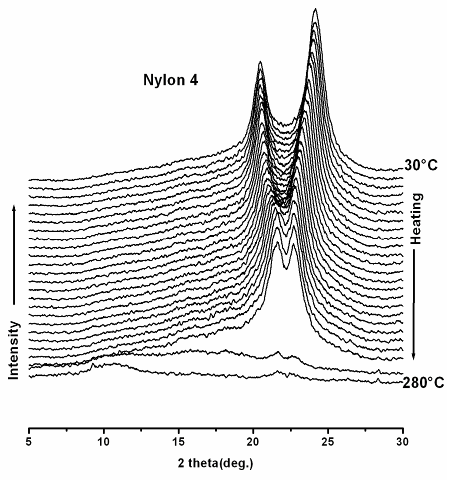

Fig.1
Behaviour of XRD patterns of nylon 4 on heating from room temperature to melt.

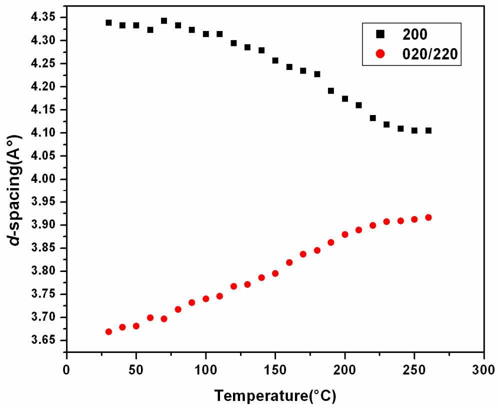

Fig.2
Change in *d*-spacing for nylon 4 with temperature.

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Crystallization of miktoarm star copolymers in comparison to linear diblock copolymer analogs

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Linear AB block copolymers and terpolymers (ABA and/or ABC) have have been extensively studied in view of the remarkable correlation between the molecular characteristics of the components (lengths of the blocks and the segregation strength) and the ordered morphologies that these materials can exhibit.[1,2] On the contrary, a modest knowledge has been gathered about star block copolymers,[3-5] where the number and localization of the arms can be now controlled (by high vacuum anionic polymerization techniques).

AB diblock copolymers and A_2B_2 miktoarm star copolymers of poly(ε-caprolactone) (PCL) and polystyrene (PS), and AB diblock and AnBm miktoarm star copolymers (with n and m ranging from 1 to 3) of polyethylene (PE) and PS were synthesized employing anionic polymerization techniques.[4-6] The morphology and thermal properties were studied by transmission electron microscopy (TEM), Small-Angle X-ray scattering (SAXS) and differential scanning calorimetry (DSC). It was found that the relationship between the volume fractions of the various arm types and the micro (and nano) domain morphology was different from the results found in linear block copolymers. Such unexpected and novel behavior[7] was explained in terms of the higher resistance of the arms to be stretched in miktoarm star copolymers as compared to analog linear diblock copolymers.[7,8] The morphology, crystallization kinetics and thermal fractionation of the crystallizable blocks within the materials were extensively studied as a function of composition and molecular architecture. The effects of confinement on the crystallizable phases lead to well established first order crystallization kinetics in the limits of isolated cylinders and spheres.[9]

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Use of Biodegradable Polymers to improve new Antifouling coatings : Erosion of marine paints

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It is generally agreed that the prevention of marine fouling can be achieved by coatings from which a controlled release of toxic molecules prevents the growth of adhered organisms (bacteria, algae, molluscs) by killing them. Since the end of 90's, antifouling paints have been realized by the blending of polyacrylic resins with biocides. The aim of this study was to use new polymers in order to obtain biodegradable antifouling paints with control release of biocide.

Polyesters, such as poly(ε-caprolactone), PCL, poly(lactide), PLA, and their copolymers have received much interest in environmental applications because of their biodegradability. Polyanhydrides have also been considered as useful carriers of active molecules. Two families of biodegradable binders were studied: poly(phtalic acid-co-ricinoleic acid-co-isophtalic acid ester anhydride and poly(ε-caprolactone-co-L-lactide). Antifouling paints were formulated with these polymers and compared with commercial binders (PMMA-PBMA +rosin and PMMA-TBT). Several methods have been used to investigate polymer erosion such as X-ray microanalysis (EDX), scanning electronic microscopy (SEM) and confocal laser scanning microscopy (CLSM). We have demonstrated that the polymers undergo predominantly surface erosion for poly(ester-anhydride) and PMMA-TBT and bulk erosion for polyester and PMMA-PBMA+rosin.

New paints containing biodegradable polymers lead to a good antifouling activity.

Comparing and contrasting the properties of blends of urethane dispersion and acrylic emulsion with those of individual polymers

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Abstract

The urethane dispersion and the acrylic emulsion were prepared and their blends in different proportions were evaluated along with their film properties and compared with those of the individual urethane and acrylic polymers. The blends as well as the individual polymers were evaluated for their appearance, particle size, % solid, pH, viscosity and Freeze-Thaw stability. The films were evaluated for drying time, scratch resistance, abrasion resistance, impact resistance, % gloss, water and solvent resistance. The mechanical properties of emulsion cast films were determined by using universal tensile tester (Instron). Thermal properties were studied by using thermo gravimetric analysis (TGA) and differential scanning calorimeter (DSC). It was observed that the elasticity and abrasion resistance of acrylic polymers and water and alkali resistance of urethane polymers were enhanced by using their blends.

HYBRID NANOMATERIALS FROM POLYMER GELS AND ORGANOGELS

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In this talk two types of hybrid materials made up from covalent polymers and self-assembling systems will be presented. The first system consists of filaments of a bicopper complex (see figure 1-left). encapsulated in isotactic polystyrene fibrils, the second system deals with intermingled gels of stereoregular polystyrenes and an organogel produced from oligo(*p*-phenylenevinylene) molecules (see figure 1-right).

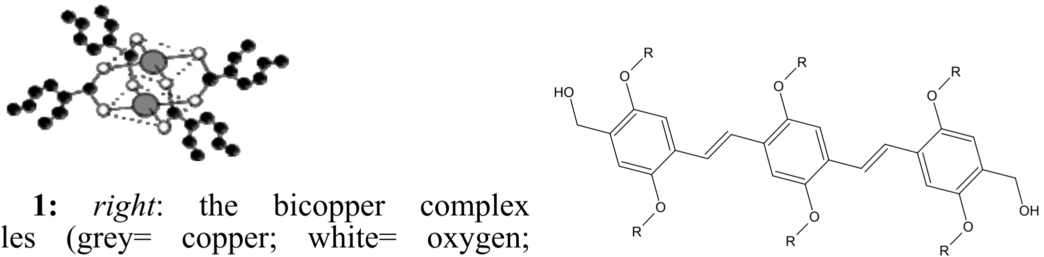

Figure 1: *right*: the bicopper complex molecules (grey= copper; white= oxygen; black= carbon). *left*: chemical structure of OPV16, the oligo(*p*-phenylenevinylene) used in this study where R= $C_{16}H_{33}$.

Results on the formation thermodynamics as observed by DSC, the morphology as determined by AFM and the molecular structure as obtained by SANS and SAXS will be presented and discussed. It will particularly be shown that a high degree of compatibility exists between all the components thus allowing one to prepare materials where one component is finely dispersed within the other. A typical AFM can illustrate this point (see figure 2).

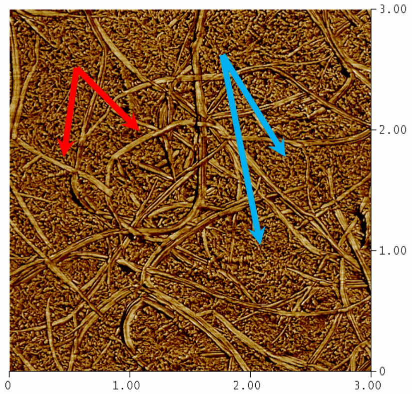

Figure 2: AFM picture of OPV16 organogels (large fibrils, red arrows) and isotactic polystyrene gel (small fibrils, blue arrows) showing the high degree of intermingling. Both gels display their own morphology, in particular the fibrils cross-sections are the same as in the binary systems. Hybrid gel prepared from *trans*-decalin. Scale in µm.

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This work has been carried out as part of a IFCPAR contract n°3708-2 involving ICS, Strasbourg, and NIIST, Trivandrum. D. Dasgupta is indebted to IFCPAR for a post-doctoral fellowship.

Tailoring Functional Nanoporous Materials from Ordered Block Copolymers

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Over the last decade, the generation of organic porous materials with controlled pore sizes and narrow pore size distributions as well as desired functionalities has been the subject of increasing attention in materials science. Such well-defined porous frameworks are of great interest, mainly due to the large variety of applications in which they are involved, *e. g.* monoliths, filters, supports for catalysis, sensors, etc. Much progress has recently been achieved toward engineering porous polymers with controlled morphology. Miscellaneous approaches are now applied by selectively removing single domains acting as porogen templates from macromolecular architectures, *e.g.* removal of self-assembled molecules from supramolecular architectures, selective thermal or photochemical destruction of a thermoplastic polymer homogeneously blended within a thermostable matrix, as well as selective removal of one partner from (semi-) Interpenetrating Polymer Networks (IPNs). Furthermore, block copolymers develop well-defined equilibrium domain morphologies (*i.e.* lamellar, hexagonally packed cylindrical, bicontinuous gyroid, and spherical, in linear diblock copolymers), and thus constitute arguably ideal nanostructured precursors for the formation of ordered mesoporous polymers. In this context, the selective removal of the sacrificial minority block from self-organized block copolymers constituted of at least two components of contrasted degradability has proven to be a very prolific route to a wide array of nanoporous materials with a defined porosity.

In this lecture, we will describe an original strategy for generating mesoporous polystyrene membranes with a simultaneous control over the porosity and functionality through the synthesis of polystyrene-*block*-poly(D,L-lactide) (PS-*b*-PLA) diblock copolymers with functional groups at the junction between both blocks, followed by their macroscopic orientation, and the subsequent selective hydrolysis of the PLA block. We used a combination of "living"/controlled anionic or Atomic Transfer Radical Polymerization (ATRP) and Ring Opening Polymerization (ROP) techniques to prepare well-defined diblock copolymers with carboxylic or amino functionalities at the junction between the PS and PLA blocks. By the proper design of the copolymer composition and a good control over the polymerization conditions, polymers with preferentially cylindrical morphology (PLA cylinders in PS matrix) could be obtained. After macroscopic alignment of the nanodomains, the PLA phase was quantitatively removed by basic hydrolysis, leaving behind the porous PS membrane with functional groups located along the pore walls. The PS-*b*-PLA precursors as well as the resultant porous materials were analyzed by a wide array of physico-chemical techniques, including Size Exclusion Chromatography, ^{1}H NMR, Differential Scanning Calorimetry (DSC), Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM) and Small-Angle X-ray Scattering (2-D SAXS). The porosity of the functional nanoporous materials was also quantified by nitrogen sorption porosimetry.

Obtained functional nanoporous membranes are of potential interest for heterogeneous catalysis, advanced filtration techniques and selective transport applications.

Acknowledgements

Financial support of the National Agency for Research (programme ANR/PNANO, project POLYNANOCAT "ANR-05-NANO-025") is gratefully acknowledged.

Rheological properties of viscoelastic fluids and fracture under stress

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The viscoelastic fluids studied are solutions of living polymers which are chains of small molecules forming reversible non covalent bonds. The interest of these systems is motivated by their numerous potential applications in fields such as lubrication, cosmetics or food processing. We have focused on disubstituted bis-ureas which self-assemble in apolar solvents through hydrogen bonding to form molecular wires. The macroscopic properties of these supramolecular polymers have been studied by rheology and the structure of the molecular wires has been derived from scattering experiments. We report the rheological properties of solutions of disubstituted bis-ureas in the linear and non linear regimes, including a fluidization observed under stress that exhibits features similar to the fracture of solid materials. Delayed fracture is known since many decades in the domain of solid materials. It is known that the time for a fracture to occur strongly depends on the imposed stress indicating that thermal activated processes are involved.

Shear-banding appears at a given strain value in step shear rate experiment. In addition, in creep experiment, a delay is observed before the shear-banding occurs. This delay depends very sensitively on the applied stress. Finally, all the experiments are gathered in a strain vs. fluidization time diagram and we show that the data collapses onto a master curve that exhibits two branches.

Ref : Ducouret, G.; Chassenieux, C.; Martins, S.; Lequeux, F.; Bouteiller, L. *J. Coll. Interface Sci.* **2007**, *310*, 62

Synthesis and self-assembling properties of end-capped poly(ethylene oxide) and grafted poly(acrylamide) hydrophobically modified with 3-pentadecylcyclohexylamine.

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Water-soluble hydrophobically modified polymers continue to receive major attention since they form an important class of macromolecular additives involved in aqueous-based formulations. They actually find an increasing number of applications in technological areas such as enhanced oil recovery, cosmetic lotions, paints and coatings, food additives and pharmaceuticals. These systems are generally designed with a water-soluble backbone bearing a small number of hydrophobic stickers either dispersed along the polymer chain or present as terminal groups. While the architecture of the macromolecule highly influences the structure of the physical network, the chemical nature of hydrophobic groups strongly impact its dynamics.

In the present study we used 3-pentadecylcyclohexylamine (PDC), a hydrophobic compound synthesized starting from cashew nut shell liquid (a renewable resource material), for the preparation of two series of associating polymers: telechelic end-capped poly(ethylene oxide) (PEO-PDC) {1} and randomly grafted poly(acrylamide) (PAM-g-PDC). Starting with a single type of sticker, this work offers the opportunity to compare the associating properties of telechelic PEO, prepared from different molecular weights (10K and 20K), with those of PAM grafted with various mount of PDC; from 0.5 to 0.9% (see example in **Figure 1**).

After an introduction to the synthesis and characterization of these new associating polymers, we will investigate their self-assembling behaviour in aqueous solution using different points of view: the structure, the thermodynamic stability and the dynamic properties.

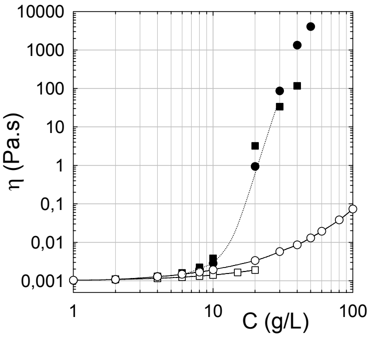

Figure 1
Concentration dependence of the viscosity for aqueous solutions of associating polymers and hydrophilic precursors:
☐ PEO20K
○ PAM
■ PEO20K-PDC
● PAM-g-0.7%PDC

{1} V. S. Kadam, M. V. Badiger, P. P. Wadgaonkar, G. Ducouret, D. Hourdet, Polymer 2008, *49*, 4635.

SRF fellowships by CSIR (India) and Sandwich Ph.D. scholarships by French Embassy (New Delhi) to Vijay Kadam and Sony Varghese are gratefully acknowledged. The authors want also to thank CEFIPRA, promoter of this collaboration.

Nanocomposites of calcium carbonate and polyethylene: Preparation and Characterization.

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Abstract

Calcium carbonate (nano sized) was synthesized by *In-situ* deposition technique and its size (35 to 60 nm) was confirmed by transmission electron microscopy (TEM). Composites of the filler $CaCO_3$ (conventional and nano) and the matrix polyethylene (LLDPE) were prepared with different filler loading (1-5 wt. %). The variation of torque was studied for these formulations using a Brabender torque rheometer. In addition, mechanical properties and crystallization behavior of the nano and conventional composites were also studied. A marginal effect of nano $CaCO_3$ on the magnitudes of torque was observed; however, the tensile strength of LLDPE-nanocomposites filled with low contents (1 and 2 wt. %) of calcium carbonate was higher than that filled with corresponding conventional calcium carbonate-LLDPE composites. The crystallization peak temperature for these nanocomposites showed a significant increase. This change is accounted in terms of the uniform dispersion of nanocalcium carbonate particles or more particles per unit wt. at lower wt. % as compare to the higher wt. % of nanocalcium carbonate. WAXD showed flocculation of calcium carbonate nanoparticles on the surface of the LLDPE nanocomposites. Tensile fractured surfaces, studied using the scanning electron microscope (SEM), showed uniform dispersion of nanoparticles for 1 wt. than 3 & 5 wt. % filler loading.

Keywords: Nanoparticles, calcium carbonate, polyethylene, Brabender torque rheometer.

Cyanate Ester Resins Containing (Substituted) Cyclohexyl Moiety

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Abstract

Cyanate ester monomers viz 1,1-bis(4-cyanatophenyl) cyclohexane (BPZCN) and 1,1-bis(4-cyanatophenyl)-3-pentadecyl cyclohexane (BPC-15CN) containing (alkyl substituted) cyclohexyl moiety , were synthesized and characterized by FTIR, ^{1}H NMR, ^{13}C NMR and elemental analysis. BPZCN and BPC-15CN showed better processability with lower melting points, lower cure onset with broad exotherm. As compered to cured 2,2-bis(4-cyanatophenyl) propane (BPACN), BPZCN resin has higher glass transition termperature (302 °C) due to rigid cardo moiety while due to presence of C15 alkyl chain, cured BPC15CN has lower glass transition temperature (160 °C). Cured BPZCN has higher storage modulus (1.59×10^9 Pa) than BPC-15CN (1.07×10^9 Pa) and BPACN (1.39×10^9 Pa). The order of thermal stability was found to be BPACN > BPZCN> BPC15CN. The moisture absorption of cured resins BPZCN and BPC15CN was found to be lower than BPACN implying their hydrophobicity.

Abstract for Poster Presentation

Synthesis and Characterization of New Aromatic Polyesters Containing Pendant Pentadecyl Chains

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Aromatic polyesters are one of the most versatile synthetic, high performance polymers. High thermal stability, solvent resistance and good mechanical properties of these polymers makes them possible to meet the demands of the modern industry in the areas of aviation, automobile, electronics, etc. However, most aromatic polyesters encounter processing difficulties due to their high glass transition temperatures or melting temperatures coupled with insolubility in common organic solvents. Therefore, development of aromatic polyesters for high temperature applications with improved processability is an important goal. Several approaches have been adapted to improve solubility and processability of aromatic polyesters such as, Insertion of flexible spacers in the polymer backbone; Incorporation of bent or 'crankshaft' units along the backbone; Appending of bulky side groups or flexible side chains.

The approach of interest is introduction of flexiblizing linkages either in the backbone or as pendant group, both of which lead to improved solubility/processability. When the flexiblizing group is appended to the polymer chains it is referred to as an "internal plasticizer" which can also act as a bound solvent. The pendant flexibilizing groups affect the polymer properties leading to reduction in melt viscosity and lowering the glass transition temperature by providing more number of rotational degrees of freedom and relative ease of rotational mobility.

Thus, a new bisphenol containing pendant pentadecyl chain was designed and synthesized starting from cashewnut shell liquid; a renewable resource material *via* simple organic transformations. A series of (co)polyesters was synthesized by low temperature interfacial polycondensation of bisphenol containing pendant flexible pentadecyl chain with aromatic diacid chlorides. (Co) polyesters were characterized by inherent viscosity measurements, solubility tests, FTIR, ^{1}H-NMR, ^{13}C-NMR spectroscopy, gel permeation chromatography, X-ray diffraction, thermogravimetric analysis (TGA), and differential scanning calorimetry (DSC). The effect of pendant pentadecyl chain on properties of polyesters was investigated.

Effect of electric field on the wetting characteristics of PEDOT:PSS films doped with sorbitol

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Abstract

Conducting organic materials are used for low-cost, flexible electronic applications using printing techniques such as screen printing, inkjet printing, micro contact printing, spin coating etc. Wetting characteristics of the polymer over the substrate plays an important role in these printing techniques. Poly(3,4-ethylene dioxythiophene): poly(styrene sulfonic acid) (PEDOT:PSS) is found to be a potential candidate for hole injection polymer in organic light emitting diodes. Addition of sorbitol, a polyhydroxy alcohol, to the aqueous dispersion of PEDOT:PSS, is known to enhance the conductivity of the polymer thin film [1]. Addition of sorbitol can result in-homogeneous distribution of PEDOT:PSS. In this study, we have investigated the effect of sorbitol (i) on the spreading of PEDOT:PSS with and without the influence of electric field on glass substrate, (ii) on conductivity PEDOT:PSS films and (iii) on I-V characteristics of PEDOT:PSS coated on ITO coated-glass. Effect of varying sorbitol content and electric field on the contact angle of PEDOT:PSS dispersion is shown in Figure 1. The conductivity increases to two orders of magnitude, as the concentration of sorbitol increases till 4 wt% and then remains constant.

The I-V characteristics of PEDOT:PSS with sorbitol was studied [2] for voltage amplitudes of -10 V- 10V, -5 V to 5 V and -4 V to 4 V with 0.1V/s as step increment. From this study, we could find that the charge storage at the interface of polymer and substrate (ITO) increases as the voltage amplitude increases.

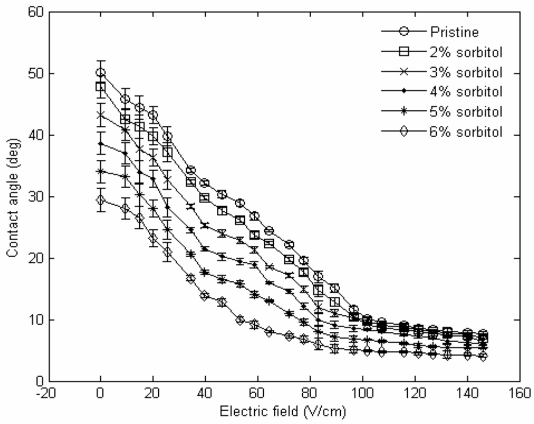

Fig. 1. Effect of sorbitol and electric field on the contact angle made by PEDOT:PSS dispersion on glass slide.

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Effect of nanoclay on the mechanical and dynamic mechanical properties of cyanate ester syntactic foams

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Abstract

The properties of cyanate ester syntactic foams were improved by nanoclay modifcation. Nanoclay reinforced cyanate ester syntactic foams with 2% and 4% nanoclay loadings (by volume) were processed. The volume percentage of the filler (microballoon+nanoclay) was kept constant at 70. XRD analysis showed exfoliated morphology of the clay particles in the foam composites. The composites were characterised for mechanical and dynamic mechanical properties. The results were compared with bare cyanate ester syntactic foams of same filler concentration. A considerable improvement in the mechanical properties viz. tensile, flexural and compressive strengths and corresponding modulus was observed by nanoclay reinforcement. The corresponding specific properties also showed substantial improvement on nanoclay incorporation. The storage modulus and loss modulus values were higher for the foam composite with 4% nanoclay. However, the T_g of the nanoclay reinforced systems is lower than bare cyanate ester syntactic foam due to increase in plasticization of the matrix. The fracture features of the composites were studied using SEM.

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Nanoclay reinforced thermoplastic toughened epoxy hybrid syntactic foam: Fracture toughness and Mechanical properties

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Abstract

Epoxy hybrid syntactic foams were prepared with diglycidyl ether of bisphenol A (DGEBA) epoxy resin, diamino diphenyl sulfone (DDS), hydroxyl terminated polyether ether ketone with pendant methyl group (PEEKMOH) and nanoclay. The density of the foam was maintained between 0.6 to 0.7g/cc for all compositions. Fracture toughness, tensile, flexural and compressive properties of the foam were evaluated with respect to clay and PEEKMOH concentrations. Addition of nanoclay significantly improved the fracture toughness and other mechanical properties of the epoxy foam. A further enhancement in properties was observed by the addition of PEEKMOH to the system. The hybrid epoxy syntactic foam thus prepared exhibited 58%, 77% and 38% improvement in compressive strength, percentage elongation and fracture toughness respectively, compared to the neat epoxy syntactic foam.

NITRILE RUBBER –CLAY/ULTRASIL HYBRID NANOCOMPOSITES

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Abstract

Acrylo Nitrile butadiene Rubbe(NBR)-clay/Ultrasil hybrid nanocomposites were prepared by melt mixing using Brabender plasticorder and solution blending techniques using methyl ethyl ketone as solvent. Cure characteristics were monitered by oscillating disc rheometer. X-ray diffraction studies showed an intercalated morphology. NBR clay nanocomposites showed a remarkable improvement in mechanical properties compared to the pristine rubber. Tensile strength, percentage elongation, tensile modulus were improved by six fold, one fold and three fold respectively with a 15phr loading of nanoclay into the NBR matrix. Oxygen gas permeability was reduced by 85-90% for 15phr clay loaded system compared to the NBR micro composites containing 40phr ultrasil and 5phr carbon black. Tensile strength and percentage elongation were reduced by 40% and 20% respectively with a 40% improvement in tensile modulus while the Shores A hardness was retained. The effect of nanoclay ultrasil hybrid ratio on mechanical and oxygen gas permeability properties of NBR nanocomposites is studied. A comparison in oxygen gas permeability was also made for NBR hybrid nanocomposites prepared from melt mixing and solution blending techniques.

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Morphological studies of amphiphilic hyperbranched polymer films

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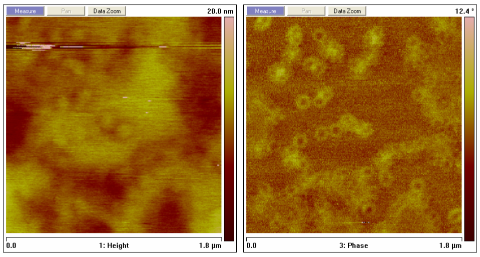
Dendrimers and hyperbranched (HB) polymers have aroused great interest because of their potential applications such as drug delivery agents, catalysts, hybrid systems and nanosystems. Dendrimers are perfectly branched structures where as the hyperbranched structures are macromolecules with a large number of defects in branching. Dendrimers are particularly interesting because of large number of accessible functionalities at the periphery. For example, unique copolymers with core-shell architecture can be acquired via the incorporation of hydrophilic linear segments at the periphery of the dendritic structures. Recently we have developed a methodology to synthesize similar ‘core-shell’ kind of hyperbranched polymer in a single step applying transetherification strategy. The core shell morphology of hyperbranched polymer is not quite obvious as in the case of dendrimers. Dye uptake studies using the amphiphilic HB polymer suggested possible core-shell morphology. TM-AFM study has been performed on a thin film of HB polymer, drop casted from methanol and dried under benzene vapour. Two prominent aggregated features were found in the study. Smaller assemblies of average dimension 50 nm were observed in the height image. Single molecule dimension of this HB polymer is much smaller than the dimension observed in AFM. Similar kind of results were observed earlier for self-assembly of arborescent polystyrene-graft- poly(ethyleneoxide) copolymer at the air water interface (*Macromol. Chem. Phys. 2008, 209, 907–918*). Larger aggregates of dimension 127 nm, with surprisingly uniform size distribution, were also observed. These structures appear as rings in phase image indicating core-shell morphology. This kind of organization of HB polymer has been suggested earlier (V. Percec, et al., *Nature*, (1998) **391**, 161-164). Unfavorable core solvent interaction results in the formation of aggregates with the hydrophobic core sheltered inside the hydrophilic PEG shell. These, when casted, get adsorbed on freshly cleaved mica. Presence of benzene vapour while drying the film forces the PEG shell to collapse revealing the core. The difference in the viscoelastic nature of the core and shell, thus formed, gives a phase contrast in the TM-AFM phase image. The absence of well defined height image reassures the collapsed morphology suggested in the possible mechanism of aggregation.



AFM pictures of core-shell type hyperbranched polymers

NATURAL RUBBER NANOCOMPOSITES USING NANO ZnO

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Abstract:

Zinc oxide (ZnO) of nanometer particle size was prepared by solid-state pyrolytic method. TEM and XRD studies showed that the prepared zinc oxide had particle size in the range of 50-89 nm. This nano zinc oxide was used as a curing agent in natural rubber (NR). The optimum dosage of nano ZnO was found to be low compared to commercial ZnO. The cure characteristic and mechanical properties were compared with those containing conventional ZnO. It was found that a low dosage of nano zinc oxide was enough to give equivalent curing and mechanical properties compared to one containing a higher dosage (5 phr) of commercial zinc oxide in natural rubber. The dry NR nanocomposite containing 2 phr of nano ZnO exhibits enhancement of mechanical properties (tear strength and tensile modulus). The incorporation of nano ZnO in NR latex and pre-vulcanised NR latex also exhibited enhancement of mechanical properties (tear strength and tensile modulus) for 2 phr and 1.5 phr of nano ZnO dosage respectively. The enhancement of mechanical properties is due to the strong filler-matrix interactions in these compositions. The diffusion of water is strongly influenced by the microstructure of the nanocomposites. The nanocomposites with nano ZnO up to a particular phr (*viz* 2 phr for NR latex nanocomposites and dry NR nanocomposites and 1.5 phr for pre-vulcanized latex nanocomposites) show less diffusion, low porosity (0.24%, 1.18% and 1.06% respectively) thereby exhibiting strong interaction between the filler and the matrix.

Keywords: nano zinc oxide, natural rubber, solid-state pyrolytic method, SEM, TEM

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Regulating molecular weight and polydispersity of hyperbranched polymers

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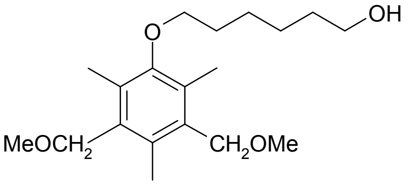
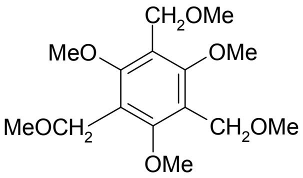
Hyperbranched polymers have received considerable attention over the past few decades due to their interesting properties such as large number of end groups, low melt/solution viscosities, and three dimensional architectures. One of the drawbacks of hyperbranched polymers is the very broad molecular weight distribution that is typically seen. Recent theoretical as well as experimental studies suggest that the use of a suitable core molecule provides the opportunity to generate polymers with significantly narrower distribution.

AB$_2$



B$_3$



During the past decade, a novel melt-transetherfication approach for the preparation of polyethers was developed in our laboratory and it has been utilized to access and study a wide range of hyperbranched structures. Typically, the hyperbranched polyethers are prepared using an AB$_2$ type monomer carrying one hydroxyl group (A) and two methoxybenzyl ether (B) groups. Recently we have designed an activated B$_3$ type core molecule that, when used as a comonomer along with the standard AB$_2$ type monomer, leads to a substantial decrease in the polydispesity index of the polymer. As evident from the structure, the B$_3$ comonomer carries three activating methoxy groups that enhance the reactivity of the benzylmethyl ether groups towards the transetherification process, which in turn is essential for effective control of the molecular weight and polydispersity. Furthermore, by varying the relative mole-fraction of the B$_3$ comonomer it was possible to control the final molecular weight of the polymer as well. A comprehensive study of the various factors that lead to such a control of molecular weight and polydispersity will be discussed in the presentation.

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Aliphatic-Aromatic Copolyesters Derived from Isosorbide with different Ratios of Isophthalic and Terephthalic Acid

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ABSTRACT

Among the important byproducts of biomass are the dianhydrohexitols obtained in the sugar industry by the double dehydration of starch. These chiral compounds exist as three stereoisomers according to the relative configuration of their two hydroxyl functions namely, isosorbide, isomannide, isoiodide. These three isomers have been used as monomers for the manufacture of new biodegradable polymers, including polyesters, polyurethanes and polycarbonates based on natural and renewable raw materials. These polymers presented promising high glass transitions, excellent thermal stabilities and interesting physical properties.

Among this class of compounds, isosorbide is the less studied isomer as the less accessible one within four steps from D-mannose. However, it is certainly the most interesting for polymer synthesis due to the improved accessibility of the two hydroxyl groups lying in exo (pseudoequatorial) positions. Furthermore, on the basis of thermal measurements (DSC), it has been shown that the exo sustituent increases the ring thermal stability.

The copolyesters prepared from aliphatic diols such as isosorbide are of great interest to the chemical industry because such aliphatic diols can be produced from renewable resource materials, namely sugars, rather than from petroleum feed stocks as for most presently used diol monomers. Therefore, it would be desirable to have an efficient method to produce high quality, random polyesters or copolyesters from isosorbide.

In the present work, we have synthesized a series of new copolyesters derived from isosorbide and different ratios of isophthalic and terephthalic acid by melt polymerization in the presence of a catalyst. The effect of varying ratios of isophthalic and terephthalic acid was studied on the properties of copolyesters. The isosorbide/isophthalic acid/terephthalic acid copolyesters were characterized by FTIR and ^{1}H NMR spectroscopy, solution viscosity, differential scanning calorimetry, thermogravimetric analysis and X-ray diffraction.

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MICRO/NANO HYBRID FILLERS FOR POLYPROPYLENE MODIFICATION

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ABSTRACT

Engineering polymers are attractive materials for structural applications. Thermoplastic polymer composites which have good mechanical and thermal properties could be cheaper alternative matrix materials for the same. The main advantages of polymers are their easy processing and light weight. Polypropylene (PP) is a widely using thermoplastic. Traditionally, composites were reinforced with micron sized fillers. Recently nanosized fillers have been developed but the dispersion quality is one of the main difficulties regarding the use of inorganic nanoparticles in PP. Different from the conventional micro-fiber reinforced thermoplastic composites that are reinforced by the micro-fiber system or the nanocomposites which are reinforced by nanofillers, a new type of polymer composite which is reinforced by both the micro-fibers and nano-powder will be discussed in this paper.

Polypropylene (PP)-glass fiber composites with nanosilica and modified nanosilica (using silane coupling agent) were fabricated by melt compounding. The reinforcing and toughening effects of the micro and nano fillers on polypropylene were studied at different loading levels of glass fiber and nano silica/modified nanosilica. The synthesized nanosilica powder was used as reinforcing filler in PP-glass fiber composites The use of two types of fillers leads to synergistic effect on the mechanical properties of the fiber composite. 1wt.% modified nanosilica loading in PP-10wt.% glass fiber composite showed higher mechanical properties compared to PP-30 wt.% glass fiber composite

Keywords : *PP, nanosilica, coupling agent, mechanical properties*

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NANOSTRUCTURED ELECTRO-MAGNETIC FUNCTIONAL MATERIALS FROM INORGANIC ORGANIC HYBRID GUEST-HOST SYSTEM.

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ABSTRACT

Nanostructured electro-magnetic materials have attracted considerable attention for their potential applications in various fields such as electromagnetic interference (EMI) shielding, antistatic coatings, chemical sensors, transducers, rechargeable battery, and corrosion protection coatings.[1-5] Nanostructured electro-magnetic polyaniline- magnetite-clay composite (PCMC) having core-shell morphology was prepared by the oxidative radical emulsion polymerization of aniline in presence of Iron-polycation intercalated clays (PHIC) as magnetic precursors. Formation of self-assembled aggregates of nanostructured magnetite-polyaniline with core-shell morphology was manifested by the studies made by FT-IR, XRD, SEM and TEM. Electrical and magnetic properties of these materials were investigated at room temperature. Materials exhibited saturation magnetization of 47 memu/g , coercivity 13.9 Oe and retentivity of 2.6 memu Electrical conductivity measurement exhibited positive variation from 0.003 S/cm → 0.015 S/cm → 0.205 S/cm → 1.06 S/cm → 1.05 S/cm on increasing the amount of PHIC. The prospects for the direct application of this material is for the development of processable electromagnetic interference shielding materials having high mechanical strength and thermal stability with electro-magnetic properties for high tech applications from low cost materials.

Nano-clay Incorporated Polyurethane with Shape Memory Properties

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Abstract

Thermo-responsive shape memory polymers (SMPs) are emerging as functional materials that can find broad applications in temperature sensing elements. Segmented polyurethanes (PUs) consisting of soft segments based on polyol units and hard segments based on isocyanate and chain extender units, constitute an important class of SMPs. PU based, unreinforced SMPs are capable of exhibiting unconstrained recoverable strain of the order of 100% [1]. However, their low stiffness compared to metals and ceramics results in a relatively small recovery force under constraint and limits their application potential as an actuation material. Nano-sized ceramic particle or carbon nanotube reinforcement of SMP is gaining importance as a route to enhance the modulus of the polymer and thus increase the recoverable stress level for structural applications [2].

The synthesis, characterization and shape memory properties of PU derived from poly(tetramethyleneoxide), tolylene diisocyanate and 1,4-butanediol has been reported by us earlier [3]. The polymer with 85% hard segment content exhibited ~94% shape recovery. Modification of this SMP with the incorporation of nano-clay particles was attempted in the present study with a view to explore its suitability for lightweight structural applications. The effect of clay content (varied from 1 to 5 wt%) dispersed in PU, on the thermo-mechanical and shape memory properties of the polymer was evaluated. Transition temperature, tensile strength and modulus of the polymer increased in proportion to the nano-clay content in the composite. Modulus ratio and shape recovery characteristics showed a decreasing trend with the clay content. PU incorporated with 1 wt% clay exhibited the highest shape recovery of 92%. The study showed that mechanically stronger PU system could be realized by nano-clay loading at very low concentration without considerable loss of shape memory properties.

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Preparations And Studies On The Intercalation Characteristics Of Carvedilol drug Into Inorganic Clay For Drug Delivery Applications.

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This study deals with the preparation of Drug/layered silicate nanocomposites obtained by different technique i.e., solution-mixing, Melt mixing and Intimate mixing. Prior to the drug intercalation processes, the clay was swelled in a suitable solvent. In the swelling experiment it was observed that the swelling ratio increased with the content of clay quantity. The Carvedilol drug was successfully intercalated with Clay nanoparticles. In order to establish an optimum amount of drug intercalated clay nanoparticles, FT-IR, DSC, X-ray diffraction, and TG measurements were performed. In the solution mixing method it was observed that the loading rate of the drug was increased with the time. The solution mixing method gives higher drug loading when compared to the melting and intimate mixing methods.

In vitro Drug dissolution study was done both at stomach P^H and Intestine P^H. From the drug release study it was observed that the rates of drug releasing were decreased with the intercalate content, because the presence of clay nanoplatelets that could provide the tortuosity to the diffusion path.

Preparations And Studies On The Intercalation Characteristics Of Carvedilol drug Into Inorganic Clay For Drug Delivery Applications.

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Viscoelastic and Thermal property modified Epoxy-Clay Nanocomposites: Preparation, Characterization and Property Evaluations.

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Abstract for Poster Presentation
Synthesis and Characterization of New Aromatic Polyesters Containing Pendant Pentadecyl Chains

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Aromatic polyesters are an important class of high performance polymers. High thermal stability, solvent resistance and good mechanical properties of these polymers makes them possible to meet the demands of the modern industry in the areas of aviation, automobile, electronics, etc. However, most aromatic polyesters encounter processing difficulties due to their high glass transition temperatures or melting temperatures coupled with insolubility in common organic solvents. Therefore, development of aromatic polyesters for high temperature applications with improved processability is an important goal. Several approaches have been adapted to improve solubility and processability of aromatic polyesters such as, insertion of flexible spacers in the polymer backbone; incorporation of bent or 'crankshaft' units along the backbone; appending of bulky side groups or flexible side chains, etc.

The approach of interest is introduction of flexiblizing linkages either in the backbone or as pendant group both of which lead to improved solubility/processability. When the flexiblizing group is appended to the polymer chains it is referred to as an "internal plasticizer" which can also act as a bound solvent. The pendant flexibilizing groups affect the polymer properties leading to reduction in melt viscosity and lowering of the glass transition temperature by providing more number of rotational degrees of freedom and relative ease of rotational mobility.

In the present work, a new bisphenol containing pendant pentadecyl chain was designed and synthesized starting from cashewnut shell liquid; a renewable resource material *via* simple organic transformations. A series of (co)polyesters was synthesized by low temperature interfacial polycondensation of bisphenol containing pendant flexible pentadecyl chain with aromatic diacid chlorides. (Co) polyesters were characterized by inherent viscosity measurements, solubility tests, FTIR, ^{1}H-NMR, ^{13}C-NMR spectroscopy, gel permeation chromatography, X-ray diffraction, thermogravimetric analysis (TGA), and differential scanning calorimetry (DSC). The effect of incorporation of pendant pentadecyl chain on properties of polyesters was investigated.

Cyanate Ester Resins Containing (Substituted) Cyclohexyl Moiety

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ABSTRACT

Cyanate ester monomers containing (alkyl substituted) cyclohexyl moiety viz 1,1-bis(4-cyanatophenyl) cyclohexane (BPZCN) and 1,1-bis(4-cyanatophenyl)-3-pentadecyl cyclohexane (BPC-15CN) , were synthesized and characterized by FTIR, ^{1}H NMR, ^{13}C NMR and elemental analysis. BPZCN and BPC-15CN showed better processability coupled with lower melting points, lower cure onset with broad exotherm. Glass transition temperature of cured 2,2-bis(4-cyanatophenyl) propane (BPACN), BPZCN and BPC15CN was observed to be 288 °C, 302 °C, and 160 ° C respectively. The higher glass transition of BPZCN is due to rigid cardo moiety while due to the presence of C15 alkyl chain, cured BPC15CN exhibited lower glass transition temperature. Cured BPZCN displayed higher storage modulus (1.59×10^9 Pa) than BPC-15CN (1.07×10^9 Pa) and BPACN (1.39×10^9 Pa). The order of thermal stability was found to be BPACN > BPZCN> BPC15CN. The moisture absorption of cured resins derived from BPZCN and BPC15CN was found to be lower than BPACN implying their hydrophobicity.

Novel Cationic Photoacid Generator Monomer and PAG Incorporated Photoresists for AFM Lithography and E-Beam Lithography

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Atomic force microscope (AFM) and E-beam lithography has been used to research the formation of nanopatterns on various substrates. Chemistry of photoresist material must be carefully designed to meet requirements of each of the lithographic technology. Although these requirements vary according to the radiation source and device process requirements, the following are ubiquitous: sensitivity, contrast, resolution, etching resistance and purity. These properties can be achieved by careful manipulation of structures and molecular properties of polymers.

To develop the photoresist for the fabrication of high resolution images-a novel photoacid generating (PAG) monomer containing a sulfonium-trifluoromethane sulfonate as an electron withdrawing groups and polymerizable methacryloyl group was synthesized. It was characterized by FTIR, NMR, Mass, GC and elemental analysis to confirm its structures. The polymerization behavior PAG monomer was investigated by conducting radical polymerization of itself to get a high sensitivity negative resist. However more effectively incorporation of these PAG units into the main chain of the acrylate based copolymers was carried out. All the PAG incorporated photoresists were studied for its spectral properties such as FTIR, NMR and thermal properties by TGA and DSC. However molecular weight and more importantly molecular weight distribution were determined by GPC. In the newly developed photoresist- an intramolecular incorporation of photoacid generating units were found to have uniform distribution and an excellent film formation behavior, which are the prime demands of the current lithography for the development of integrated circuit. The effect of structure of a photoacid generator on the trends of image formation in a newly developed photoresists were studied by AFM and E-beam lithography. A photosensitive resists with excellent thermally stability applied to the high speed lithography using AFM to fabricate sub-50nm nanostructure and using E-beam to fabricate sub-20nm nanostructure.

Comparing and contrasting the properties of blends of urethane dispersion and acrylic emulsion with those of individual polymers

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Abstract

The urethane dispersion and the acrylic emulsion were prepared and their blends in different proportions were evaluated along with their film properties and compared with those of the individual urethane and acrylic polymers. The blends as well as the individual polymers were evaluated for their appearance, particle size, % solid, pH, viscosity and Freeze-Thaw stability. The films were evaluated for drying time, scratch resistance, abrasion resistance, impact resistance, % gloss, water and solvent resistance. The mechanical properties of emulsion cast films were determined by using universal tensile tester (Instron). Thermal properties were studied by using thermo gravimetric analysis (TGA) and differential scanning calorimeter (DSC). It was observed that the elasticity and abrasion resistance of acrylic polymers and water and alkali resistance of urethane polymers were enhanced by using their blends.

Nanocomposites of calcium carbonate and polyethylene: Preparation and Characterization.

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Abstract

Calcium carbonate (nano sized) was synthesized by *In-situ* deposition technique and its size (35 to 60 nm) was confirmed by transmission electron microscopy (TEM). Composites of the filler $CaCO_3$ (conventional and nano) and the matrix polyethylene (LLDPE) were prepared with different filler loading (1-5 wt. %). The variation of torque was studied for these formulations using a Brabender torque rheometer. In addition, mechanical properties and crystallization behavior of the nano and conventional composites were also studied. A marginal effect of nano $CaCO_3$ on the magnitudes of torque was observed; however, the tensile strength of LLDPE-nanocomposites filled with low contents (1 and 2 wt. %) of calcium carbonate was higher than that filled with corresponding conventional calcium carbonate-LLDPE composites. The crystallization peak temperature for these nanocomposites showed a significant increase. This change is accounted in terms of the uniform dispersion of nanocalcium carbonate particles or more particles per unit wt. at lower wt. % as compare to the higher wt. % of nanocalcium carbonate. WAXD showed flocculation of calcium carbonate nanoparticles on the surface of the LLDPE nanocomposites. Tensile fractured surfaces, studied using the scanning electron microscope (SEM), showed uniform dispersion of nanoparticles for 1 wt. than 3 & 5 wt. % filler loading.

Keywords: Nanoparticles, calcium carbonate, polyethylene, Brabender torque rheometer.