Volume 14, Issue 1

January 2014

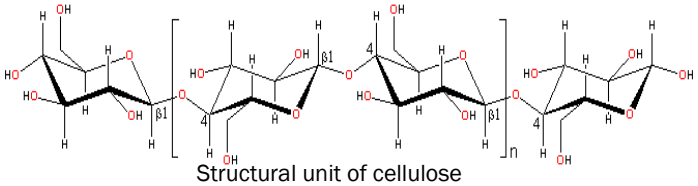
Polymer News

A newsletter of the Society of Polymer Science, India, Thiruvananthapuram Chapter

Cellulose based graft copolymers for environmental and biomedical applications

Prof. T.S. Anirudhan, Department of Chemistry, University of Kerala-Kariavattom Campus

Cellulose, the most abundant biopolymer on earth, a polysaccharide consisting of a linear chain of several hundred to over ten thousand β(1→4) linked D-glucose units. Two glucose molecules react to form a cellobiose which is the basic chemical unit of a cellulose molecule Cellulose can be derived from a variety of sources such as woods, plants and animals. These include seed fiber (cotton), wood fibers (hardwoods and softwoods), bast fibers (flax, hemp, jute, ramie), grasses (bagasse, bamboo), algae (Valonica ventricosa), and bacteria (Acetobacter xylinum) [1]. Annual production of cellulose in nature is estimated to be 1011–1012 t in two forms, partially in a pure form, for example seed hairs of the cotton plant, but mostly as hemicellu-



Structural unit of cellulose

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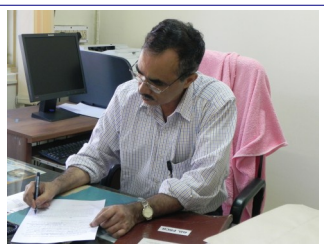
Notice

- AGM is on Sunday, 19th January 2014 , 6:00 pm at Hotel Capital, Near GPO, Thiruvananthapuram.
- SPSI Best Ph.D Paper award presentation on AGM day.
- Formation Day Lecture will be given by Dr. Suresh Das, Director, National Institute for Interdisciplinary Science and Technology (NIIST) , Trivandrum.

In this issue:

From the President's Desk...



India is one of the fastest growing markets for polymers with consumptions exceeding fifteen million tons in 2013. India has a vibrant manufacturing and processing industry, in large, medium and small sectors. The need for a Society like society of Polymer Science (India) (SPSI) to promote the advancement of the science and technology of polymers in the country and to provide a forum for the practitioners to meet periodically and exchange information on the contemporary developments in the area is self explanatory. The SPSI Trivandrum chapter established in 1995 with its national headquarters located at Pune, has done its best to meet these objectives. The Society is registered as a non-profit entity whose activities include organizing local technical events on a regular basis for the benefit of their members. It is in the forefront of all national events related to polymers. This year, the SPSI TVM chapter`s flag flew atop in MACRO-FAPS 2013 in terms of participation and that its members bagged one of the best paper awards. We could organize a seminar by the inventor of CNT, Prof. Sumio Iijima. This year too, many of the society members won laurels in their fields of specialization. Of special reference is that its vice president Dr.A. Ajayaghosh received many national and international recognitions during this year. It is gratifying that during the current year too, research activities in frontier areas of smart, conducting, photovoltaic, optical and biomedical polymers proliferated significantly in this region. As the general public is still skeptical about the "polymer pollution", it is high time we focused on serious research activities in areas of green and eco-friendly polymers too.

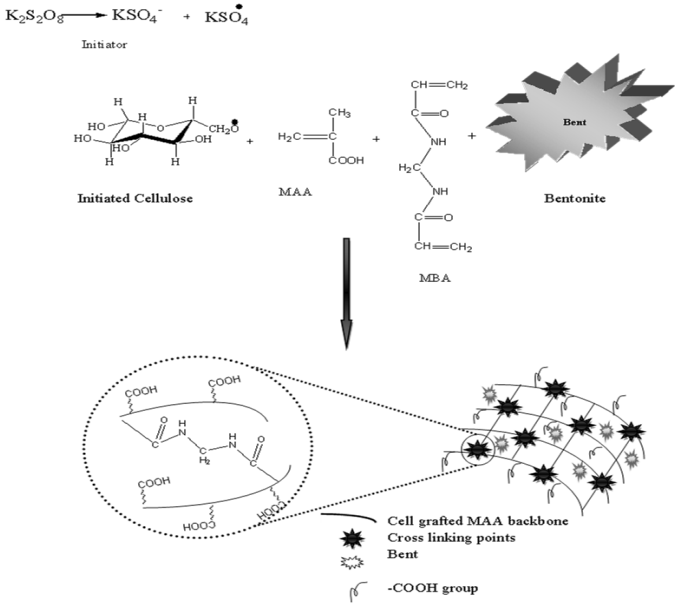
The tenure of the present Executive Committee is coming to an end. The two years of presidency was a nice experience for me. I thank all members who strived hard to make SPSI TVM Chapter one of the most vibrant scientific societies in the country. I request the members to extend similar cooperation to the new committee as well so that the efforts put forward by the founders of the Chapter be fulfilled and the vision of the Society be carried forward.

I wish all the SPSI members a fruitful year 2014.

(Dr. C.P Reghunadhan Nair
Group Director, PSCG, VSSC, Trivandrum and President, SPSI Thiruvananthapuram Chapter)

Cellulose-Based Graft Copolymers .....(contd. from Page 1)

loses in cell wall of woody plants [2]. The multiple hydroxyl groups on the glucose from one chain form hydrogen bonds with oxygen atoms on the same or on a neighbor chain, holding the chains firmly together side-by-side and forming microfibrils with high tensile strength.



Proposed reaction mechanism for the preparation of PMAA-g-Cell/Bent

Cellulose being rigid, highly crystalline, and insoluble in common organic solvents is an ideal structural engineering material. However, poor mechanical strength, lack of physical stability and microbial contamination act as a barrier to perform desired applications. To overcome such drawbacks, the controlled physical and /or chemical modification of the cellulose structure is necessary. Chemical modification can be used to vary certain properties of cellulose such as its hydrophilic or hydrophobic character, water sorbency, elasticity, adsorptive or ion exchange capability, resistance to microbiological attack and thermal resistance[3]. The β-D-glucopyranose units which make up the cellulose chain contain one primary hydroxyl group and two secondary hydroxyl groups. During modification, functional groups may be attached to these hydroxyl groups. Methods widely used to improve the properties include: (i) Densification (ii) Etherification (iii) Esterification (iv) Cross linking and (v) Graft copolymerization.

Among these, graft copolymerization (GC) technique offers an attractive and versatile means of imparting a variety of functional groups to a polymer. GC is a process in which side chain grafts are covalently attached to a main chain of a polymer backbone to form branched copolymer. Polymer materials with valuable properties can be achieved via GC by changing the parameters such as the polymer type, the degree of polymerization and the polydispersities of the main chain and the side chains, the graft density and the distribution of the grafts. Also the graft copolymerization reaction onto cellulosic material offer advantages such as chemical resistance, radiation stability and low-cost of production over conventional ion exchange method. The graft copolymerization reaction in the cellulose can be done by employing various polymer reaction mechanisms such as Free radical polymerization, Ionic and ring opening polymerization and living radical polymerization. Compared to the three polymerization techniques explained, free radical polymerization process proved to be more effective and useful in its simple mechanism and cost effective methodologies involved. Free Radical polymerization is a chain reaction process, consisting of mainly three steps: initiation, propagation and termination. Various methodologies including high energy radiation, photochemical and chemical initiation techniques have been used to activate or initiate the backbone cellulose polymer [4]. Free radicals are formed on the cellulose molecules either by decomposition of a chemical initiator, ultraviolet (UV) light or high energy radiation.

Environmental and Biomedical Applications

The recovery of uranium from natural sea water and industry wastewater is a challenging problem for chemists because uranium is one of the important resources to secure energy. Moreover based on the fundamental principles of radioactive waste management, uranium waste minimization should be done in an effective manner. Hence adsorption/recovery of uranium is important in terms of purification, environment, and radioactive waste disposal purpose [5].

Interpenetrating Polymer Network (IPN) hydrogels are one of the most promising types of 3-dimensional cross-linked hydrophilic polymeric networks being used for various applications. IPNs are the association of two or more independent polymer networks which uses both natural and synthetic polymers. A novel IPN, poly(methacrylic acid)-grafted- cellulose/ bentonite (PMAA-g-Cell/Bent) was prepared and its efficiency in removing U(VI) was tested by batch adsorption technique [6]. Homogenous graft copolymerization of the MAA onto the Cellulose backbone was carried out using K2S2O8 as a radical initiator and MBA as a crosslinking agent. The adsorbent was characterized by FTIR, SEM-EDS, and XRD analyses. The adsorption conditions for the adsorbent were optimized by varying several experimental parameters such as pH, contact time, and initial sorbate concentration of the solution. Repeated adsorption-desorption study showed that PMAA-g-Cell/Bent IPN can be effectively used as an adsorbent for the removal and recovery of U(VI) from aqueous solutions.

Cellulose has two distinct regions, the crystalline zone and the amorphous zone. Chemical reactions generally do not take place on the crystalline region of cellulose, while the incorporation of a densifying agent on cellulose should affect the crystalline structure making it suitable for activation reaction and makes it possible to take the advantage of high porosity, hydrophilicity, chemical modifiability, regular spherical shape, particle size, high density and mechanical strength [7]. Over 70 million people in Bengaladesh and in other regions of Indian subcontinent are routinely exposed to Arsenic poisoning through drink-

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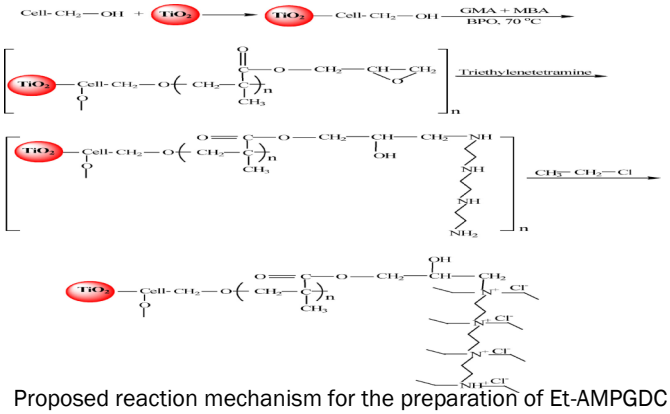
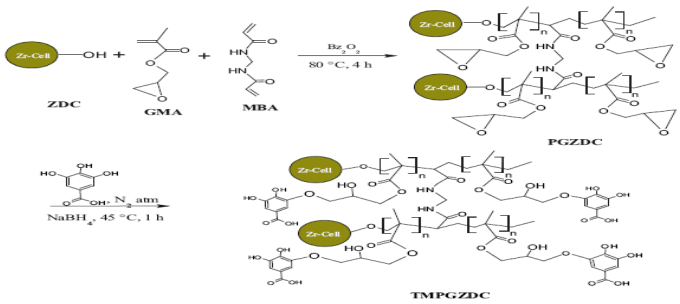
Cellulose-Based Graft Copolymers .....(contd. from Page 1)



Proposed reaction mechanism for the preparation of Et-AMPGDC

ing of ground water. Arsenic poison through ground water also observed in Mongolia in China and Japan. Toxicity of arsenic is in two ways: (i) inacti-

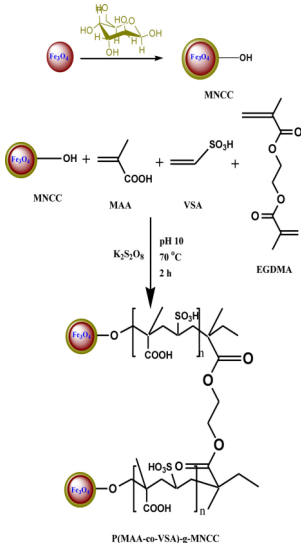
ceramic and high quality lenses. The accidental release of thorium from industries may increase its amount in the environment. Long-term exposure to thorium increases the chances of developing



Proposed reaction mechanism for the preparation of TMPGZDC

vation of pyruvate dehydrogenase by complexation with arsenic whereby generation of ATP is prevented (ii) phosphorylation reaction replaced by arsenolysis. Due to their high toxicity and to the widespread of their emissions, arsenic and its compounds are strictly controlled by environmental regulations all over the world. An Amino Functionalized Poly (Glycidylmethacrylate)-Grafted–Titanium Dioxide Densified Cellulose (Et-AMPGDC) was prepared for the Adsorptive Removal of Arsenic(V) from Aqueous Solutions [8].Thorium (Th(IV)), the most abundant heavy metal, has been widely used in nuclear fuel industry, catalysis, high temperature

lung diseases and lung, pancreas and bone cancers. The recovery of



Proposed reaction mechanism for the preparation of P(MAA-co-VSA)-g-MNCC

thorium for solving energy crisis and its effective removal to protect our environment are needed, which is a challenging problem for chemists. A novel adsorbent, tannin-modified poly (glycidylmethacrylate)-grafted zirconium oxide densified cellulose (TMPGZDC) was prepared for the recovery/removal of both BSA and Th(IV) from aqueous solutions [9]. The selective separation of biomolecules such as proteins from mixtures is a challenging problem faced in biotechnological and biomedical fields. To date, various methods have been developed for the separation of proteins, including ultra filtration, electrophoretic separation, liquid chromatography, adsorption, and membrane chromatography. Among these, adsorption is considered to be an effective technique in the selective separation of proteins. Graft copolymerization can be used for further improving mechanical strength, thermal stability and hydrophilicity, and tailoring of desired functionalities in the polymer which will help in the targeted extraction of proteins from mixtures. The encapsulation of magnetic nanomaterials like Fe3O4 in the polysaccharide matrix will increase the biocompatibility, colloidal stability, the surface to volume ratio and makes the particles for use in adsorptive separation. Nanosized magnetite (Fe3O4) particles are the most commonly used carriers for the extraction of biologically active compounds owing to their higher saturation magnetism, low toxicity, larger specific surface area and easy manipulation of surface modification. The magnetic properties of the Fe3O4 will enable to achieve the rapid separation of the adsorbent in magnetic field, via magnetic fishing. A novel multi-component super-absorbent composite poly (methacrylicacid-co-vinyl sulfonic acid)-grafted magnetite nanocellulose composite (P(MAA-co-VSA)-g-MNCC) was prepared for the selective separation of Hemoglobin (Hb) from mixture of proteins [10]. The investigation shows the stabilized performance of the P (MAA-co-VSA)-g-MNCC in several cycles for the selective recovery of Hb from mixture of proteins.

References

[1]. Nevell TP &Zeronian SH Cellulose chemistry and its applications. Ellis Horwood, Chichester York, 1985.

[2]. Klemm D, Phillip B, Heinze T, Heinze U & Wagenknetch W Comprehensive cellulose chemistry, vol 2. Wiley, Weinheim, 1998.

[3]. Khalil EMA & El-Wakil NA (2000) Infrared absorption spectra of cyanoethylated cellulose fibers. Cellulose Chem Technol 34:473–479.

[4]. Bhattacharya, A & Misra, B. N., Progress in Polymer Science, 29, 2004, 767-814.

[5]. Kilislioglu, A and Aras G., Applied Radiation and Isotopes 68, 2010, 2016-2019.

[6]. Anirudhan, T S., Tharun, A R., Rijith S, & Suchithra, P S., Journal of Applied Polymer Science 122, 2011, 874-884.

[7]. Debashish R , Mona S , James T. G & Sébastien P., Chem. Soc. Rev., 38, 2009, 2046 -2064

[8]. Anirudhan, T S., Nima, J., Sandeep S & Redheesh V R N., Chemical Engineering Journal 209, 2012, 362-271.

[9]. Anirudhan, T S & Rejeena S R., Industrial and Engineering Chemistry Research 50, 2011, 13288-13298.

[10]. Anirudhan, T S & Rejeena S R , Carbohydrate Polymers 93, 2013, 518– 527.

Plastronics through kaleidoscope

Dr. J. D. Sudha, NIIST, Thiruvananthapuram

Introduction

Plastronics also known as plastic electronics deals with electrically conductive polymers that represent an important class of functional materials for the next generation electronic and optical devices. They promise to be the most fascinating material due to their mechanical flexibility, compatibility with flexible substrate, low cost processing, lightweight and reel-to-reel printing technology. Their electronic and processing properties can be tuned by chemical design and synthesis. Plastronics place a crucial role in the design and development of flexible ,cheaply and environmentally friendly functional devices and innovative products: energy generation, telecommunications; aerospace, land transportation, storage, processing and transmission of information, healthcare, security, sensors and so forth. The printable electronics has an innovative platform supplementing and complementing current silicon-based electronics, allowing significantly more diversified product. The present article comprises a brief description about nanostructured conjugated polymers/oligomers, and their applications and finally an overview of the market status.

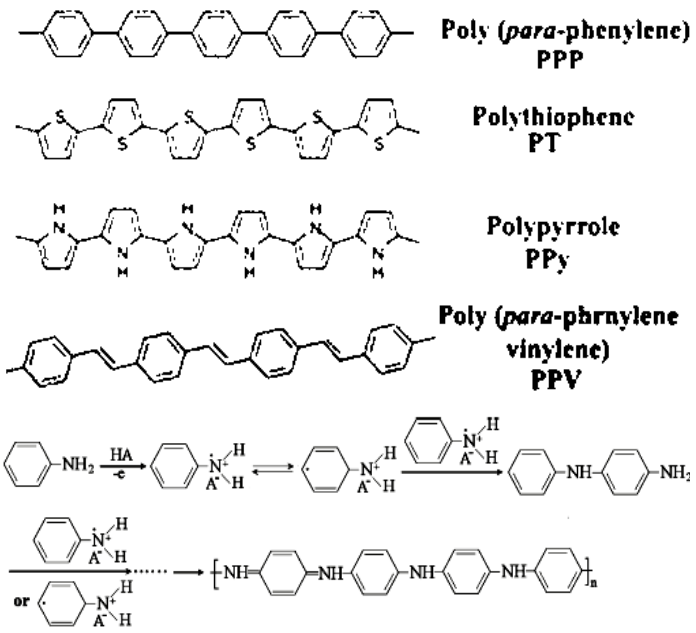


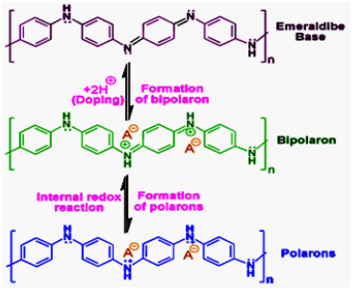
Figure1. Structure of common conducting polymers & scheme for the chemical oxidative polymerisation

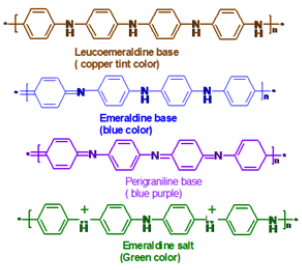
Conducting polymers

Conducting polymers represent an important class of functional conjugated organic molecules consisting of alternating single and double bonds and can conduct electricity (Figure1). Research on conducting polymer flourished after the discovery of polyacetylene which could be oxidised with halogens to produce highly conducting materials(1977). For this work, Alan J. Heeger, Alan G. MacDiarmid, and Hideki Shirakawa were jointly awarded the Nobel Prize in Chemistry in the year of 2000. They have traditionally been synthesized via chemical or electrochemical polymerization. The overall process includes the oxidation of monomers followed by the coupling of the charged monomers to produce the polymer chains (Figure 1). Chemical polymerization is advantageous for large scale production at low cost, while electrochemical polymerization offers the possibility of in-situ formation. Oxidation polymerizations with acid or peroxide initiators result in insulating materials that require a post-doping process. In electrochemical polymerisation, they can be grown electrochemically in the absence of oxidizing agents on an electrode. It is possible to tailor the polymer thickness by controlling the applied potential, polymerization time and electrolyte.

Conductivity of conjugated polymers can be increased by the process known as doping. Doping can be either oxidation or reduction (Figure 2) to produce p- and n- type semiconductors . Conjugated polymers may produce polarons and bipolarons on doping and the charged cations are not bound to each other and can freely travel along the chain to form a polaron band which is placed between the valence band and the conduction band and can almost merge with the band edges to create true metallic /semiconductivity. Based on the extent of oxidation or reduction, polyaniline can form different structures such as leuco emeraldine (copper tint color), emeraldine base (blue color), pernigraniline(purple color) and emeraldine salt (green color) as shown in the figure 2. Conductivity can be tuned from electrically insulative state to conductive state or vice versa by treating with acid or alkali as shown in figure 2. During oxidation cationic radical may form and is termed as p-type semiconductor while on reduction it may produce anionic radical which is termed as n-type semiconductor as shown in figure 2. Conduction mechanisms in such materials involves resonance stabilization and delocalization of π -electrons along entire polymer backbones, as well as mobility gaps, tunnelling and phonon-assisted hopping.

Despite the exciting results reported on these fascinating new class of plastronics, further progress was hindered by its chemical instability and intractability. Moreover, molecular weight, polydispersity, purity and chain-end functionality are the other factors that highly influences on the morphology, properties of polymers and hence performance in devices. Delicate synthetic





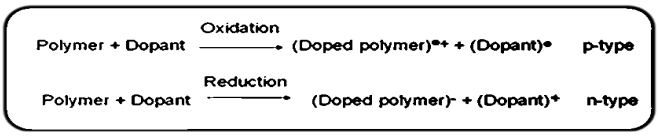


Figure 2. Doping mechanism in conducting poymers(polyaniline)

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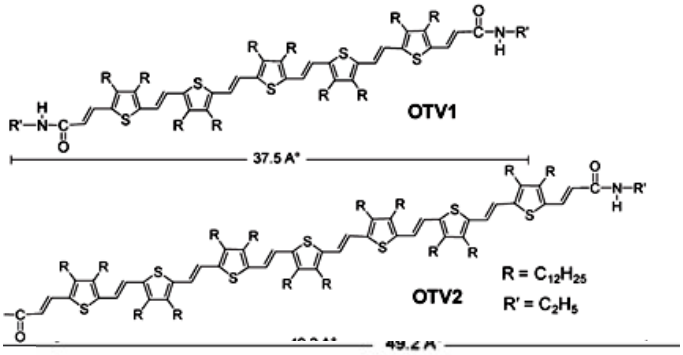
Plastronics .....(contd. from Page 4)

control is therefore demanded to ensure reproducibility between batches of materials as device characteristics which can vary greatly.

For these reasons, there is strong justification to take the oligomer approach that have been some significant on recent success. Another approach for tackling this problem is by introducing side-groups that the nature of the side groups and their position in the oligomer chain

have great advantage for controlling the electronic and charge transport properties . Three dimensional order in oligomers can be achieved through judicious regio-positioning and spacing of these side groups, giving rise to unprecedented order in conjugated oligomers through self-



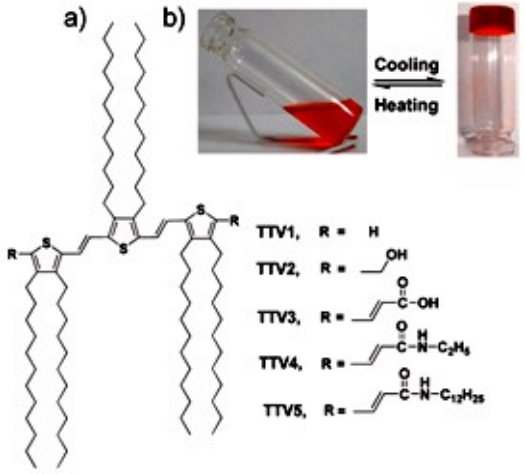


Figure 3 Effect of solvent and substitution on the self-assembly process in π-conjugated oligomers . with its mage taken under atomoc force microscope showing epitaxial arrangement of aggregates

that facilitate solvent interactions. Ajayaghosh et al (Ref.1) developed substituted oligothiophene and demonstrated it as an active material in photovoltaics with excellent microwave conductivity (Figure 3). Solubilising groups were thought to be detrimental to charge transport properties. It was also found

assembly process. A review describing various modes of molecular self-assembly which helped in the evolution and formation of variety of soft functional materials that can be used in advanced plastronics was recently reported. (Ref.2)

A promising strategy for enhanc-

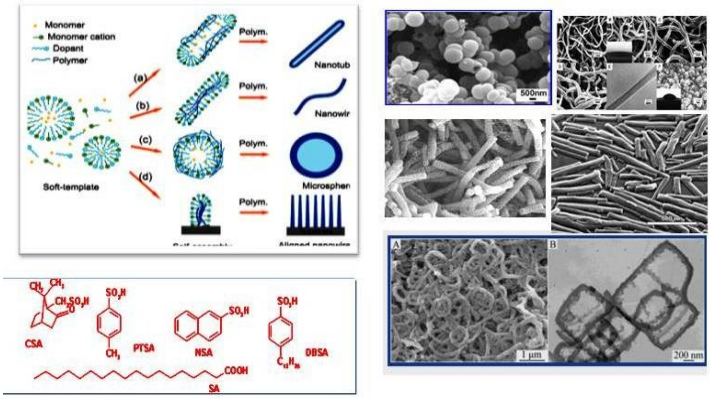


Figure 4. Formation of various shapes of micelles which will act as template during formation of different shpes of conducting polymers. Chemical structure of amphiphilic dopants

ing and controlling the property of conducting polymers is to confine them in nanometer regime. They are receiving much importance due to their uniqueness and high performance arising from their nanosize, large surface area and better dispersibility, electroactive surface area, improved charge and mass transport transfer properties which significantly enhances their performance characteristics in various devices. Literature reveals that conducting polymers with nanoscale morphologies including tubes, wires and fibres can be constructed by either self-assembly cum template approach for the fabrication of electronic devices (Figure 4). Usually, templates based on liquid crystals or surfactants may be used which will form micelles of various shapes such as spherical, tubular, cylindrical etc. depending on the functionality of the surfactant molecule.(Figure 4) Template can act as a nanoreactor for controlling the size and shape of the molecules formed. Surfactant molecules of long chain fatty acids are reported as template which can play dual function of structure directing agent and dopant. Development of nanostructured polyaniline wires /strips though self-assembly process using amphiphilic dopant developed from cashew nut shell liquid as soft template have been reported from our group. (Ref.3) We have studied the effect of functionality of amphiphilic dopant in controlling the nucleation and growth mechanism during the formation of micro/ nanostructured polyaniline. Results manifested from various studies suggested that fibrillar morphology arises from the heterogeneous nucleation followed by an indefinite growth mechanism whereas rod-like structures were formed through homo-nucleation followed by an anisotropic growth mechanism. (Ref. 4) The behavior, function and efficiency these semiconductor films involve several factors: HOMO–LUMO energy levels, crystallinity, dimensionality, reorganization, processability, functionality, interactions at interfaces, directional alignment etc..

Applications of Plastronics

There are numerous applications associated with these materials: electrochromic devices, biosensors, chemical sensors, energy storage devices/batteries and organic field effect transistors, OLEDs , solar cells, printed displays, actuators and EMI/electrostatic discharging materials.

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Plastronics .....(contd. from Page 5)

Recent developments in ink-jet - micro-contact printing, and other soft lithography techniques have improved the potential of conjugated polymers for low-cost fabrication of large-area integrated devices on both rigid and flexible substrates.

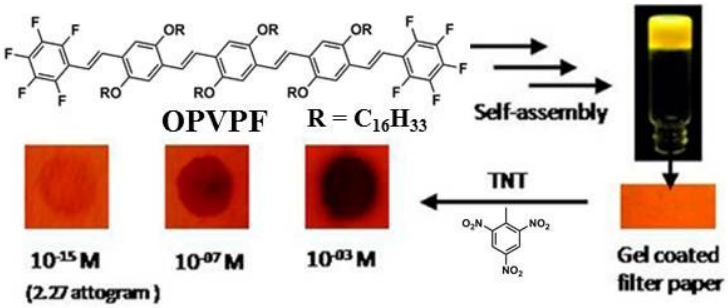

Figure 5. Oligphenylevinylene based fluorescent gel coated paper strips based chemosensor for the sensing of TNT in attogram level(Ajayaghosh et al.)

Sensors

Conducting polymers can exhibit electronic, magnetic and optical properties of metals and semiconductors while retaining the attractive mechanical properties and processing advantages of polymers. These features, along with chemical sensitivity, room temperature operation and tunable charge transport properties have positioned them as a major class of transducers, creating powerful thin/thick film sensors for over two decades.

Chemosensors

The basic strategy for the design of a chemosensor is to connect a molecular recognition site (receptor site) with a signaling unit in such a way that these two functional components communicate. Chemical sensors effectively mimic natural systems and can find many applications in the detection of pollutant and chemical warfare agents as well as bioimaging. In such a system, a binding event between the receptor site and a target analyte triggers a change in the measurable properties of the materials. The factors that can be modified by molecular design are (1) the affinity between the receptor site and the target analyte (i.e. binding constant and selectivity) and (2) the transduction efficiency of the binding event into an observable signal. In practice the signal can be optical (fluorescence, absorption) or electrical (redox, capacitance, resistive) and the medium can be molecular or a collective material. Development of new approaches for the rapid and sensitive detection of explosives such as 2,4,6-trinitrotoluene in subfemto gram level is important in the area of molecular sensors.

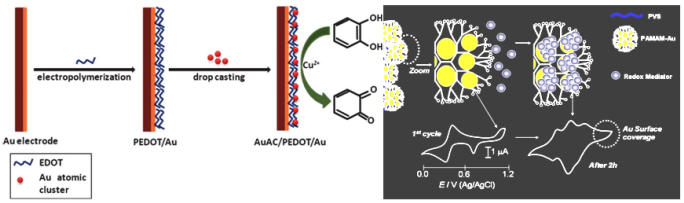

Figure 6. Construction of electrochemical based on PEDOT modified gold electrode AuAC/PEDOT/Au electrochemical sensor for the detection of catechol.

Since these explosive materials are of a major threat to homeland security and public safety. Fluorescence-quenching technique has been demonstrated by Dr. Ajayaghosh et al using a fluorescent gel coated on a disposable paper strips which could detect TNT in attogram level with a detection limit of 0.23 ppq. Figure 5 shows the chemical structure of OPV and the formation of fluorescent OPV gel paper strip coated paper acting as a chemosensor for the detection of TNT in attogram level.

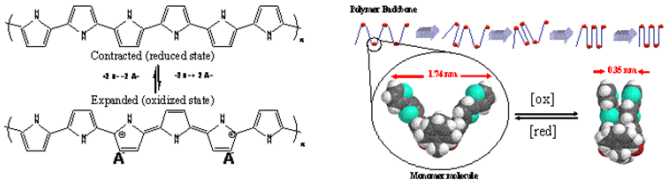

Figure 7.Schematic diagram showing how dimensional change is happening during oxidised and reduced state in polypyrrole based actuator.

Electrochemical sensor:

Electrochemical methods for the estimation of analytes have been greatly preferred during recent years due to their simplicity, accuracy, reproducibility, specificity for various chemical and biological species and are adaptable to even small sample volumes. The main drawback in this approach is represented by the high over potential needed for analytes to undergo oxidation at which many electro active substances usually present in real samples could also be oxidised to interfere. One of the most common ways to overcome this problem has been the use of modifiers which allows the direct electron transfer between its active site and the electrode surface. Among the various mediator modified electrodes, conducting polymer modified electrodes have been widely used for the immobilization of mediators. These electrodes exhibited a good stability and catalytic effects resulting from their three-dimensional mediator distribution. A variety of sensors have been formulated using conducting polymers in different transduction modes. The transduction modes can be divided into five main classes based upon the operating principle into conductometric, potentiometric, amperometric, colorimetric, and gravimetric modes. There are many approaches for increasing the sensitivity/selectivity of conducting polymers to analytes by the incorporation of synthetic or natural receptors. One such approach is the incorporation of metal nanoparticles into the conducting polymers. The porous structure of conducting polymer allows dispersing the metal nanoparticles into the polymer matrix and generates additional electrocatalytic sites. Figure 6 shows the construction of electrochemical based on PEDOT modified gold electrode for the detection of catechol.

Actuator

Electrochemically changing oxidation state leads to the addition or removal of charge from the polymer backbone and flux of ions to balance charge . Figure 7 shows the mechanism in actuator show-

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Plastronics .....(contd. from Page 6)

ing how dimensional change is happening during oxidisesd and reduced state in polypyrrole. This ion flux, which can be accompanied swelling or contraction of the material. Insertion of ions between polymer chains appears to be primarily responsible for dimensional changes, although conformational changes of the backbone and solvent flux may also play a role.

Solar cell

Photovoltaics (PV), the technology that directly converts daylight into electricity. At present, the active materials used for the fabrication of solar cells are mainly inorganic materials, such as silicon , gallium-arsenide , cadmium-telluride, and cadmium-indium-selenide. The large production costs for these inorganic materials based solar cells is one of the major obstacles. Polymer solar cells have attracted considerable attention in the past few years owing their potential for providing environmentally safe flexible, light weight , inexpensive , efficient solar cells. Especially bulk -heterojunction solar cells consisting of a mixture of conjugated polymer with a methanofullerne acceptor are considered as promising approach. The interest in the research on polymer solar cell is evidenced from the increasing number of publications ie more than 2500 publications by 2011 obtained from web of science. In the last five years there has been an enormous increase in the understanding and performance of polymer-fullerene bulk heterojunction solar cells. Comprehensive insights have been obtained in crucial materials parameters in terms of morphology, energy levels, charge transport, and electrode materials. To date, power conversion efficiencies close to 3% are routinely obtained and some laboratories have reported power conversion efficiencies of ~4–5 and now aim at increasing the efficiency to 8–10%. By combining synthesis, processing, and materials science with device physics and fabrication there is little doubt that these appealing levels of performance will be achieved in the near future.

In general, for a successful organic photovoltaic cell four important processes have to be optimized to obtain a high conversion efficiency of solar energy into electrical energy. Schematic diagram showing the four process are given in Figure 10. Absorption of light- charge transfer - separation of the opposite charges- charge transport- charge collection. For an efficient collection of photons, the absorption spectrum of the photoactive organic layer should match the solar emission spectrum and the layer should be sufficiently thick to absorb all incident light. For an efficient charge generation, it is important that the charge-separated state is the thermodynamically and kinetically most favorite pathway after photo excitation. Therefore, it is important that the energy of the absorbed photon is used for generation of the charge separated state and is not lost via competitive processes like fluorescence or non-radiative decay. In addition, it is of importance that the charge-separated state is stabilized, so that the photogenerated charges can migrate to one of the electrodes. Therefore, the back electron transfer should be slowed down as much as possible. The photogenerated charges are then transported and collected at opposite electrodes. New combinations of

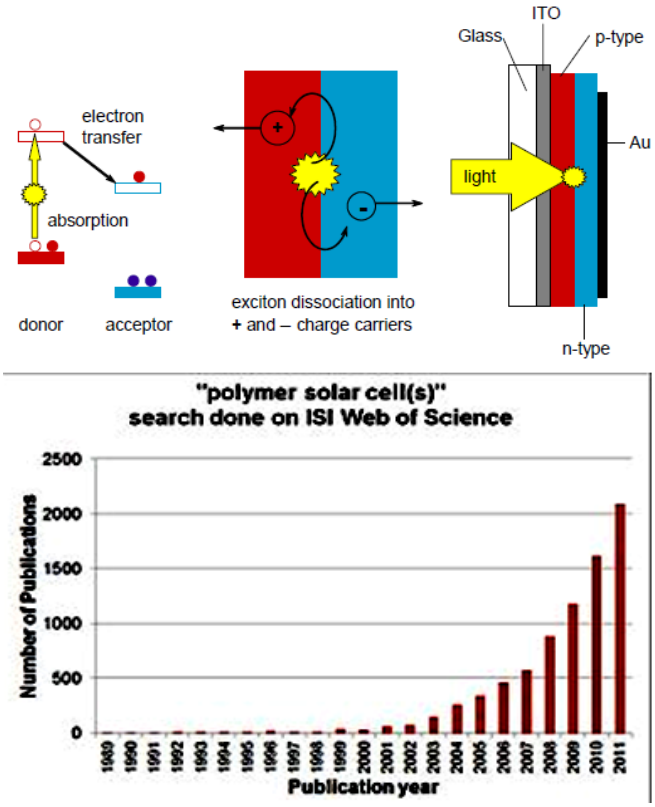

Figure 8. Schematic representation of the events in photovoltaics and the number of publications appearing per year obtained from web of science

materials that are being developed in various laboratories focus on improving the three parameters that determine the energy conversion efficiency of a solar cell, i.e. the open-circuit voltage (Voc), the short-circuit current (Jsc), and the fill factor that represents the curvature of the current density-voltage characteristic. For ohmic contacts the open-circuit voltage of bulk-heterojunction polymer photovoltaic cells is governed by the energy levels of the HOMO and the LUMO of donor and acceptor, respectively. One of the crucial parameters for increasing the photocurrent is the absorption of more photons. This may be achieved by increasing the layer thickness and by shifting the absorption spectrum of the active layer to longer wavelengths.

Figure 8 shows the schematic representation of the events in photovoltaics and the number of publications appearing per year obtained from web of science However, polymer solar cells suffer from environmental degradation owing the lack of effective protective coatings. Novel molecular chemistry and materials offer hope for revolutionary, rather than evolutionary, breakthroughs in future device efficiencies.

Organic light emitting diode(OLED)

OLED is a light-emitting diode in which the emissive electroluminescent layer is a film of organic compound which emits light in response to an electric current. This layer of organic semiconducor is situated between two electrodes. The first observation of electroluminescence in organic materials reported in the early 1950s by André Bernanose at the

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Plastronics .....(contd. from Page 7)

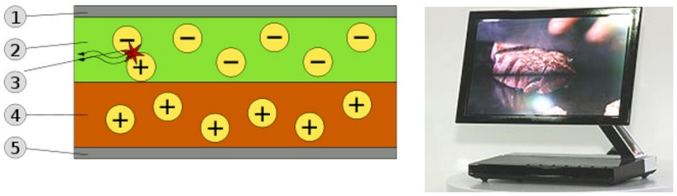


Figure 9. Schematic representation of mechanism in OLED and can be used as a display in TV screens

Nancy-Université, France in acridine orange. The first diode device was reported at Eastman Kodak by Ching W. Tang in 1987. This device used a novel two-layer structure with separate hole transporting and electron transporting layers such that recombination and light emission occurred in the middle of the organic layer. This resulted in a reduction in operating voltage and improvements in efficiency and led to the current era of OLED research and device production. Research into polymer electroluminescence culminated in 1990 with J. H. Burroughes et al. at the Cavendish Laboratory in Cambridge reporting a high efficiency green light-emitting polymer based device using 100 nm thick films of poly (p-phenylenevinylene). OLEDs are used to create digital displays in devices such as television screens, computer monitors, portable systems such as mobile phones, hand held games consoles and PDAs. Figure 9 shows the schematic diagram of a representative OLED which can be used in television screens. Printing or solution processing is the only fabrication technology that can bring the cost of OLED lighting down to a level where it would become a widely affordable alternative to other forms of lighting in the home or office. Electroluminescent lighting is a form of screen printed lighting that has been used for many years in automotive dashboard and exit signs. The first LED TV was introduced in 2009 today over 40 percent of LCD TVs feature LED backlighting technology.

Organic Thin Film Transistors

Organic thin film transistors are the basic building blocks for flexible integrated circuits and displays. The semiconductor material for a fast switching transistor should have high charge carrier mobility and on/off current ratio. It is also important that the semiconductor thin film has large, densely packed and well-interconnected grains. There are two types of organic semiconductors based on the type of charge carriers: p-type (holes as major charge carriers) and n-type (electrons as major charge carriers). To facilitate charge transport, the π-π stacking direction should ideally be along the current flow direction. This requires the semiconductor molecules to self-assemble into a certain orientation upon either vapour or solution deposition.

Electrochromic devices for smart windows and flexible displays.

Conducting polymers are one of the most attractive electrochromic materials because of the advantages such as high coloration efficiency, rapid switching ability and diverse colours. The electrochromism of conducting polymers is based on reversible redox reactions accompanying ion exchange. The switching time is mainly affected by redox reaction efficiency, which depends on the ion diffusion rate and conductivity. Stability, rapid response times, and efficient colour changes are still critical parameters that need improvement.

Electronic paper and Printed electronic interactive drum poster

Electronic paper and electronic ink are display technologies which are designed to mimic the appearance of ordinary ink on paper. Unlike conventional backlit flat panel displays which emit light, electronic paper displays reflect light like ordinary paper, theoretically making it more comfortable to read, and giving the surface a wider viewing angle compared to conventional displays. An ideal e-paper display can be read in direct sunlight without the image appearing to fade. Many electronic paper technologies can hold static text and images indefinitely without using electricity. Flexible electronic paper uses plastic substrates and plastic

Figure 10. Picture showing plastic solar panels, e-paper , printed lighting , smart blister packaging in pharmaceutical companies, soft plastronic battery

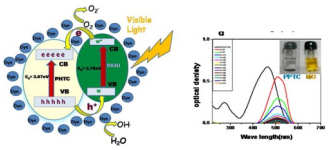


Figure 11. Photo catalytic activity of polyaniline- titanate nanocomposite for the degradation of dyes . Degration kinetics studied using .UV- vis spectra of methyl orange taken at different intervals of time

electronics for the display backplane. Picture showing plastic solar panels, e-paper , printed lighting , smart blister packaging in pharmaceutical companies, soft plastronic battery depicted in Figure 10.There is ongoing competition among manufacturers to provide full-colour ability. Applications of electronic visual displays include electronic pricing labels in retail shops, and digital signage, time tables at bus stations, electronic billboards, mobile phone displays, and e-readers able to display digital versions of books and e-paper magazines.

Printed interactive capacitive touch using conductive ink that transforms a simple graphic into a fully interactive audio poster. They will also be tweeting live from a self-adhesive label and introducing an interactive poster that has been produced using conductive ink systems that incorporate graphene to lower the sheet resistance.

Security Applications

Printed smart labels with electronic functions can help to protect products from counterfeiting or grey-market re-selling. Smart labels and security features on plastics and paper can enable traceability throughout the whole supply

Contd. in Page 9

Plastronics .....(contd. from Page 8)

chain. The labels could be applied by printing technologies directly during the production of the packaging or high value paper based items. Customized formulations based on Clevios™ are available for a range of security applications.

Photocatalyst

Conducting polymers (p-type) with wide band gap inorganic semiconductors (n-type) are receiving importance for photocatalytic applications. Photocatalytic activity of conducting polymer- titania composite in which p-n junctions could be realized by intercalating p-type conducting polymer into the n-type polytitanate. The mechanism for the photo degradation of dyes in presence of conductive nanocomposite can be explained as per the schematic representation given in figure 11. When PPTC is illuminated under natural light, both PHTC and PANI absorb photons and charge separation occurs at the interface. Since the conduction band of PHTC and the lowest unoccupied molecular orbital (LUMO) level of PANI are well matched for the charge transfer. The generated electrons from PANI can be transferred to the conduction band of PHTC, whereas holes in the valence band of PHTC are transferred into the PANI, and enhancement in the charge separation occurs and promoting the photocatalytic activity of photocatalyst. The Ti–OH groups are effective traps for the photogenerated holes, reducing their recombination with the electrons, and the surface OH groups allow the adsorption of O2 from water. Then, the photoformed electrons reduce O2 to O2- species, which in turn can interact with water to form further oxygenated radicals (mainly hydroxyl radicals .OH). Consequently, the presence of Ti–OH groups may improve the photocatalytic activity of PPTC by both photooxidation and photosensitizing mechanisms. Studies revealed that this multifunctional PPTC nanocomposite with higher photocatalytic efficiency will be a potential candidate for environmental purification under visible light at ambient conditions(Ref.6).

Electromagnetic interference shielding materials

Electromagnetic interference shielding and electrostatic dissipating materials are receiving enormous attention recently due to the rapid proliferation of miniaturised portable electronic devices , display devices and telecommunication systems. The spurious unwanted electromagnetic radiations emitted by these electronic devices may be harmful for the human brains and also electronic devices exposed to these radiations. So these electromagnetic radiations should be shielded before reaching to us . Depending upon the shielding efficiency of these composite materials, they may be used for the encapsulation of different microelectronic devices, computer housings, switches, connector gaskets etc. The required conductivity levels are approximately 10-3-10-7 Sm-1 for electrostatic dissipating and greater than 10-2 Sm-1 for electromagnetic shielding applications. Electromagnetic composites are novel class of materials that combine the mechanical properties electrical and magnetic properties of conducting polymers, ease of processability, low density and corrosion mechanism and unique shielding mechanism of absorption makes it as a suitable candidate for the fabrication of EMI shielding materials. Our group (Ref.7) have successfully developed electromagnetic shielding material from the conductive blends of polystyrene/polycarbonate/ethylene vinyl acetate/polyvinyl chloride and nanostructured electromagnetic nanocomposite based on polyaniline -iron-clay which were prepared from a low cost renewable resource based amphiphilic dopant.

Development of nanostructured electro-magnetic polymer composites with electric and magnetic properties endowed with high mechanical strength and thermal stability are challenging because of their ease of processability, light weight and so forth. We have demonstrated the preparation of water dispersible nanostructured electro-magnetic polyaniline-laponite-keggin iron cation composite by the oxidative radical emulsion polymerization of aniline in presence of aqueous dispersion of keggin iron intercalated laponite at with electrical conductivity of ~ 10-2 S/cm, saturation magnetization was found to be ~ 7emu/g and thermal stability ~ 300 °C.

Summary

In summary, significant progress has already been made in the field of Plastronics which are the promising candidates for future the flexible electronic devices. However, better understanding of the structure- property relationship is still needed so that we can rationally design materials to achieve desired device performance parameters. One day soon, these attributes may enable disposable tags made from field-effect transistors, large-area photovoltaic cells painted on building roofs and economically replaced every year to match colour preferences of home owners. The impact of research on plastronics made generation of extremely impressive with some quite mouth-watering products in the market such as large screen OLED televisions with a mere width of 4 mm, foldable smart phones with even thinner dimensions and artificial skin made from OFETs that respond to mechanical and chemical stimuli. It can be summarised that plastic electronics is predicted to be a multibillion pound industry in the short term and that the field is rich in yet unaddressed challenges that will push the boundaries of our imagination much, much further by the progress being made by the multidisciplinary research teams in industry and academia. For me it is a treat to be part of the large community that is helping to progress the field which was truly kick-started by the seminal work of MacDiarmid and his colleagues. The future in plastronics are expected based on solution based printed devices on flexible substrates. Considerable progress is made over the last 12 months in processing printed sheet-to-sheet or roll-to roll photovoltaics and integrated systems.

References.

1. Prasanthkumar, A. Gopal, A. Ajayaghosh, J. Am. Chem. Soc.2010, 132, 13206 – 13207.

2. S. S. Babu, S. Prasanthkumar and A. Ajayaghosh, Angew. Chem. Int. Ed. 2012, 51,. 1766 – 1776.

3. V.L. Reena, C. Pavithran, V. Verma, J. D. Sudha, J. Phys. Chem. B, 2010, 114, 2578-2585

4. J. D. Sudha & S. Sivakala, Colloids and Polymer Science, 2009, 287, 1 347.

5. K. K. Kartha, S. S. Babu, S. Srinivasan, A. Ajayaghosh, J. Am. Chem. Soc. 2012, 134, 4834.

6. Rajaraman Ramakrishna, J.D. Sudha*, and Viswan L.Reena, RSC Advance. RSC Adv., 2012, 2 (15), 6228 – 6236.

7. J. D.Sudhaa, Andrij Pich b, Sarojam Sivakalaa, Viswan L. Reena , Hans-Juergen P. Adler , J.Mater.Chem. 2011, 21, 16642

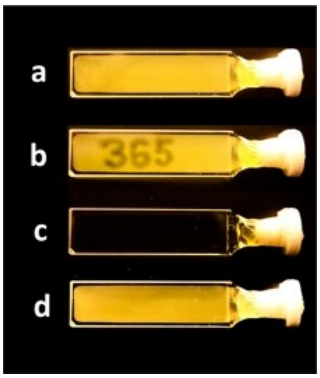
Polymer cis-trans isomerism to write on water

Now we can write on liquids– literally. University of Helsinki researchers have manufactured photochemically active polymers which can be dissolved in water or certain alcohols. Vladimir Aseyev and his colleagues at the University of Helsinki used a 365-nm laser to aim at a solution into which the polymer was partially dissolved. When exposed to light, the polymer switched to its cis conformation, dissolving completely and leaving a clear form which was visible in the cloudy solution.

The polymer under investigation was based on poly (azocalix[4]arene). Scientists found that the two isomers of this polymer have different solubility parameters at the same temperature. For example, at 20 °C, the trans form is barely soluble in ethanol, but the cis isomer dissolves easily. The azobenzene groups in these polymers' backbones cause the polymer to switch between a cis and trans isomer when excited by light.

As the two conformations are different in solubility, a ray of light can "draw" in an ethanol-based dispersion of the polymer. The switch from trans to cis happens in the entire polymer chain. This effect where light causes the polymer to dissolve completely and be made visible can last several hours depending, for example, on the concentration of the solution.

Macromolecules 2013, 46 (15), pp. 6209



(a) light sensitive polymer dispersed in alcohol

(b) Letters traced using 365 nm laser

(c) Mixture heated at 40 °C

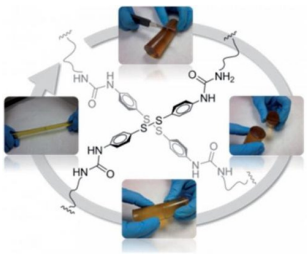
(d) Cooling to 20 °C erases the characters.

Courtesy: Chemical and Engineering News

Self-healing polymer that spontaneously and independently repairs itself

Scientists in Spain have reported the first self-healing polymer that spontaneously and independently repairs itself without any intervention. The new material could be used to improve the security and lifetime of plastic parts in everyday products such as electrical components, cars and even houses. The researchers have dubbed the material a 'Terminator' polymer in tribute to the shape-shifting, molten T-100 terminator robot from the Terminator 2 film.Self-healing polymers that can spontaneously achieve quantitative healing in the absence of a catalyst have never been reported, until now. The scientists prepared the self-healing thermoset elastomers from common polymeric starting materials using a simple and inexpensive approach. the permanently cross-linked poly(urea-urethane) elastomeric network completely mends itself after being cut in two with a razor blade. A metathesis reaction of aromatic disulphides, which naturally exchange at room temperature, causes the regeneration.

The polymer behaves as a Velcro-like sealant or adhesive, displaying an impressive 97 per cent healing efficiency in just two hours. The fact that poly(urea-urethane)s with similar chemical composition and mechanical properties are already used in a wide range of commercial products makes this system very attractive for a fast and easy implementation in real industrial applications.



A Rekondo et al, Mater. Horiz., 2014. DOI: 10.1039/C3MH00061C

Ultra-sensitive polymer that detects explosive devices

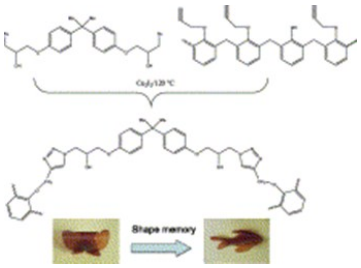
The polymer, which potentially could be used in low-cost, handheld explosive detectors and could supplement or replace bomb-sniffing dogs, was invented in the lab of William Dichtel, RDX, is an explosive material common in military and industrial applications that is also a favorite of bomb-making terrorists. It requires a detonator to explode, but when detonated, it's more powerful than TNT. What's more, RDX's vapor pressure is 1,000 times lower than TNT's, making it almost impossible to detect without direct contact with a concentrator, like the swabs used at airport security. Dichtel and graduate student Deepti Gopalakrishnan made a polymer that uses fluorescence to quickly and accurately ascertain whether RDX is present on a surface or in the air. One of the goals is to make detectors that can detect not just explosives on someone's hands, but in the cloud around them.

The researchers' work builds on a previously established technology that uses "fluorescence quenching" as the basis for detecting TNT; in the presence of the explosive, the polymer's fluorescence shuts off.The polymer has a random, cross-linked structure that allows it to absorb light and transport the resulting energy throughout its structure. After a certain period of time, the polymer releases this energy as light, as fluorescence. If the energy encounters a molecule of explosive as it travels through the polymer, it can be converted into heat instead of light, which causes the polymer to stop glowing. This design allows the polymer fluorescence to sense extremely small amounts of the explosive of interest, enabling identification of IEDs or people who have recently handled them.

(J. Am. Chem. Soc., 2013, 135 (22), pp 8357–8362)
DOI: 10.1021/ja402668e)

Shape memory polymers via click chemistry

Our chapter members introduced click chemistry for deriving shape memory polymers for the first time. Phenolic cross linked-



epoxy resin based shape memory thermoset was realized through 'click' chemistry. Towards this, propargylated novolac and bisphenol A (bis azido hydroxy propyl) ether were synthesized and co-cured by click reaction between alkyne and azide group. The triazole coupled phenolic-epoxy thermoset displayed shape memory properties with high foldability, shape fixity of 99% and shape recovery of 90% at a low transition temperature of 73 °C.

(K. Sunitha, K.S. Santhosh Kumar, Dona Mathew,C.P. Reghunadhan Nair, Materials Letters, Volume 99, 15 May 2013, Pages 101–104)

"The triazole coupled phenolic-epoxy thermoset displayed shape memory properties with high foldability.."

Dr. Ajayaghosh's invention creates headlines

Dr A. Ajayaghosh has devised a novel scientific solution based on a fluorescent material to easily identify counterfeit currency. He has applied for patent to the US and the patent office has approved its publication. Circulation of fake currency is a threat to the country's security and economy. Present invention provides a novel fluorescent molecule which exhibits emission colour change when in contact with moisture or water and it can be used to prevent fake currency and for security labeling,

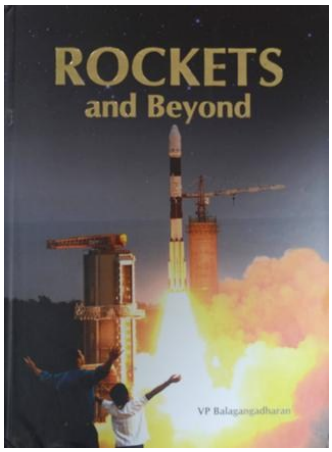
On normal paper currency, when coated with this fluorescent chemical molecule, it results in blue emitting surfaces on which writing is possible using water as ink. On moistening, blue colour turns to green and images undergo self- erasal after six hours and the colour turns back to blue if it's original. If it is a fake currency, there will be no change in colour. Possibility of using these fluorescent molecules to create Test Scrip's and cheap diagnostic kits to detect cancer and other diseases are being explored

(Excerpts from Newspaper article published in the online edition of The Times of India, October 15, 2013, written by Laxmi Ajai Prasanna, TNN. Credit goes to the author).

Dr.A. Ajayaghosh is the Vice President of SPSI Thiruvananthapuram Chapter.

Rockets and Beyond...a must read for children

Rockets have always ignited the imagination of children. But there are not many around who can adequately answer their queries on rockets and satellites. Shri V.



P Balagangadharan has in his recent book 'Rockets and Beyond' has discussed the answers to such questions elegantly with the help of eye-catching pictures.

The book is meant for children but is also equally interesting and informative for adults.

In his end-note the author says that he has been quizzed by many children while he was interacting with them during the outreach activities of Vikram Sarabhai Space Centre. The book is a collection of answers to such questions.

"The books is meant for children but is also equally interesting and informative for adults"

Rockets and Beyond was originally published by VSSC in English and Hindi and already had two reprints. It is in the process of publication by Vigyan Prasar. Malayalam version can also be expected soon.

Shri V.P. Balagangadharan is an Executive Committee member of SPSI and has been its President

In a lighter vein..... some definitions

Activation Energy: The useful quantity of energy available in one cup of coffee.

Bunsen Burner: A device invented by Robert Bunsen (1811-1899) for brewing coffee in the laboratory, thereby enabling the chemist to be poisoned without having to go all the way to the company cafeteria.

Chemical: A substance that:
1. An organic chemist turns into a foul odor;
2. an analytical chemist turns into a procedure;
3. a physical chemist turns into a straight line;
4. a biochemist turns into a helix;
5. a chemical engineer turns into a profit.

Chemical Engineering: The practice of doing for a profit what an organic chemist only does for fun.

First Order Reaction: The reaction that occurs first, not always the one desired.

Grignard: A fictitious class of compounds often found on organic exams and never in real life.

Inorganic Chemistry: That which is left over after the organic, analytical, and physical chemists get through picking over the periodic table.

Natural Product: A substance that earns organic chemists fame and glory when they manage to synthesize it with great difficulty, while Nature gets no credit for making it with great ease.

Organic Chemistry: The practice of transmuting vile substances into publications.

Physical Chemistry: The pitiful attempt to apply y=mx+b to everything in the universe.

Courtesy: http://www.jokebuddha.com/Polymer/recent#ixzz2qaATqjWn

Chapter News

Prof. Iijima felicitated

Prof. Iijima appreciated the Indian education system and forecasted big future for young researchers in India..

Prof. Iijima interacts with SPSI members

Prof. Iijima with the audience and Chapter members

It was a gratifying moment for all the SPSI members when the Thiruvananthapuram Chapter joined hands with Materials Research Society of India (MRSI), Kerala Academy of Sciences (KAS) and High Energy Materials Society of India (HEMSI) to felicitate one of the pioneers in carbon nanotube research, Prof. Sumio Iijima.

When the Chapter came to know about his travel plans to India, arrangements were made to give him a grand reception at Trivandrum. All the major scientific societies in Trivandrum joined together to make the event a memorable one. The popularity of Prof. Iijima among the scientific communities in Trivandrum was evident at the auditorium which was fully packed and many of the audience had to stand at the backside and corridors to listen to his talk. He gave a wonderful lecture on carbon nanotubes, one of the most talked after material in this century. He gave a detailed account on how the material was noticed by him in the transmission electron microscope and how he got interested in that material. He described the exceptional properties of carbon nanotube

According to Prof. Iijima, carbon nanotubes are a potential material for energy devices, drug delivery system and others. In order to tap the potential of such nanomaterials, research is required to produce them in abundance meeting the quality requirements. He also touched upon various characterization methods of carbon nanomaterials such as TEM, EELS and Raman Spectroscopy. He stressed the need for finding out the applications of these nanomaterials for the benefit of the society to exploit their right potential

He also mentioned of other forms of carbon nanomaterials such as nanohorns, nanowires and nanoonions. He talked in a lighter vein that he will not work on graphene, another important carbon nanomaterial as it is the enemy of carbon nanotube as far as research and research funding are concerned.

Prof. Iijima interacted with the audience and answered all their questions. He was felicitated by representatives of MRSI, KAS and HEMSI. Prof. Iijima appreciated the Indian education system and forecasted big future for young researchers in India. He also talked about the world class research facilities in some of the educational and research institutions in India. He assured that given an opportunity, he would visit Kerala again.

Academic and technical contributions of Chapter members

Publications

- Dr. C,P. Reghunadhan Nair has Authored 27 publications in international journals during 2013 (13 published and 14 communicated), He has also contributed 13 conference papers, 4 popular articles, 3 book chapters and is an inventor in 6 patents during the year. Two papers presented by his students in international and national conference won the best paper awards.
- Prof. T.S. Anirudhan has published 20 research papers during 2013 in peer reviewed international journals including Carbohydrate Polymers, Reactive & Functional Polymers, Separation and Purification Technology, Colloids and Surfaces B: Biointerfaces, Journal of Chemical and Engineering Data (With Cover Page). Five research students of Prof. Anirudhan, have been awarded Ph.D Degrees to during 2013.

Book chapters

1. E. Bhoje Gowd, and C. Ramesh – Crystallization and polymorphism behaviour of nylon-clay nanocomposites in J.K. Pandey, K. R. Reddy, A. K. Mohanty and M. Misra eds., Handbook of Polymer Nanocomposites: Processing, Performance and Application Chapter 12, 247-265 (2014) Springer: New York.
2. T S Anirudhan, Biopolymer–Based Stimuli-Sensitive Functionalized Graft Copolymers as Controlled Drug Delivery Systems, Chapter 12-Surface Modification of Biopolymers, edited by Vijay K. Thakur and Amar S. Singha, John Wiley & Sons, Inc., Hoboken, 2013.
3. T S Anirudhan, Synthesis and characterization of a sulfonyl-terminated polymer-grafted- magnetic nanocellulose and its application as a pH-responsive antibiotic drug carrier for the controlled delivery of ciprofloxacin Chapter 07-Cellulose-Based Graft Copolymers: Structure and Chemistry, edited by Vijay K. Thakur, Taylor & Francis, USA, 2013.
4. Dr. K. S Santhosh Kumar, Dr. Bibin John, Dr. Satheesh chandran M and Dr. C.P. Reghunadhan Nair have contributed three chapters to the book, Handbook of Thermoset Plastics (Third Edition), 2014 (Pages 45-73, 459-510 and 511-554). Editor: S. Goodman and H.D.Kenig, Publishers: Elsevier Inc.

Awards, Honors and Achievements

- The following members of SPSI got Hon Fellowship/Fellowship of the Kerala Academy of Sciences:
  1. Dr. A. Ajaya Ghosh- Honorary Fellow
  2. Dr. C P Reghunadhan Nair- Fellow
  3. Dr. C Gouri- Fellow
  4. Prof. K N Rajasekharan- Fellow
  5. Dr. Benny K George - Fellow
  6. Dr. J D Sudha- Fellow
  7. Shri M. Shaneeth-Fellow
  8. Shri N Raveendran Pillai- Fellow
- Dr. K.N.Ninan Emeritus professor, Indian Institute of Space Science and Technology (IIST) was selected for the prestigious Melpadom Attumalil Georgekutty Merit Award instituted by the Mar Thoma Church. The award, started in May, 2000, is given for "outstanding work in the field of medicine, science, science & technology and peace that has significantly contributed the welfare of humanity and nation".
- Dr. A. Ajayaghosh has been awarded TWAS Chemistry Prize 2013 by The World Academy of Sciences, Trieste, Italy and CRSI Silver Medal.
- Dr. T S Anirudhan, Professor, Department of Chemistry, University of Kerala has received Sri Chithra Prize for his contributions to Science and Technology . He has been nominated as Dean, Faculty of Science and as Director, School of Physical and Mathematical Sciences, University of Kerala
- Shri Vijendra Kumar, VSSC, has won the Best Paper Award in the International Conference: 3rd FAPS Polymer Congress and Macro 2013 for the paper titled "Combination of silane and urethane chemistry to access superhydrophobicity on calcium carbonate nanoparticles". The paper was co-authored by Dr. KS Santhosh Kumar, Dr. K.Y Sandhya and Dr. C.P. Reghunadhan Nair.
- Dr. E. Bhoje Gowd, Senior Scientist, Material Sciences and Technology Division, CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST) has been awarded the IUSSTF Research Fellowship, Indo-US Science and Technology Forum (2013-2014).
- Dr. Vidya Raj has won the gold medal for the Best Ph.D Paper, during the Annual General Body Meeting of SPSI in January 2013. She did the Ph.D under the supervision of Dr.K.Sreenivasan, Sree Chitra Tirunal Institute for Medical Sciences and Technology .
- Smt. N. Supriya, VSSC, has received the Best Oral Presentation Award for the paper presented in the 19th Symposium on Thermal Analysis (THERMANS-2013), held at BARC, Mumbai, during December 19-21, 2013.

The Society congratulates all the award winners for their wonderful achievements.

Congratulations!


Dr. K.N. Ninan


Dr. C.P. Reghunadhan Nair


Dr. A. Ajayaghosh


Dr. C. Gouri


Shri. N. Raveendran Pillai


Prof. K.N. Rajasekharan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A newsletter of the Society of Polymer Science, India, Thiruvananthapuram Chapter

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Please visit our website at www.spsitvm.org for updated information on Chapter activities, latest research findings on polymers etc.

Seminars/talks organized during 2013

- Thiruvananthapuram Chapters of Society for Polymer Science, India (SPSI), Materials Research Society of India (MRSI), Kerala Academy of Sciences (KAS) and High Energy Materials Society of India (HEMSI) jointly organized a Seminar on "Nano-Carbon: Science and Applications" by Prof.Sumio Iijima, Professor, Meijo University, and NEC Corporation and Director, Research Center for Advanced Carbon Materials, JAPAN, on 2nd March 2013.
- "Reactive Graft Copolymers of Cellulose and Chitosan with Functional Ligands for use as "Globe-Compatible Materials" in the Field of Analytical, Environmental and Biomedical Applications" by Prof. (Dr.) T.S. Anirudhan, Department of Chemistry, University of Kerala on 2nd May 2013.
- "New Approaches for the Synthesis of Thermo-responsive Shape Memory Polymers" by Dr. K. S. Santhosh Kumar, Vikram Sarabhai Space Centre, Thiruvananthapuram on 2nd May, 2013.
- "Hydrogel Sealed Vascular Prosthesis: Development and Evaluation" Speaker: Dr. Roy Joseph, Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum on 30th October 2013.
- "Polymer Bonded Explosives – An Overview" by Dr. M. Nallaperumal, Vikram Sarabhai Space Centre, Thiruvananthapuram on 30th October 2013.

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Congratulations!

SPSI Thiruvananthapuram Chapter congratulates Team ISRO for the successful launch of GSLV-D5, using the indigenously developed cryo engine, which placed India in the elite club of nations having this technology. Many of the SPSI members have contributed immensely to the Project, success of which made the nation proud. Kudos to the entire team.

The Executive Committee of 2012-'14 thank all SPSI members for their wholehearted support during the tenure. One National Seminar was conducted in addition to the regular arrangement of invited talks. The Society also joined hands with other scientific societies in Trivandrum in organizing a talk by Dr. Sumio Iijima, who contributed immensely to the research interest on carbon nanotube. It was a nice time for all the EC members who worked together to make SPSI Thiruvananthapuram Chapter one of the most vibrant scientific societies in Thiruvananthapuram. The committee requests that similar co-operation be extended to the next committee as well so that the efforts put forward by the founders of the Chapter be fulfilled and the vision of the Society be carried forward. Best Wishes to all SPSI Members.

Send your feedback to spsitvm@gmail.com

Published by SPSI Thiruvananthapuram Chapter.