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Synthesis, growth and structural characterization of 1-(furan-2-yl)-3-(2,4,6-trimethoxyphenyl) prop-2-en-1-one crystal

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ABSTRACT

The compound 1-(furan-2-yl)-3-(2, 4, 6-trimethoxyphenyl) prop-2-en-1-one (FT2MP) was synthesized using solution growth method and UV–Visible, FT-IR and FT-Raman spectroscopy studies were carried out. In addition, thermal and optical studies have also been carried out. Thermal studies indicate that acetyl furan substituted chalcone crystal FT2MP is thermally stable. It was also observed that chalcone derivatives substituted with multiple methoxy group show better crystallizability. In case of chalcone derivative such as FT2MP, methoxy group linked on benzoyl ring at one end acts as an electron donor and a methyl furan ring at the other end acts as strong electron acceptor thereby enhancing nonlinearity. Third order nonlinear optical studies have been carried out using both open and closed aperture Z-scan experiments. Third order nonlinear optical properties such as absorption coefficient, refractive index, and susceptibilities have been extensively studied and the results show that the high third order optical nonlinearities of the crystal may lead to important applications in optical devices.

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1. Introduction

Nonlinear optical (NLO) materials have become important due to their wide range of optical nonlinearities as well as wide range of transparency, quick response, high threshold for damage etc. [1] which is useful for various applications. Considerable progress has been made in recent years in synthesis of materials with enhanced nonlinear effects useful for practical devices. Different types of materials are showing nonlinear optical behaviors [2]. Although inorganic materials are used for non-linear optical applications due to their excellent optical properties, high mechanical strength, high melting point and chemical inertness, organic materials are increasingly becoming important due to their interesting NLO properties [3].

The origin of NLO response in these materials depends on the polarization at the molecular level [1]. The electronic response in organic materials gives rise to a quick response for non-resonant optical excitations and has a significant advantage for photonic device applications over some of the inorganic counterparts [4]. Moreover, as the organic materials are highly polar in nature, a predominant effect of molecular interaction in solutions and growth behavior is highly anisotropic in organic crystals. A few of the characteristics of the laser light itself are modified as nonlinear optical effects due to the interaction of its intense electromagnetic fields with the material [3–5]. The fundamental property of nonlinear organic optical materials is mainly on the system of π-bond. In such molecules, the overlap of π-orbital leads to the delocalization and dispersion of electronic charges. This results in high electron density, which in effect exhibits strengthened optical nonlinearity [6]. Chalcones show good crystallizability and are stated to be highly nonlinear due to their extended conjugation length. The basic structural necessity of organic NLO materials is an

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Thermal, mechanical and linear optical studies of pyridine based trimethoxy substituted chromophore for NLO applications

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ABSTRACT

A new potentially useful pyridine-based; 1-(pyridin-2-yl)-3-(2, 4, 5-trimethoxyphenyl) prop-2-en-1-one (2PTM) organic crystals were grown at room temperature by means of slow evaporation solution growth method. The grown crystals were characterized for their linear optical studies using UV–visible and photoluminescence spectroscopy. The thermal and mechanical properties are analyzed by vicker's microhardness and the thermogravimetric and differential thermal analysis. Thermal study confirms that the crystal is thermally stable up to 119.2 °C. The studies of photoluminescence reveal that the 2PTM crystal exhibits the characteristics of blue light emissions. The pyridine-based grown novel crystal has an optical band gap of 2.89 eV. Hence 2PTMP crystals can be used for NLO applications.

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1. Introduction

Many researchers interested in studying organic crystals over other nonlinear optical materials owing to their strong thermal, mechanical, linear and nonlinear optical coefficients in the frontier category of nonlinear optical materials [1,2]. Because of its many applications in various fields including laser technology, optical parametric oscillations, optical information processing and optical data storage technologies organic crystals with better properties have gained great interest [2,3]. During their synthesis, it is possible to target the desired nonlinear optical properties of organic materials by selecting suitable ingredients. It is well established to have excellent NLO properties for a molecule with polarizable electrons, i.e. π electrons over large distances [3,4]. The thermal, mechanical, chemical and linear optical properties are factors influencing any nonlinear optical material to be used in practical applications, especially in photonic and optoelectronic devices [5]. The classification is also the significant method for defining material property in the physics and chemistry domain. A variety of methods to explain newly identified crystals are currently available. The newly discovered materials should generally be characterized by (a) destructive and (b) non-destructive methods. The internal structure and the components of the novel material are identified using non-destructive methods, such as x-ray diffraction, UV–visible spectroscopy and photoluminescence spectroscopic techniques [6]. The strength and stability of the material in the application atmosphere is the key factor [5,7]. Such sort of portrayals is carried out through the destructive techniques such as micro hardness analysis, Differential Scanning Calorimetry, Thermogravimetric Analysis, and Differential Thermal Analysis. Subsequently, the grown pyridine based methoxy substituted 1-(pyridin-2-yl)-3-(2, 4, 5-trimethoxyphenyl) prop-2-en-1-one (2PTM) organic crystals are characterized and discussed their qualities and elevations in this paper.

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A review on effect of alloying elements and heat treatment on properties of Al – Sn alloy

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ABSTRACT

Aluminum (Al) –Tin (Sn) alloys are potential lead free bearing materials, widely used in automobile and marine applications. These alloys possess good fatigue strength, seizure resistance, corrosion resistance and embedability properties. However, properties of Al – Sn alloy have to be modified to suit for engineering applications. In this paper we present a review on characterization of mechanical and tribological properties of Al – Sn alloys subjected to heat treatment (Annealing) and also effect of addition of alloying elements such as Bi, Mg, Pb, Nano Si and Nano Gr. The review suggests that heat treated alloys exhibited better mechanical properties whereas ternary alloyed samples showed improved tribological properties.

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1. Introduction

Self – lubricating bearing materials are widely used in various applications such as machine tools, small motors, home appliances, construction equipment and aerospace industries [1,2]. Aluminum (Al) –Tin (Sn) alloys are known as anti-frictional materials due to their self – lubricating property and they are regarded as lead free bearing materials [3,4]. Al–Sn is a binary alloy with a solid solubility of Sn in Al below 0.09 wt% at room temperature. Due to the immiscibility of Al–Sn system and big density difference between Al (2.7 g/cm^3) and Sn(7.2 g/cm^3), there is very strong sedimentary tendency in the casting of Al–Sn alloy [5,6]. During solidification soft tin which forms a dendritic structure distributes evenly on the grain boundaries of Al matrix, Sn imparts seizure resistance property to the alloy while aluminum matrix supports the load bearing property. However, it is difficult to achieve uniform distribution of Sn within aluminum matrix due to strong sedimentary properties [7]. Various techniques such as physical vapour deposition, stir casting, rapid solidification and cold rolling have been used in manufacturing of Al – Sn alloys [4,8]. Al – Sn alloys possess good tribological and mechanical properties and are widely used in the manufacture of engine bearing and cylinder liners. However, recent trend in automobile industries demand more efficient engine to support higher loads; hence, it is necessary to improve the properties of the alloys [9]. Various investigators have worked on enhancing the properties of the alloy [10–13]. In this short review characterization techniques used by some of the researchers to study the effect of alloying element and heat treatment on mechanical and tribological properties are presented.

2. Effect of alloying elements

2.1. Effect of Si addition

Si added Al – Sn alloys were prepared by cladding process. The prepared alloys were tested for mechanical and tribological properties. The addition of Si increased the hardness and tensile value when compared to Al-Sn alloys without Si. Further, there is a greater enhancement in the wear resistance properties due to the presence of hard Si particles surrounded by soft Sn phase [14]. The properties are presented in Table 1 and Table 2.

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Optimum hydrogen flowrates and membrane-electrode clamping pressure in hydrogen fuel cells with dual-serpentine flow channels

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ABSTRACT

Hydrogen fuel cells have been designed and fabricated with an aim to investigate effect of cell clamping pressure and hydrogen flowrates on the performance of fuel cells. Fuel cells with active area 1.9 cm × 1.6 cm were fabricated with aluminum anode, cathode and other accessories. Membrane Electrode Assembly (MEA) was made up of nafion 212 (50 μm) membrane sandwiched between two gas diffusion electrodes (GDE) on either side of nafion membrane. Anode and cathode GDE had carbon cloth with 0.25 mg/cm^2 and 0.50 mg/cm^2 Pt loading, respectively. Double serpentine flow channels were used for the flow of hydrogen and oxygen at anode and cathode. Hydrogen was humidified with an external humidifier. Cells were fabricated with two clamping pressures, 5 kg/cm^2 and 25 kg/cm^2 both at 80 °C. Hydrogen and oxygen flowrates were varied from 10 sccm to 70 sccm. The polarization plots indicate that the cell with clamping pressure of 25 kg/cm^2 and with a flowrate 20 sccm have higher power output (350 mW/cm^2) compared to other flowrates thereby implying an optimum flowrate for a given design.

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1. Introduction

Fuel cell is one of the most important energy devices which can convert chemical energy of the fuel (such as methanol, hydrogen etc.) directly to electrical energy with high efficiency and, in the case of hydrogen, with zero pollution. Further, due to depleting fossil fuels, energy sustainability is a serious concern. According to the various electrolytes and fuels used, there are many different types of fuel cells, such as polymer electrolyte membrane fuel cell (PEMFC), direct methanol fuel cell (DMFC), solid oxide fuel cell (SOFC), molten carbonate fuel cell (MCFC), phosphoric acid fuel cell (PAFC), alkaline fuel cell (AFC), and alkaline anion exchange membrane fuel cell (AEMFC) [1–4]. Among all these, PEMFC with hydrogen fuel is considered as the most promising alternative energy source for variety of applications; for automotive application especially, owing to their advantage of low noise, low operating temperature and high power density, hydrogen fuel cells (HFCs) have become very attractive [5]. Obviously therefore, hydrogen fuel cells have received increasing attention in recent years primarily due to increasing concerns and awareness in the use of fossil fuels which cause environmental damage and global warming. Further, due to their high conversion efficiency (~60%) and high energy capability HFCs are suitable for portable devices as well as residential buildings [6]. Despite the many advantages, the high cost of catalyst (Pt) and nafion membranes has hindered the rapid progress of HFCs. There are also technical challenges such as water management impacting performance enhancement and commercialization of HFCs. Water control was seen as a key issue for the realization of HFCs [7]. The membrane needs to have sufficient hydration level to transport protons efficiently. Further, operation of HFCs at low humidification or non-humidification levels may accelerate the membrane degradation process due to the radical formation [8]

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Structural, morphological and optical properties of barium doped bismuth ferrite thin films deposited by spray pyrolysis

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ABSTRACT

In the area of material science and technology, fabrication and characterization of nano-materials play an important role since it leads to the development of devices with interesting performance and potential applications in electronics, magnetics, optics, and photonics. Among the materials perovskite materials are gaining prominence. In this investigation, thin films of bismuth ferrite have been prepared and the impact of co-substitution of barium on their structural, morphological and optical properties have been studied. The spray pyrolysis procedure was used to prepare the thin films of bismuth ferrite with medium thickness by doping barium with concentrations of 1%, 3%, 5% and 10%. Various characterization techniques were employed to study the films. The presence of barium, bismuth and iron in the samples was confirmed by EDAX spectra. X-Ray diffraction studies confirmed the polycrystalline nature of the films having a rhombohedrally distorted pervoskite crystal structure fitting to space group R3c. The Scherrer rule was applied to obtain the crystallite size which was found to be small. Surface morphology studies carried out using field emission scanning electron microscopy revealed that the grain size and roughness of the films are modified with increase in doping concentration. The measurement results of optical absorption showed an increase in optical band gap with doping with barium. The results of structural, morphological and optical parameters with the increasing doping concentration indicate that these films are promising candidate for applications in opto-electronics, photovoltaics and gas sensors.

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1. Introduction

Recently, ABO_3 family of materials, known as perovskites, have generated considerable attention due to their remarkable physical properties and have found applications in many technological fields. Out of several perovskites, $BiFeO_3$ (BFO) have been gaining prominence due to co-existence of ferroelectric and magnetic order concurrently in the single-phase compound [1] which has rhombohedrally distorted perovskite structure [2]. BFO finds its importance in photovoltaic applications having small band gap of ~2.8 eV [3,4], which falls in the visible light range. The smaller band gap of BFO having ferroelectric properties at room temperature is a main feature for upcoming solar cell applications. BFO finds its application in gas sensors too because of the redox reaction happening on the oxide layer of the thin film when oxidizing or reducing gases come in contact with it; the resistance of the thin films will decrease/increase based on whether the gas is reducing/oxidizing.

Various deposition technologies such as chemical vapor deposition, atomic layer deposition, radio frequency magnetron sputtering, sol-gel, pulsed laser deposition and spray pyrolysis have been used to grow BFO thin films. Spray pyrolysis is a useful method for depositing thin films of BFO as large areas can be grown

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Methanol crossover reduction and power enhancement of methanol fuel cells with polyvinyl alcohol coated Nafion membranes

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ABSTRACT

This paper presents the effect of polyvinyl alcohol (PVA) coated Nafion membranes on their water uptake, swelling and proton conductivity for various PVA coating thicknesses. These studies show that the optimum coating thickness of PVA on Nafion is 2 μm. Methanol permeation studies show that 2 μm thick PVA coating forms a barrier for methanol and significantly reduces methanol permeation through the membranes. Further, passive methanol fuel cells are tested with 2 μm thick PVA coat on Nafion as proton exchange membranes and their polarization plots show a significant enhancement in power as compared to the methanol fuel cells with pristine Nafion due to reduction in methanol crossover.

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1. Introduction

Methanol fuel cells (MFCs) have received attention over the last decade because of their high efficiency and high power density generation capacity [1–3]. MFCs have provision for miniaturization/scaling laws [4], and MFC is therefore, an evolving technology [5,6]. They consume methanol as fuel together with oxygen to generate electrical power and hence, they are considered as electrochemical devices. MFCs are fuel cells that use Nafion proton exchange membrane (PEM). Pt-Ru nanoparticles aid the splitting of methanol at anode into carbon-di-oxide, electrons and protons [7]. The electrons travel through the outer electrical circuit while the protons diffuse through the PEM to the cathode and generate electrical power. At the cathode, e^-, H^+ and O_2 combine to generate water with Pt acting as nano-catalyst [8].

The most important membrane presently used in FCs as PEMs are perfluorosulfonic acid (PFSA) membranes (such as Nafion); Nafion has excellent mechanical strength in addition to excellent stability. They have backbone of hydrophobic fluorocarbon chains along with hydrophilic sulfonic acid groups [9]. These hydrophilic groups contribute to proton conductivity. The conductivity of the protons will be small with low water content and the membranes with hydrophilic groups having higher water content will have higher proton conductivity [10,11]. On the other hand, the membrane will be mechanically compromised by excess hydrophilic groups [12]. Hence, an optimal density of hydrophilic groups should be present in the PEM along with their optimum crosslinking density [13]. When the PEM absorbs water, hydrophilic domains swell facilitating the protons to conduct. There has been extensive study on how water sorption affects proton conductivity of nafion [14–23]. Hence, by studying the hydration of PEM, proton conductivity is evaluated followed by the power density of MFCs. Water soluble polymers (WSPs), like Poly (styrene sulfonic acid), chitosan (CS), Poly (vinylpyrrolidone) (PNVP), poly (ethylene glycol) (PEG), poly (2-acrylamido-2-1-propanesulfonic acid) (PAMPS), polyvinyl alcohol (PVA), etc, have lately become progressively interesting to both academia and industry, as it is possible to use them in soft material applications [24–27]. WSPs that are hydro-

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Development of novel porous membrane for filtration of dump yard ground water contaminants

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ABSTRACT

Water in urban areas and especially in developing countries is being polluted due to various reasons. Few of the pollution are due to disposal of industrial effluents directly into rivers, improper treatment of waste water and infiltration in waste disposal sites. The primary reason for contamination near dump yards which do not have proper lining material is due to infiltration. This poses a huge threat to the people living near the dump yard sites. In this paper we report a novel membrane developed using PVC and PVA for filtration of water in which PVA partially acts as a sacrificing component in the creation of pores. The porosity of the polymer composite membrane was studied using scanning electron microscope. The contaminations due to Vamanjoor dump yard site located near Mangalore, Karnataka, India are investigated and the various pollutants in the ground water are identified. A composite filter membrane unit is designed and developed which is used as an integral part of the filtration unit for the purification of water obtained from the areas surrounding the above dump yard. This filtration unit is able to reduce the contamination significantly making the filtered water fit for human consumption. The high quality of filtered water coupled with its low cost are expected to be of significant benefit to society.

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1. Introduction

Ground water contamination is a universal issue and more so in the developing countries. The effluents may enter water bodies due to several reasons and thus rapid urbanization in developing countries poses threat to the environment [1–3]. Effluents are supposed to be monitored and treated before discharging them into waste water. Although several regulations are in place the lack of implementation at the ground level is the major cause of damage to the environment. Waste disposal at dump yard sites is also not regulated and hence, poses a threat to the environment.

Analysis and purification of water is another issue. Membrane-based separations for water purification and desalination have increasingly been implemented to deal with the challenges of water scarcity and environmental pollution. In addition, Municipal wastewater effluents in water-stressed areas are often used for many indirect drinking uses, including irrigation, thus adding a wide range of micro-pollutants into freshwater supplies [4,5]. Membrane technology is a procedure not commonly used in the handling of potable water, except for applications like reverse osmosis. This technology is being investigated for the potential application of ultrafiltration, microfiltration, and nanofiltration to water treatment systems, due to increasingly stringent regulations [6,7]. Membranes can be used as the primary means of adsorbing contaminants from water. The use of ultrafiltration (UF) using a polyvinyl chloride (PVC) membrane (LH3-1060-V) as a pre-treatment component for a secondary water effluent reverse osmosis (RO) treatment system is well known [8–12]. On the other hand, Polyvinyl alcohol (PVA) is a polyhydroxy polymer intensively studied for its good film-forming and physical properties, high hydrophilicity, processability, biocompatibility and good chemical resistance [13–15]. PVA membrane would dissolve when it is immersed in water, as PVA is a water soluble polymer. Therefore, the PVA polymer must be crosslinked and the membranes in wet

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Structural, linear and nonlinear optical characterization of Ni and Al Co-Doped CdO semiconductor nanostructures for nonlinear optical device applications

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Third order NLO

ABSTRACT

The effects of metallic doping (Ni and Al) on thin film CdO nanostructures have been investigated and their morphological, structural, linear and nonlinear optical properties have been studied. Thin films were grown using spray pyrolysis method with a substrate temperature of 300 °C for different Ni and Al doping concentrations (0, 1, 3, 5 and 10 wt%). Studies of films with Powder X-ray diffraction confirm the polycrystalline nature with the cubic crystal structure. The Scherer rule was employed to determine the crystallite size and found to be enhanced. The elemental analysis confirms the incorporation of Ni and Al into the host CdO matrix. The surface morphology was analysed using the Field Emission Scanning Electron Microscope and the grain size was found to be altered by increasing the doping content. To understand the characteristics of the defect state, open and closed aperture Z-scan measurement was performed using the DPSS continuous wave (532 nm) laser excitation and nonlinear absorption, refractive index and nonlinear susceptibility values of third order were calculated and found to be increasing with the increased concentration of the dopants. The encouraging findings of the nonlinear optical parameters with the increasing concentration of Ni and Al on CdO nanostructures indicate that doped films are a promising source for nonlinear device applications.

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1. Intruduction

In the development of optoelectronics, thin films and thin film devices play an important role. Optoelectronics include photodiodes, phototransistors, photomultipliers, optoisolators, integrated optical circuits, photo resistors, tools for CCD imaging, laser diodes, LEDs, OLEDs, OFCs and so on. Thin films have multiple applications in various fields. Critical components like transparent electrodes in flat panel displays [1], solar cells [2], gas sensors, smart windows etc. are transparent conducting oxides (TCOs). Metal oxides have been studied for their use in optoelectronic technology. TCOs such as pure and doped zinc oxide, cadmium oxide, indium oxide and tin oxide have been extensively studied due to their widespread use in optoelectronic system technology. We are concentrating on Cadmium Oxide and tune its optoelectronic properties by doping it with Nickel and Aluminium. CdO-based TCOs are of great interest because of their metal-like charge transport behavior with good optical transmittance in the visible region and exceptionally large carrier mobility [3]. CdO is a 2.2–2.8 eV bandgap n-type semiconductor with low resistivity (10^{-2} to 10^{-4} ohm cm) due to interstitial cadmium defects and oxygen vacancy. The direct and indirect band gaps of the CdO are smaller than those of ZnO, due to which CdO has transmission range in the visible wavelength

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Simulation and analysis of P(VDF-TrFE) cantilever-beams for low frequency applications

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ABSTRACT

The work presented here describes a structural design of piezoelectric co-polymer P(VDF-TrFE) cantilever-beams for very low frequency applications; the design is based on silicon bulk-micromachining and micro-electromechanical systems technology. COMSOL simulation software has been used to study the mechanical and electrical behavior of cantilever-beams. The dimensions of the beams designed are: $3mm \times 0.6mm \times 5\mu m$, $5mm \times 1mm \times 5\mu m$ and $10mm \times 3mm \times 5\mu m$. The configuration of the cantilever-beam comprises of an active layer of piezoelectric P(VDF-TrFE) with chrome-gold interdigitated electrodes for electrical signal output generated due to vibration of piezoelectric beams. Simulation results show that the cantilever-beam of dimension $10mm \times 3mm \times 5\mu m$ has a resonant frequency of 42.68 Hz, indicating that P(VDF-TrFE) is a favorable piezoelectric material for low and very low frequency applications.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Laser Deposition: Nanostructures, Hetero-structures and 2D layers.

1. Introduction

During the past few decades, piezoelectric materials obtained significant attention due to their wide range of applications in many devices like energy harvesters, actuators, vibration sensors and other low frequency devices [1–5]. For the development of piezoelectric based micro-devices, the advancement of micro-electromechanical systems (MEMS) process technologies is very important [6–8]. As piezoelectric thin films can be easily incorporated into MEMS based structures and their piezoelectric energy conversion does not drop significantly in the micro-scale, piezoelectric based devices are extremely suitable for miniaturization [9].

Inorganic ceramics such as lead zirconium titanate (PZT), zinc oxide (ZnO), aluminum nitride (AlN), etc. [10] and organic polymers like Polyvinylidene fluoride (PVDF) along with its co-polymers are most commonly used piezoelectric materials [10]. Piezoelectric ceramics have high spring constant and hence, use of these materials for designing low/very low frequency devices is challenging even though they have significant uses in micro-electromechanical systems (MEMS) based devices [11,12]. Hence, polymers and their co-polymers with piezoelectric properties find applications in low/very low frequency devices due to their soft and flexible nature and these properties result in lower resonant frequencies. In addition to these there are other advantages such as weak dielectric constant, strong piezoelectric properties and low electromechanical coupling factors [13]. Polymers with piezoelectric properties are therefore, favorable materials for low/very low frequency MEMS based devices, such as vibration sensors [14,15].

The most commonly used polymer for various piezoelectric based devices is PVDF and its co-polymers [16–19]. The advantages of PVDF are low cost, chemical inertness and comparatively

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Third order non linear optical properties of novel furan based organic crystal

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ABSTRACT

A crystal for potential nonlinear optical applications, namely 1-(furan-2-yl)-3-(3, 4, 5-trimethoxyphenyl) prop-2-en-1-one (FT3MP), has been synthesized using slow evaporation technique. The functional groups present in the compound have been studied with Fourier transform infrared spectroscopy. The Z-scan technique with the single beam was used to examine the third-order NLO properties of the crystal. The measured nonlinear optical absorption coefficient (β), nonlinear refractive index (n2) and the third order nonlinear optical susceptibility ($\chi^{(3)}$) of FT3MP suggest that the crystal is good for possible photonic applications.

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1. Introduction

Organic optic materials have been an area of interest due to their optical nonlinear properties and possible applications in optical computing, frequency mixing, laser radar, electro-optics and laser industry, optical data storage, remote sensing, optical communication and dynamic processing of images [1]. Particularly organic nonlinear optical materials are considered to be ideal materials for electronics and optical communication [2]. Chalcone molecules are highly polarized due to the presence of donor and acceptor groups in aromatic rings [1]. Furan based chalcone is one among the most commonly utilized electron rich material, and as the donor strength of the molecules increases, NLO response is observed to increase [3,4]. The donor or acceptor ability is decided by the existence of functional groups/elements present in the molecule. Usually, in these chalcone molecules, the methoxy (OCH3) groups act as donating electron groups and the carbonyl group (C=O) acts as an electron withdrawal group. In 2-acetyl furan substituted chalcone derivatives namely, FT2MP ((E)-1-(2-Furyl)-3-(3,4,5-trimethoxyphenyl)prop-2-en-1-one) and FT3MP (1-(furan-2-yl)-3-(3,4,5-trimethoxyphenyl) prop-2-en-1-one), the presence of oxygen in furan ring makes the furan moiety to act like an acceptor. One the other hand, benzene ring is electron rich and three methoxy substituted phenyl end of these molecules acts as an electron donor and hence, both are A-A-D type molecules. The donor / acceptor group substituted on the furan and phenyl group greatly alters the molecular hyper-polarizability of the chalcone derivatives [5,6]. Considerable research and development work has been carried out in tracing and exploring the materials with fascinating properties. To understand the material behaviour as an NLO material, knowledge of their properties is very essential. The third-order NLO properties of novel methyl furan-based chalcone material 1-(furan-2-yl)-3-(3, 4, 5-trimethoxyphenyl) prop-2-en-1-one (FT3MP) are presented in this paper.

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Role of UV irradiation of Nafion membranes on ionic groups responsible for proton conduction and mechanical strength: A FTIR spectroscopic analysis

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ABSTRACT

This work presents an evidence of why proton conductivity of Nafion increases with increase in UV-radiation dosage and drops beyond ultraviolet radiation dosage of 198 mJ cm^{-2}. FTIR spectroscopic analysis is used to analyse the shifting of the peaks of groups responsible for proton conduction (i.e. sulfonic acid ($-SO_3H$) and hydronium (H_3O^+) ions) of Nafion irradiated by various dosages of UV-radiation. The analysis showed that crosslinking of $-SO_3H$ increases up-to UV-radiation dosage of 198 mJ cm^{-2}. Beyond this optimum UV-radiation dosage the chain-scission of these groups takes place. On the other hand, UV-radiation has significant degradation effect on H_3O^+. FTIR spectra of H_3O^+ show that even with slightest dosage of UV-radiation, chain-scission takes place. Further, the effect of UV-radiation of Nafion on the groups responsible for providing mechanical strength, i.e. $-CF_2$ is also analysed using FTIR spectroscopy. The analysis showed that the intensity of transmission spectrum of $-CF_2$ increases up-to UV-radiation dosage of 198 mJ cm^{-2} and drops beyond this dosage indicating that there is a possibility of enhancing the mechanical stability up to this dosage. These analysis show that optimum dose of UV-radiation is an effective tool for enhancing the proton-hopping mechanism and thereby, proton conductivity, and also the mechanical stability of Nafion.

1. Introduction

Nafion membranes are resins of perfluorinated sulfonic acid developed by the E. I. DuPont Company. They find their uses in many areas like energy conversion devices which include redox flow batteries, electrolytes in devices for detection of humidity in a corrosive environment [1], gas separation [2] etc. In addition to these, Nafion finds its applications in proton exchange membrane fuel cells (PEMFCs) [3]. PEMFC is an electrochemical device that uses hydrogen-rich fuels (such as methanol, hydrogen etc.) together with oxygen to generate electricity and heat [4,5]. Nafion membrane has attracted attention because of its widespread usage in PEMFCs. Several studies on its microstructure and properties have been conducted using numerous approaches over the last few years [6]. Nafion membrane is a type of cation exchange membrane which contains groups with negative charge, like $-SO_3^-$, bonded with the backbone of membrane and thereby, allows the cations to pass but block anions [7]. Nafion membrane has a backbone which is hydrophobic and contains polytetrafluoroethylene (PTFE) i.e. $-CF_2-$ that provides mechanical strength and heat resistance to Nafion [8]. This hydrophobic chain terminates with sulfonic acid group ($-SO_3H$) which is hydrophilic and can conduct protons while blocking the electrons [9,10]. This sulfonic acid group, in other words, has affinity to protons and thus aids the movement of protons through it while the electrons are blocked [9,10]. Apart from the sulfonic acid group, the water content in the membrane also impacts the movement of protons [10]. Further, these ionic groups have affinity to water resulting in the absorption of water by polymer leading to the hydration of polymer. It is also known that optimal hydration of membrane is required for conduction of protons along with its mechanical stability and durability [11].

Proton conduction is important in PEMs and is typically the first feature considered when assessing membranes for possible use in PEMFCs. The molecular level protonic transport in hydrated polymer matrices is usually defined on the basis of one of the two major mechanisms: "proton hopping " or "Grotthus mechanism" and "vehicular mechanism" (similar to diffusion) in which water molecule is used as a vehicle [12–14]. Proton hopping mechanism takes place in Nafion where proton hops from one hydrolysed site ($-SO_3H$ groups) to another site through the membrane. As per tri-phase tubular model, Nafion consists of an outer flexible polymer backbone, a hydrophilic layer i.e.

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Synthesis, growth and NLO studies of a novel pyridine centered chalcone derivative

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ABSTRACT

A novel pyridine based derivative 1-(pyridin-2-yl)-3-(2,4,5-trimethoxyphenyl) prop-2-en-1-one (PTMP) was synthesized and single crystals were grown using slow evaporation technique. The functional groups of the synthesized compound PTMP were confirmed using FTIR spectroscopy. Z-Scan technique was used to find the third order nonlinear optical properties of PTMP. Single crystal X-ray diffraction technique was used to investigate the molecular structural properties. X-ray diffraction studies show that the PTMP crystals belong to centrosymmetric space group $P\ 21/c$ with lattice parameters a = 8.6516(3) (Å), b = 8.7478(3) (Å) and c = 19.5245(7) (Å). Z-scan studies suggest that the compound PTMP is a promising non-linear optical material for NLO applications.

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1. Introduction

In the last couple of decades organic chalcone derivatives have gained considerable attention primarily owing to the accessibility of strong optical nonlinearities arising from the substantial movement of electron density throughout the molecular system. Constructed with two aromatic end ring π-conjugation the chalcone molecule offers a massive charge-transfer axis with adequate substituent groups. Nonlinear optical (NLO) applications, such as optical parametric oscillations, optical data storage, frequency conversion and frequency mixing, etc., require materials with high NLO coefficients and ultra-fast response [1,2]. Recently, due to its application to eye protection and for protection to sensitive optical devices from high-power laser pulses, the phenomenon of one of the NLO-limiting effects has attracted great attention. Since the optical limiting phenomenon was discovered, considerable effort has been directed to synthesize new materials with sufficient optical limiting properties. The existence of strong non-linear absorption (NLA) enhances the optical limiting property. The NLA properties of organic materials may be influenced by several complex factors. It is therefore essential to investigate the relationships of organic materials with the structure and effect of the NLA. But most of these compounds are C=C, C=O, C=S and C=N bond compounds with π-conjugation bridge; the compounds with C=C having C=N are less studied in the literature. Chalcones and their derivatives have recently been studied with an interest in their important nonlinear optical property and also because of their high propensity to crystallize; they also have good optical limitation activity with 532 nm wavelength nanosecond laser pulses [3–6]. In this paper we present our experimental findings on structural characterization, NLO parameters in the third order and structure and NLO property relationship of a novel chalcone derivative 1-(pyridin-2-yl)-3-(2,4,5 trimethoxy)prop-2-en-1-one (PTMP).

2. Experimental procedure

The Claisen-Schmidt condensation process has been used to synthesize pyridine-based derivatives of PTMP [7,8]. This is the reaction in the presence of an alkali and substituted acetyl pyridine

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Role of Zn in tuning the structural, morphological and optical properties of V_2O_5 nanostructures deposited by spray pyrolysis

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ABSTRACT

Venadium Pentoxide (V_2O_5) thin films were deposited by employing a spray pyrolysis technique on glass substrates at 573 K for different Zn-doping levels (0, 1, 3, 5 and 10 wt%) to study the optical, structural and morphological properties of pure and Zn-doped V_2O_5 thin films. The characterisation study with powder X-ray diffraction confirms the orthorhombic structure and also that the films grow along (2 0 0) direction with increase in the doping concentration. The Scherer rule was employed to determine the crystallite size and found to be enhanced. Field Emission Scanning Electron Microscopy study reveals that the surface morphology modifications increase with Zn-doping. The surface topography of the prepared films was also studied using AFM and found to be enhanced. The optical energy band gap (Eg) of the prepared films was found to be varying between 3.27 eV and 3.72 eV due to increase in doping concentration. The interesting results of structural and optical parameters with the increase in Zn-doping concentration suggest that these nanostructured films are a promising material for opto-electronic device applications.

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1. Introduction

Among the important transition metal oxides, V_2O_5 has received a considerable attention due to their excellent physio-chemical properties [1–4]. Its optical transmittance, magnetic susceptibility, variable oxidization states, n-type conductivity, electrical resistivity and high energy density [5–8] make V_2O_5 based devices to have wide applications in storage medium, sensors, field effect transistors, switching devices, electro-optical devices, hydrogen storage, UV detectors, catalysts, piezoelectric devices and others [9–14].

Recent studies on V_2O_5 nanomaterials have shown different oxidation states of vanadium ions that form an useful oxide surface that can sense gas through chemisorption and also control defects [15–18]. The current work based on physical properties of Zn doped V_2O_5 nano structures prepared by spray pyrolysis for gas-sensing and opto-electronic device applications. Inorder to tailor the optical and electrical properties, doping with various ions into vanadium oxide lattice has been found to be more effective. Hence, many doping experiments have been undertaken with W, Mo, Nb, F, Cr, Al and S, for this purpose to find a suitable dopant [19–23]. In this work, zinc was chosen as the dopant for the first time in order to optimize optical and optoelectronic properties of V_2O_5 thin films. Zn^{2+} ions can easily penetrate the V_2O_5 crystal lattice and replace the V^{2+} position in the crystal because it is an important transition metal element with an ionic radius of 0.074 nm, which is marginally lower than that of V^{2+} (0.079 nm). In this paper we

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Novel methyl furan based chalcone material for potential nonlinear optical applications

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ABSTRACT

A mixture of 2-acetyl furan and 3, 4, 5-trimethoxybenzaldehyde was used to synthesize and grow the novel methyl furan-based chalcone derivative 1-(furan-2-yl)-3-(3, 4, 5-trimethoxyphenyl) prop-2-en-1-one (FT3MP) crystal. Thermal stability of the crystal was found to be up to its melting point and the second harmonic generation efficiency was found to be 1.5 times higher than KDP crystal. UV–Vis spectrum showed a cut-off wavelength at 442 nm. The UV–Vis absorption spectral studies showed that the crystal has better transparency in the visible region of electromagnetic spectrum.

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1. Introduction

Nonlinear optical materials are becoming increasingly important for technological applications such as optical computing, laser radar, electro-optics and laser industries, optical data storage, remote sensing, optical communication and dynamic image processing [1,2]. Organic non-linear optical (NLO) materials have attracted considerable interest in providing essential optical frequency amplification, optical modulation, optical switching, and optical memory functions for emerging technologies in areas such as optical communication, signal processing, and optical information storage devices [3]. Attention is focused on organic nonlinear optical materials as they are considered to be ideal materials for optical communication and electronics due to their advancements in data processing at great speed and higher density [4]. The present need is to find the organic NLO materials which possess high nonlinear optical (NLO) coefficients with ultra-fast response for rapid photonic applications. Amongst all organic NLO materials, chalcone derivatives are the most promising candidates for NLO applications due to their high NLO coefficients, single harmonic generation (SHG) efficiency, greater transparency, high threshold for laser damage, thermal stability, good crystallizability, high nonlinear absorption coefficient, nonlinear refractive index, and excellent blue light transmittance [5–7]. Chalcone based on furan is one of the most widely used electron-rich materials and its NLO response is found to increase as the donor strength of the molecules improves [6,8].The FT2MP((E)-1-(2-Furyl)-3-(3,4,5-trimethoxyphenyl)prop-2-en-1-one) and FT3MP(1-(furan-2-yl)-3-(3,4,5-trimethoxyphenyl) prop-2-en-1-one) molecules containing three OCH_3 groups at 2,4,6 and 3,4,5 positions; phenyl moiety acts as a donor and electron-acceptor acetyl furan ring forms acceptor-π-donor (A-π-D) where the transfer of charges from the donor ends with the recipient. The transfer of charges to the carbonyl group is successful from the donor attached to the phenylene group (asymmetric transfer of charges) resulting in enhanced optical nonlinearity of the third order [9,10]. Hence, it is indeed essential to study the structure-property relationship for a better understanding. In this paper we report the growth of new methyl furan based chalcone material 1-(furan-2-yl)-3-(3, 4, 5-trimethoxyphenyl) prop-2-en-1-one (FT3MP) and their thermal and optical properties.

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Third order non linear optical properties of novel furan based organic crystal

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Susceptibility

ABSTRACT

A crystal for potential nonlinear optical applications, namely 1-(furan-2-yl)-3-(3, 4, 5-trimethoxyphenyl) prop-2-en-1-one (FT3MP), has been synthesized using slow evaporation technique. The functional groups present in the compound have been studied with Fourier transform infrared spectroscopy. The Z-scan technique with the single beam was used to examine the third-order NLO properties of the crystal. The measured nonlinear optical absorption coefficient (β), nonlinear refractive index (n2) and the third order nonlinear optical susceptibility ($\chi^{(3)}$) of FT3MP suggest that the crystal is good for possible photonic applications.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Laser Deposition: Nanostructures, Hetero-structures and 2D layers.

1. Introduction

Organic optic materials have been an area of interest due to their optical nonlinear properties and possible applications in optical computing, frequency mixing, laser radar, electro-optics and laser industry, optical data storage, remote sensing, optical communication and dynamic processing of images [1]. Particularly organic nonlinear optical materials are considered to be ideal materials for electronics and optical communication [2]. Chalcone molecules are highly polarized due to the presence of donor and acceptor groups in aromatic rings [1]. Furan based chalcone is one among the most commonly utilized electron rich material, and as the donor strength of the molecules increases, NLO response is observed to increase [3,4]. The donor or acceptor ability is decided by the existence of functional groups/elements present in the molecule. Usually, in these chalcone molecules, the methoxy (OCH3) groups act as donating electron groups and the carbonyl group (C=O) acts as an electron withdrawal group. In 2-acetyl furan substituted chalcone derivatives namely, FT2MP ((E)-1-(2-Furyl)-3-(3,4,5-trimethoxyphenyl)prop-2-en-1-one) and FT3MP (1-(furan-2-yl)-3-(3,4,5-trimethoxyphenyl) prop-2-en-1-one), the presence of oxygen in furan ring makes the furan moiety to act like an acceptor. One the other hand, benzene ring is electron rich and three methoxy substituted phenyl end of these molecules acts as an electron donor and hence, both are A-A-D type molecules. The donor / acceptor group substituted on the furan and phenyl group greatly alters the molecular hyper-polarizability of the chalcone derivatives [5,6]. Considerable research and development work has been carried out in tracing and exploring the materials with fascinating properties. To understand the material behaviour as an NLO material, knowledge of their properties is very essential. The third-order NLO properties of novel methyl furan-based chalcone material 1-(furan-2-yl)-3-(3, 4, 5-trimethoxyphenyl) prop-2-en-1-one (FT3MP) are presented in this paper.

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A review on effect of alloying elements and heat treatment on properties of Al – Sn alloy

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ABSTRACT

Aluminum (Al) –Tin (Sn) alloys are potential lead free bearing materials, widely used in automobile and marine applications. These alloys possess good fatigue strength, seizure resistance, corrosion resistance and embedability properties. However, properties of Al – Sn alloy have to be modified to suit for engineering applications. In this paper we present a review on characterization of mechanical and tribological properties of Al – Sn alloys subjected to heat treatment (Annealing) and also effect of addition of alloying elements such as Bi, Mg, Pb, Nano Si and Nano Gr. The review suggests that heat treated alloys exhibited better mechanical properties whereas ternary alloyed samples showed improved tribological properties.

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1. Introduction

Self – lubricating bearing materials are widely used in various applications such as machine tools, small motors, home appliances, construction equipment and aerospace industries [1,2]. Aluminum (Al) –Tin (Sn) alloys are known as anti-frictional materials due to their self – lubricating property and they are regarded as lead free bearing materials [3,4]. Al–Sn is a binary alloy with a solid solubility of Sn in Al below 0.09 wt% at room temperature. Due to the immiscibility of Al–Sn system and big density difference between Al (2.7 g/cm^3) and Sn(7.2 g/cm^3), there is very strong sedimentary tendency in the casting of Al–Sn alloy [5,6]. During solidification soft tin which forms a dendritic structure distributes evenly on the grain boundaries of Al matrix, Sn imparts seizure resistance property to the alloy while aluminum matrix supports the load bearing property. However, it is difficult to achieve uniform distribution of Sn within aluminum matrix due to strong sedimentary properties [7]. Various techniques such as physical vapour deposition, stir casting, rapid solidification and cold rolling have been used in manufacturing of Al – Sn alloys [4,8]. Al – Sn alloys possess good tribological and mechanical properties and are widely used in the manufacture of engine bearing and cylinder liners. However, recent trend in automobile industries demand more efficient engine to support higher loads; hence, it is necessary to improve the properties of the alloys [9]. Various investigators have worked on enhancing the properties of the alloy [10–13]. In this short review characterization techniques used by some of the researchers to study the effect of alloying element and heat treatment on mechanical and tribological properties are presented.

2. Effect of alloying elements

2.1. Effect of Si addition

Si added Al – Sn alloys were prepared by cladding process. The prepared alloys were tested for mechanical and tribological properties. The addition of Si increased the hardness and tensile value when compared to Al-Sn alloys without Si. Further, there is a greater enhancement in the wear resistance properties due to the presence of hard Si particles surrounded by soft Sn phase [14]. The properties are presented in Table 1 and Table 2.

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Methanol crossover reduction and power enhancement of methanol fuel cells with polyvinyl alcohol coated Nafion membranes

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ABSTRACT

This paper presents the effect of polyvinyl alcohol (PVA) coated Nafion membranes on their water uptake, swelling and proton conductivity for various PVA coating thicknesses. These studies show that the optimum coating thickness of PVA on Nafion is 2 μm. Methanol permeation studies show that 2 μm thick PVA coating forms a barrier for methanol and significantly reduces methanol permeation through the membranes. Further, passive methanol fuel cells are tested with 2 μm thick PVA coat on Nafion as proton exchange membranes and their polarization plots show a significant enhancement in power as compared to the methanol fuel cells with pristine Nafion due to reduction in methanol crossover.

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1. Introduction

Methanol fuel cells (MFCs) have received attention over the last decade because of their high efficiency and high power density generation capacity [1–3]. MFCs have provision for miniaturization/scaling laws [4], and MFC is therefore, an evolving technology [5,6]. They consume methanol as fuel together with oxygen to generate electrical power and hence, they are considered as electrochemical devices. MFCs are fuel cells that use Nafion proton exchange membrane (PEM). Pt-Ru nanoparticles aid the splitting of methanol at anode into carbon-di-oxide, electrons and protons [7]. The electrons travel through the outer electrical circuit while the protons diffuse through the PEM to the cathode and generate electrical power. At the cathode, e^-, H^+ and O_2 combine to generate water with Pt acting as nano-catalyst [8].

The most important membrane presently used in FCs as PEMs are perfluorosulfonic acid (PFSA) membranes (such as Nafion); Nafion has excellent mechanical strength in addition to excellent stability. They have backbone of hydrophobic fluorocarbon chains along with hydrophilic sulfonic acid groups [9]. These hydrophilic groups contribute to proton conductivity. The conductivity of the protons will be small with low water content and the membranes with hydrophilic groups having higher water content will have higher proton conductivity [10,11]. On the other hand, the membrane will be mechanically compromised by excess hydrophilic groups [12]. Hence, an optimal density of hydrophilic groups should be present in the PEM along with their optimum crosslinking density [13]. When the PEM absorbs water, hydrophilic domains swell facilitating the protons to conduct. There has been extensive study on how water sorption affects proton conductivity of nafion [14–23]. Hence, by studying the hydration of PEM, proton conductivity is evaluated followed by the power density of MFCs. Water soluble polymers (WSPs), like Poly (styrene sulfonic acid), chitosan (CS), Poly (vinylpyrrolidone) (PNVP), poly (ethylene glycol) (PEG), poly (2-acrylamido-2-1-propanesulfonic acid) (PAMPS), polyvinyl alcohol (PVA), etc, have lately become progressively interesting to both academia and industry, as it is possible to use them in soft material applications [24–27]. WSPs that are hydro-

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Role of UV irradiation of Nafion membranes on ionic groups responsible for proton conduction and mechanical strength: A FTIR spectroscopic analysis

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ABSTRACT

This work presents an evidence of why proton conductivity of Nafion increases with increase in UV-radiation dosage and drops beyond ultraviolet radiation dosage of 198 mJ cm^{-2}. FTIR spectroscopic analysis is used to analyse the shifting of the peaks of groups responsible for proton conduction (i.e. sulfonic acid ($-SO_3H$) and hydronium (H_3O^+) ions) of Nafion irradiated by various dosages of UV-radiation. The analysis showed that crosslinking of $-SO_3H$ increases up-to UV-radiation dosage of 198 mJ cm^{-2}. Beyond this optimum UV-radiation dosage the chain-scission of these groups takes place. On the other hand, UV-radiation has significant degradation effect on H_3O^+. FTIR spectra of H_3O^+ show that even with slightest dosage of UV-radiation, chain-scission takes place. Further, the effect of UV-radiation of Nafion on the groups responsible for providing mechanical strength, i.e. $-CF_2$ is also analysed using FTIR spectroscopy. The analysis showed that the intensity of transmission spectrum of $-CF_2$ increases up-to UV-radiation dosage of 198 mJ cm^{-2} and drops beyond this dosage indicating that there is a possibility of enhancing the mechanical stability up to this dosage. These analysis show that optimum dose of UV-radiation is an effective tool for enhancing the proton-hopping mechanism and thereby, proton conductivity, and also the mechanical stability of Nafion.

1. Introduction

Nafion membranes are resins of perfluorinated sulfonic acid developed by the E. I. DuPont Company. They find their uses in many areas like energy conversion devices which include redox flow batteries, electrolytes in devices for detection of humidity in a corrosive environment [1], gas separation [2] etc. In addition to these, Nafion finds its applications in proton exchange membrane fuel cells (PEMFCs) [3]. PEMFC is an electrochemical device that uses hydrogen-rich fuels (such as methanol, hydrogen etc.) together with oxygen to generate electricity and heat [4,5]. Nafion membrane has attracted attention because of its widespread usage in PEMFCs. Several studies on its microstructure and properties have been conducted using numerous approaches over the last few years [6]. Nafion membrane is a type of cation exchange membrane which contains groups with negative charge, like $-SO_3^-$, bonded with the backbone of membrane and thereby, allows the cations to pass but block anions [7]. Nafion membrane has a backbone which is hydrophobic and contains polytetrafluoroethylene (PTFE) i.e. $-CF_2-$ that provides mechanical strength and heat resistance to Nafion [8]. This hydrophobic chain terminates with sulfonic acid group ($-SO_3H$) which is hydrophilic and can conduct protons while blocking the electrons [9,10]. This sulfonic acid group, in other words, has affinity to protons and thus aids the movement of protons through it while the electrons are blocked [9,10]. Apart from the sulfonic acid group, the water content in the membrane also impacts the movement of protons [10]. Further, these ionic groups have affinity to water resulting in the absorption of water by polymer leading to the hydration of polymer. It is also known that optimal hydration of membrane is required for conduction of protons along with its mechanical stability and durability [11].

Proton conduction is important in PEMs and is typically the first feature considered when assessing membranes for possible use in PEMFCs. The molecular level protonic transport in hydrated polymer matrices is usually defined on the basis of one of the two major mechanisms: "proton hopping " or "Grotthus mechanism" and "vehicular mechanism" (similar to diffusion) in which water molecule is used as a vehicle [12–14]. Proton hopping mechanism takes place in Nafion where proton hops from one hydrolysed site ($-SO_3H$ groups) to another site through the membrane. As per tri-phase tubular model, Nafion consists of an outer flexible polymer backbone, a hydrophilic layer i.e.

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Sunlight driven decomposition of toxic organic compound, coumarin, p-nitrophenol, and photo reduction of Cr(VI) ions, using a bridge structure of Au@CNT@TiO_2 nanocomposite

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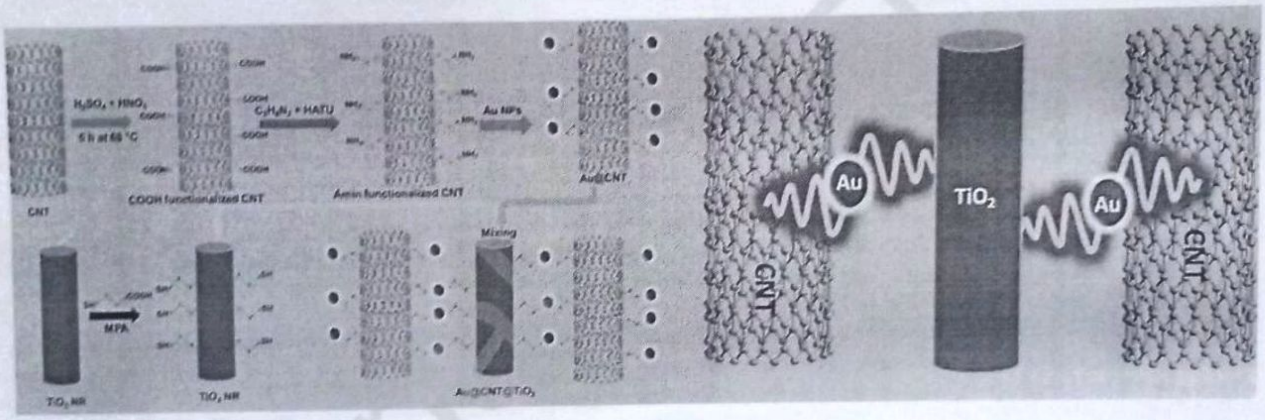

Highlights:

- Novel surface functionalization approach for synthesis of Au@CNT@TiO_2 nanocomposite.
- CNTs act as electron reservoirs to trap electrons from TiO_2 and Au nanoparticle.
- Au@CNT@TiO_2 shows about 7.5 times higher photocurrent generation than the TiO_2.
- Au@CNT@TiO2 shows efficient decomposition of industrial toxic compound and ion

A Review on Design and Implementation of Micro Weather Station

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Abstract: **The advancement of Internet of Things (IoT) has made a major impact on technology. It collects an enormous amount of data using which can be used in an application. One such system is Micro Weather Station, which gives us different environment variable values such as temperature, humidity, soil moisture, Ultraviolet (UV) radiation, air pressure, air quality, and rainfall. Initially research or advancements done on weather monitoring were limited, but over the last century it has evolved into a well-organized and professional global activity that reflects its crucial importance for a wide range of economic, environmental, civil protection and farming activities. Due to human activities these days there is a drastic change in the climate, hence an accurate and cost-efficient system is needed which is used to monitor the changes in the environment. The application of weather station is not just bounded for getting the live data and prediction of weather, but also includes the advancement in the agricultural sector and the military applications. Cloud storage technology and Geo-tagging have made it much simpler to get the data of any place at any time.**

Keywords: Raspberry Pi, Sensors, IoT, Accuracy, Real-time monitoring.

I. INTRODUCTION

Micro weather station is a system which measures the environmental variable values and it is transferred to server where the computations are made and displays the result in web page or mobile applications. The sole purpose of the micro weather station is to gather or collect major weather attributes like temperature, humidity, soil moisture, UV radiation, air pressure, and air quality at a remote location in a most effective and cost-efficient manner with the help of micro weather station equipment. This uses multiple micro weather stations and aggregates the data provided by multiple data collection points in real-time. Raspberry Pi is interfaced with various sensors using General-Purpose Input/Output (GPIO) pins. The Raspberry Pi has an inbuilt Secure Digital (SD) card slot that helps to fetch and store data. All the data fetched are time tagged from the Raspbian OS, in addition to this, the system is Geo-tagged which gives the location of the weather station. The data fetched by Raspberry Pi will then be pushed to the web server where the required calculations are made and display the data in terms of table/graph with the help of webpage in real-time. This enables the user an easy and reliable way to understand the data and make further decisions accordingly. The data collected over time can be used for various purposes such as weather prediction, study the change in the weather pattern and research purposes. The supply for the micro weather station system is provided with the help of a battery and a solar panel.

II. LITERATURE SURVEY

Sravani et al [01] proposed a method for recovering ecological circumstances like temperature, humidity, and Carbon Monoxide (CO) level at a precise position and create information accessible anywhere in the world using IoT. The model comprises numerous modest remote sensors, which are equipped for gathering, handling natural data, and speaking with neighboring hubs. Arduino is used as the microcontroller which collects the data from the sensors. A Wireless Fidelity module is used to send these data to the cloud where it'll be stored in the form of a spreadsheet. Using this data different graphs can be plotted for better understanding.

Kajal and Narendra [02] have presented the method of processing a huge amount of data which is collected by the sensors. Plants require very specific conditions for optimal growth and health. So, for monitoring the condition of the crop

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Design and Implementation of Automated Hydroponic System

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Abstract - Traditional farming requires large amount of water for irrigation, and the pesticides used are polluting the soil and water bodies too. In addition to this, the rapid industrialization and urbanization have severely affected the resources like land, water and soil fertility. Climate change has had a disastrous impact on the growth of plants and vegetables. This can be controlled by an alternative method called hydroponics. Hydroponics is the method of growing plants in a soilless medium, i.e., water or nutrient solution. This method is preferable as the plant production and yield is very high, and the plants need to be sparingly watered. The growing roots get the nutrients readily as they are submerged in a nutrient-rich pool. The plants grow comparatively faster. The chances of being infected by pests and bacteria from the soil can be eliminated. The human intervention can be kept at minimum by automating the system, by the help of microcontrollers and sensors. The monitoring and control of the system can be done using Internet of things (IOT). Sensors like temperature, pressure, humidity, pH, electrical conductivity can be used in order to grow the plants in a controlled environment.
This paper provides a comprehensive understanding of the hydroponic farming system and its automation. An artificial growing environment, similar to a plant incubator, can be created by placing the hydroponic system in a closed environment or a greenhouse. The plants can be grown in vertical stacks which increases planting density.

Key Words: **Hydroponics, Soilless farming, Automated hydroponic system, Internet of Things (IOT)**

1. INTRODUCTION

Agriculture in India is large and intensive. The land is being broken up into smaller plots leading to smaller yields. Also, intensive farming needs large amount of water and labor. This increases the production costs and makes the traditional farming methods unsustainable in the longer run. Pesticides are being used incorrectly, resulting in the produce to be loaded with pesticides. Since most of the agriculture is rain-fed, any disruption in monsoon cycle fails the harvest. The rural to urban immigration is rapidly increasing, draining the farms of farmers and over-populating the urban areas. The farms can follow the farmers to urban areas by this technique.

Hydroponics can be implemented on roof tops, any open area. It can be implemented vertically in stacks, or on walls of the houses. The maintenance is very low and the water does not get wasted. The plants are not prone to pests which is not usually the case in traditional farming, hence extensive use of pesticides can be avoided. Automation helps avoid supervision and maintains the processes like water level sensing, adequate exposure to light, sensing of temperature and humidity. The current agricultural technologies can be implemented in urban areas without interruption. Urban farming can be done in balconies, unused lands, rooftops and even inside houses. It is a closed controlled system where the water can be reused several times, making it cost-effective and sustainable. As there is no use of pesticides, the food grown is free of chemicals. With the environmental conditions controlled within the system, any kind of exotic plants can be grown without the limitations of climate, location, relief, space.

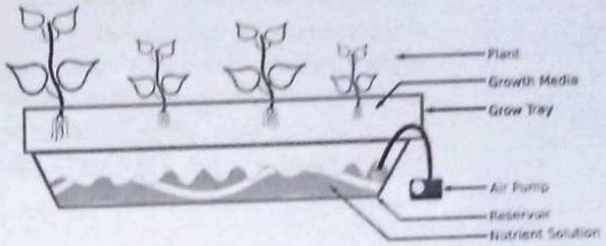

Fig.1.1. Hydroponic system

Vertical farming can be made possible where plants are grown in a vertical stacks as shown in Fig.1.2. The water used in traditional farming either gets evaporated or seeps inside and becomes a part of ground water, but there is no wastage of water in this method. In this method, the data is collected from the sensors and the system can be controlled based on the requirements. The electrical conductivity of the nutrient solution determines the amount of nutrients present in the pool. The water level can be sensed using a water level sensor. Light emitting diodes are used in order to provide artificial lightning when necessary. There is lot of room for innovation in hydroponics.

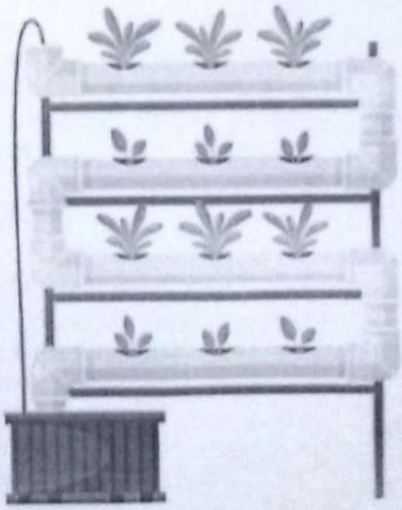

Fig.1.2. Vertical farming using hydroponics

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FOOT STEP POWER GENERATIONUSING PIEZOELECTRIC SENSOR

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Abstract: *Step by step, the number of inhabitants in the nation is expanding and the prerequisite of force is additionally expanding. Simultaneously the wastage of force is likewise expanding from multiple points of view. So improving this energy back to us place an extremely significant job. The generation of power by conventional method is no longer helpful as it damages the environment. So elective method to produce the electrical energy is found that is by using human step on piezoelectric sensor where here the pressure will be converted into electrical energy. Main principle is conversion of mechanical energy into electric energy. We can generate up to 10 00 w of power for just 120 footstep. It can be installed on road side footpath, public place, airport etc. This technique can make a very big impact on electrical power generation.*

Keywords- Footstep, piezoelectric sensor, power generation.

1 INTRODUCTION

The generation of electrical energy from the force exerted by the footstep on the floor is discussed in this paper. It is surprising to know the amount of energy generated by a normal footstep. As a large amount of energy is lost by each person during routine walk which can be used to generate the electrical energy.

This approach of conversion of kinetic energy into electrical energy is a clean resource which is eco-friendly also. We are using piezoelectric sensor to produce the energy. The basic principle of piezoelectric sensor is conversion of mechanical energy into electrical charge. This procedure is unlike piezoresistive and capacitive transducers, piezoelectric sensor components require no outside voltage or flow source. They produce a yield signal straightforwardly from the applied strain. The yield from the piezoelectric component is a charge relative to pressure. Identifying this requires a charge intensifier to change the sign over to a voltage. This is to a strategy deliver power by utilizing the piezoelectric sensor that can create voltage by the utilization of pressure on them which can be utilized to charge battery and which thus can be effortlessly use to create power.

2 LITERATURE REVIEW

Shivendra et al [1] has introduced his work on creation of mechanical stride power age. In his venture work, the straight forward drive system, for example, rack and pinion gathering and chain drive instrument is utilized for producing power by use of power which is acquired during the strolling on advances is changed over in to electrical energy with the assistance of mechanical L9systems. The produced power is put away through battery and this is utilized for initiating the associated loads. This is one of the conservative and productive frameworks for creating power which can be easily handily introduced.

Anemol et al [2] in his paper he introduced audit on stride power age utilizing piezoelectric transducer. The piezoelectric material proselytes the mechanical