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Highly Efficient and Durable Piezoelectric Nanogenerator and Photo-power cell Based on CTAB Modified Montmorillonite Incorporated PVDF Film

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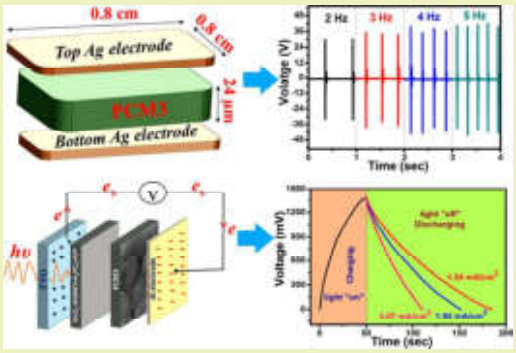
Supporting Information

ABSTRACT: Herein, we have successfully designed two ecofriendly, biocompatible, and cost-effective devices, i.e., a piezoelectric nanogenerator (PENG) and a self-charged photo-power cell (PPC) by developing a multifunctional cetyltrimethylammonium bromide (CTAB) modified montmorillonite (MMT) incorporated poly(vinylidene fluoride) (PVDF) thin film with large electroactive β crystallites and dielectric properties. Incorporation of CTAB modified MMT in PVDF leads to nucleation of piezoelectric β crystallite ($F(\beta)$) ~ 91% as well as the dielectric constant ~48 at 3 mass % doping of CTAB-MMT. The enrichment of the electroactive β phase crystallization and high dielectric constant pilot to a good piezoelectricity (d_{33}) ~ 62.5 pC/N at 50 Hz of the thin film. Our CTAB-MMT/PVDF based PENG (CMPENG) with superior piezoelectricity shows high output power generation with power density ~ 50.72 mW/cm^3 under periodic finger impartation and having the ability to charge a 1 μF capacitor up to 2.4 V within 14 s under gentle finger impartation. CMPENG also have the potential to glow up commercially available 26 blue light-emitting diodes (LEDs) connected in series. The self-charged PPC has been designed with the thin film in association with MnO_2-MWNT/PVP/H_3PO_4. Our PPC is able to generate supercilious output voltage ~ 1.38 V and short circuit current ~ 3.7 mA/cm^{2}under light illumination with specific areal capacitance and energy storage efficiency of ~1501 F/m^2 and ~93%, respectively. The realistic application of our PPC is investigated by lighting 24 blue LEDs for 7 days with the same intensity by charging the device once for 50 s.



KEYWORDS: *MMT, PVDF, Dielectric, Piezoelectric, Energy, Power density*

INTRODUCTION

Increase of energy expenditure of our modern societies and the depletion of traditional fossil fuels such as coal, petroleum, and so on have polarized the scientific community with deep concern about the development of novel energy harvesting materials as well as simple techniques to design highly efficient energy generating and storage devices to exploit sustainable and green energy for miniaturization and multifunctionalization in electronics industry. Our daily life is being surrounded by various types of multifunctional modish electronic gadgets such as mobile phones, tablets, laptops, and sensors, etc., which are driven by conventional electrochemical or lithium ion batteries for a long time period.[1−4]

Now it is the time to minimize use of power consumption from traditional resources of energy, which are associated with environmental pollutions and global warming issues.[1−4] Recently, energy harvesting from our living systems such as mechanical energy linked with human movement, air flow, and sea waves, etc., and solar energy along with storage in the same unit are highly appreciated by scientists and engineers due to its environmentally friendly nature and cost-effectiveness.[4−12] Energy harvesting and its storage have two different issues. Designing of a portable hybrid device by integrating an energy conversion and storage part in a single unit with superior performances is not only very promising but also very challenging.[4,5,12] Though few such types of hybrid systems have been reported previously, development of highly efficient

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Photo-Rechargeable Organic−Inorganic Dye-Integrated Polymeric Power Cell with Superior Performance and Durability

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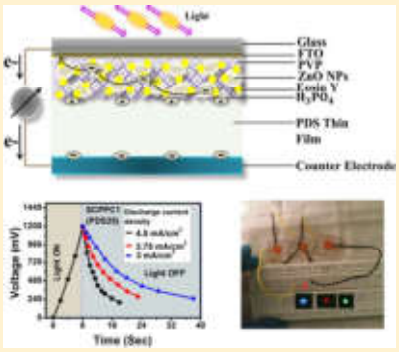
Supporting Information

ABSTRACT: In the present work, we propose a simple and unique approach to design a lightweight, low-cost, self-charging power cell with considerable capacity to generate and store photocharges named self-charged photo-power cell (SCPPC). Initially, highly electroactive sodium dodecyl sulfate (SDS)-incorporated poly(vinylidene fluoride) (PVDF) composite thin films with a large dielectric constant of ∼525 are synthesized via a simplistic solution casting process. Then, the as-prepared high-dielectric SDS/PVDF thin film is used as a charge-storage medium in combination with an inorganic−organic dye film, i.e., ZnO nanoparticles−eosin Y−poly(vinylpyrrolidone) film, as a photoelectron generator in our SCPPC. An open-circuit voltage of ∼1.2 V is attained after charging SCPPC under illumination light with intensity ∼110 mW/cm^2 and then discharging fully with a constant current density of ∼4.5 mA/cm^2. A specific areal capacitance of ∼450 F/m^2 is obtained with large energy and power densities of ∼90 mWh/m^2 and 54 W/m^2, respectively. The improved overall efficiency, ∼3.78%, along with 89% storage efficiency leads to promising application possibilities of our rechargeable photo-power cell. The recyclability, i.e., rechargeability and storage durability, of the photo-power cell are also checked for 35 days without no such reduction in voltage generation and storage. Also, multicolored light-emitting diodes are lightened up using the photo-power cell as power source.



1. INTRODUCTION

Investigation of clean energies such as mechanical, solar, chemical, etc. and their application to the global development for overall environmental security is one of the most intense research topics for the modern society. So, our target should be redirected to overcome these critical issues by establishing development of technologies and devices for clean energy conversion, storage, and conservation. On the basis of this concept, development of piezoelectric nanogenerators, Li-ion batteries, supercapacitors, and dye-sensitized solar cells has already received attention for clean energy conversion and storage.[1−11]

As a fresh and sustainable energy supply, solar energy may be considered as one of the most prosperous choices to replace regular fossil fuels like petroleum, coal, etc.[1−3] Due to the increasing requirement of clean energy to reduce the greenhouse effect and to obtain multifunctional operation in single device, researchers and engineers are highly focused on constructing different types of energy-harvesting devices.[4,5,11] Currently, electrical energy harvesting using the photovoltaic effect with high conversion and storage efficiency is the dominant technology in the electronics industry. So, the most essential demand of scientists is to integrate energy in a single "harvesting-storage" unit with improved performance.[1]

Very recently, solar electricity or photovoltaic technology has been earning heightened attention for the production of sustainable energy.[1,8−11] But to date, reports on the various types of photo-power cell with high conversion efficiency and storage are limited. Few photovoltaic units based on perovskite structure and dye-sensitized solar cell are reported by some researchers.[12−15] Different types of polymer-based solar device and TiO_2 nanotube-functionalized dye-sensitized solar cells were also recommended by Guo at al.[15] Integration of solar cells with an energy-storage part (Li-ion cell, capacitor, etc.) through an external circuit was also proposed by some scientists.[16,17] But the output characteristics of such integrated hybrid power cells reduce due to the increase of the total impedance of the systems as well as some difficulties of light exposure.[18] Such shortcomings might be overcome by integrating the solar part and the energy-storage part in a single unit.[13,19] The initial idea of self-charging photocapacitor

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ORIGINAL ARTICLE

Self-charging photo-power cell based on a novel polymer nanocomposite film with high energy density and durability

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Abstract

The present work emphases the fabrication of a simple, solid-state, and cost-effective multifaceted device called a "self-charging photo power bank" based on an in situ-synthesized MgO_2 NP-impregnated electroactive and high dielectric poly (vinylidene fluoride) thin film composite as its active material. Positioned under visible-light illumination of 110 mW/cm^2 and in the absence of any sort of external bias, our optimized multilayered device can self-charge to a voltage of 1170 mV in just 24 s. An excitingly high energy density of 240 mW h/m^2 and a remarkable charge density of 1350 C/m^2 along with the excellent energy-retaining power of the device for a considerable period of time illustrate its potential as an efficient power bank. The device is used for 30 consecutive days to prove its commendable long-term cycling stability. Three blue, commercial LEDs and a digital table clock are successfully powered by our device. Our fabricated device portends an innovative approach for self-generation and simultaneous storage of electrical energy, making it an efficacious nascent aspirant in the realms of energy harvesting and storage, which can undoubtedly meet the energy necessities in the imminent future.

Introduction

Over the last few decades, electroactive polymers (EAPs) have been acknowledged by the scientific community for their outstanding contributions to the fields of actuators, acoustic transducers, membranes, nonvolatile memories, batteries, piezoelectric sensors/nanogenerators, flexible energy harvesting and storage systebiomaterials, etc [1–8]. Among all EAPs, PVDF (CH_2–CF_2) has been the most popular semicrystalline plastic because it is highly flexible and economically and ecologically nonthreatening. Although the α polymorph (TGTG′ dihedral conformation) of PVDF is the most thermodynamically stable nonpolar phase, the β polymorph of PVDF, with all *trans* TTTT planar conformations, has received attention from the research community owing to its possession of a remarkably high dipolar moment per unit cell of 8×10^{-30} Cm due to the disparity in the electronegativity of fluorine atoms and hydrogen and carbon atoms; thus this configuration exhibits the highest piezo-, pyro-, ferro-, and dielectric characteristics when matched with other polar polymorphic forms (γ and δ) of PVDF [1, 7–10].

To date, innumerable endeavors have been employed to obtain complete crystallization of a stable β-phase from the nonpolar α form of PVDF, but accomplishing this task is challenging. Electrospinning [11], electric and magnetic field application [12], and stretching and poling [13] of nonpolar PVDF are a few of the many techniques adopted

Supplementary information The online version of this article (https://doi.org/10.1038/s41428-019-0230-3) contains supplementary material, which is available to authorized users.

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Applied Physics Letters ARTICLE scitation.org/journal/apl

Photo-charging polymeric sodium-ion cell based on YSZ/PVDF film

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ABSTRACT

A cost-effective, light-weighted, and easy to handle photochargeable Na-ion power cell (NPPC) has been demonstrated by integrating solar active solid electrolyte poly(vinyl alcohol)-carbon black-V_2O_5-Na_2SO_4 and a high dielectric YSZ/PVDF film in a very simple and unique way. An open circuit voltage of ~1.18 V is obtained under photocharging of the NPPC by light with an intensity of ~110 mW/cm^2. The discharging phenomenon is investigated at a constant discharge current density of ~0.63 mA/cm^2. The reversible charging-discharging nature of the device is recorded repeatedly for 200 cycles to investigate the storage capacity. A maximum capacitance of ~2.84 mF/cm^2 is obtained with an energy density and a power density of ~5.6 mWhr/m^2 and ~ 7.4 W/m^2, respectively. The high storage impact of NPPC is realized in practical by glowing blue light emitting diodes for two days with high intensity.

The utilization of clean and renewable energy sources such as sunlight, wind, water, biomass energies, and geothermal energy is significantly increased due to the overall energy crisis.[1] So researchers are highly focused on the production of efficient, low-cost energy storage technologies for large-scale clean energy implementation. At present, different types of batteries (lithium and sodium ion batteries) have attracted tremendous attention in the application of medium/wide-scale energy storage arena.[2] But scientists are very much interested to develop some innovative idea of both renewable energy conversion and storage in one system.

Improvement of photovoltaic solar cells by using dye is a very good option for the restoration of the natural fossil fuels (petroleum, coal, etc.). Although the progress of lithium-ion/sodium-ion based energy storage devices, sodium ion capacitors, etc.,[3] is burgeoning, the photovoltaic self-charging polymeric composite system based on the sodium ion, which is capable of undergoing both solar to electrical energy conversion with storage, is rarely reported until now. Some kinds of dye sensitized solar cells, self-charging photocapacitors, etc., were already reported by Ma *et al.*, Guo *et al.*, and Miyasaka *et al.*[4,5] Previously, we have evaluated some different types of photoinduced power cells with the help of high dielectric polymer composite films and nanoparticle dye in combination with light absorbing organic dye with superior storage capability.[6–8]

As an electroactive polymer, poly(vinylidene fluoride)(PVDF) ([-CH2-CF2-]n) and its copolymers are very well known for their flexibility and cost effectiveness for the application of piezoelectric nanogenerators, capacitors, thin film transistors, grid leveling, rail runs, nonvolatile memories, sensors, and actuators, in biomedical fields, and also photopower banks. PVDF is an electroactive semicrystalline polymer with five polymorphs α, β, γ, δ, and ε and shows piezoelectric, pyroelectric, and ferroelectric properties with very good thermal stability and chemical resistance.[9–11] Among the five crystalline phases, the β phase is the most electroactive phase since it contains the *all trans* (TTTT) planar zigzag arrangement with the orthorhombic unit cell matrix.[12]

So for the advancement of the β phase with good dielectric properties, we choose a ceramic compound yttria stabilized zirconia (YSZ), which is a cubic crystal of zirconium oxide stabilized by the addition of yttrium oxide as a filler of PVDF.[13] YSZ is a ceramic material, which has many applications in the case of jet engines, gas turbines, etc., due to its hardness and chemical structure, and it is also applicable as an electroceramic in different types of fuel cells for its ion-conducting properties. Here, a Na-ion based photovoltaic self-charging energy storage system, i.e., a photopower cell, is developed by using the initially prepared dielectric improved YSZ-PVDF composite film and a mixture of poly(vinyl alcohol) (PVA), vanadium pentoxide (V_2O_5),

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Portable Self-Powered Piezoelectric Nanogenerator and Self-Charging Photo-Power Pack Using In Situ Formed Multifunctional Calcium Phosphate Nanorod-Doped PVDF Films

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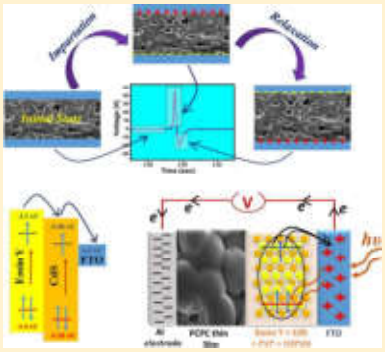
Supporting Information

ABSTRACT: Herein, biocompatible $Ca_3(PO_4)_2$ nanorod-incorporated poly(vinylidene) difluoride films have been prepared via an in situ process. A good piezoelectricity ($d_{33} \approx 56.6$ pC/N) along with a large dielectric constant of ∼3.48 × 10^5 at frequency 20 Hz has been achieved. Then, we have designed a biocompatible, highly durable, low-cost piezoelectric nanogenerator (CPNG) which shows the superiority in open-circuit voltage ∼47 V and current ∼1.8 μA generation with power density ∼47.4 mW cm^{-3} under the gentle touch of a finger. Excellent mechanical to electrical energy conversion efficiency (∼65.5%) of our developed CPNG leads to fast charging of a capacitor of 1 μF in 18 s and glowing of 26 light-emitting diodes (LEDs) under finger impartation. Further, a portable light-charging power pack (LCPP) has been developed using the high dielectric film as the storage function. Under light illumination, our LCPP generates open-circuit output voltage ∼1.29 V with short-circuit current 5.7 mA cm^{-2}. Areal capacitance ∼1779 F m^{-2} and storage efficiency ∼88% are achieved. The device is able to lighten up 22 LEDs for 10 days after charging once.



1. INTRODUCTION

At the end of the age of fossil fuels, exploring the challenging issues in energy research possibilities of sustainable, renewable, green energy sources such as wind, sunlight, rain, and geothermal is one of the most significant topics because of oil depletion, air pollution, and water pollution because of expenditure of traditional fossil fuels like petroleum, coal, and so forth. In this decade, modish electronic gadgets with multifunctionalities such as tablets, mobile phones, laptops, and various types of sensors are being widespread in our regular lives everywhere, which are run for a long time by the conventional lithium-ion electrochemical batteries.[1−7]

Therefore, our scientific community has been extensively involved to develop simplistic techniques for green energy-harvesting systems from the abundant energy resources in nature such as solar energy, water waves, winds, and so forth and also from our living systems like human motion, walking, talking, and so forth as well as they tried to design the electrical energy storage unit into the energy-harvesting device to overcome the energy demands and global warming issues in electronics industry.[5,8−14] Recently, few scientists are associated with the designing of a multifunctional device which have the energy-harvesting and electrical energy storage part in a single unit.[5,14] Numerous studies have been done on different materials, and methods for developing such types of energy-harvesting device are associated with the storage part, but the actual success is very much challenging to meet the modern society demands.[6,15−18]

In this decade, piezoelectric nanogenerators (PENGs) are the promising candidates for the direct mechanical energy to electrical energy convertor through the piezoelectric effect.[1,19,20] From the beginning, prototype PENGs have developed different types of piezoelectric materials such as PZT, $ZnSnO_3$, ZnO, $BaTiO_3$, (Na,K)−NbO_3, and piezoelectric perovskite materials, but there are some high weight, nonflexibility issues as well as toxicity effect that limited their adoptable utilization in various fields.[21−28] To overcome that type of limitation, due to lightweight, flexibility, cost effective, biocompatibility of electroactive poly(vinylidene fluoride) (PVDF) and its co-polymers have been widely used as the promising piezoelectric material to fabricate PENGs.[5,6,20,29−31]

PVDF is a thermoplastic and semicrystalline polymer having five distinct crystalline phases such as α, β, γ, δ, and ε which are

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Constraints on quintessence scalar field models using cosmological observations

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We consider a variety of quintessence scalar field models in a homogeneous and isotropic geometry of the Universe with zero spatial curvature aiming to provide stringent constraints using a series of cosmological datasets, namely, the cosmic microwave background (CMB) observations, baryon acoustic oscillations (BAOs), joint light curve analysis (JLA) from supernovae type Ia, redshift space distortions (RSDs), and the cosmic chronometers (CCs). From the qualitative evolution of the models, we find that all of them are able to execute a fine transition from the past decelerating phase to the presently accelerating expansion where, in addition, the equation of state of the scalar field (also the effective equation of state) might be close to that of the ΛCDM cosmology depending on its free parameters. From the observational analyses, we find that the scalar field parameters are unconstrained irrespective of all the observational datasets. In fact, we find that the quintessence scalar field models are pretty much determined by the CMB observations, since any of the external datasets such as BAOs, JLA, RSDs, and CCs does not add any constraining power to the CMB. Additionally, we observe a strong negative correlation between the parameters H_0 (present value of the Hubble parameter) and Ω_{m0} (density parameter for the matter sector, i.e., cold dark matter plus baryons) exists while no correlation between H_0 and σ_8 (amplitude of the matter fluctuation). We also comment that the present models are unable to reconcile the tension on H_0. Finally, we conclude our work with the Bayesian analyses which report that the noninteracting ΛCDM model is preferred over all the quintessence scalar field models.

DOI: 10.1103/PhysRevD.100.023522

I. INTRODUCTION

Since the detection of the accelerating Universe by measuring the luminosity distances of type Ia supernovae [1,2], a new era of modern cosmology has began. Subsequent investigations by different groups [3,4] conveyed that the current acceleration of our Universe could be an effect of some hypothetical fluid with large negative pressure known as dark energy [5], which is completely unknown by its character and origin. Usually, there are two distinct approaches to describe such accelerating expansion —one route is through modifications of the matter sector in the context of Einstein gravity [5–7], and the other way around is to modify Einstein's gravitational theories [8–16], which leads to some extra geometrical terms (alternatively known as geometrical dark energy fluids in order to make a difference between the accelerating effects coming from the matter modifications or geometry modifications). Apart from the above two approaches, there is another alternative to describe this accelerating Universe—the gravitational particle production mechanism; see [17–26], and references therein. However, overall, the actual dynamics of these mysterious components are unknown, but, thanks to the recent observational evidences, we have an estimate of such dark fluids. According to the observational predictions, such dark energy fluids contribute nearly 68% of the total energy density of our Universe [4]. Additionally, another bulk content of the matter sector, about 28% of the total energy density of our Universe, is occupied by some nonluminous dark matter component. Thus, overall, almost 96% of the total energy content of our Universe has been filled up by these dark fluids, namely, dark energy and dark matter, and probing their nature, evolution, and origin is one of the most intriguing facts of modern cosmology.

In the present work, we confine ourselves to Einstein gravity and, thus, incorporate dark energy fluid through the

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Association of Nutritional Status with Depression and Cognitive Function of Older Women Residing in Old-age Homes of Kolkata, India

Bidisha Maity, Debnath Chaudhuri,[1] Indranil Saha,[2] and Minati Sen[3]

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Abstract

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Introduction:

Ecotoxicology
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Check for updates

Evaluation of arsenic induced toxicity based on arsenic accumulation, translocation and its implications on physio-chemical changes and genomic instability in indica rice (*Oryza sativa* L.) cultivars

Barsha Majumder[1,2] · Susmita Das[1] · Baidyanath Pal[2] · Asok K. Biswas[1]

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Abstract

Arsenic (As) accumulation in rice is a principal route of As exposure for rice based population. We have tested physiochemical and molecular parameters together to identify low As accumulating rice cultivars with normal growth and vigor. The present study examined potential toxicity caused by arsenate (AsV) among four rice cultivars tested that varied with respect to accumulation of total arsenic, arsenite (AsIII) and their differential translocation rate which had deleterious impact on growth and metabolism. Intracellular homeostasis of rice cultivars viz., TN-1, IR-64, IR-20 and Tulaipanji was hampered by 21 days long As(V) treatment due to generation of reactive oxygen species (ROS) and inadequate activity of catalase (CAT; EC 1.11.1.6). Upregulation of oxidative stress markers viz., H_2O_2, proline and MDA along with alteration in enzymatic antioxidants profile were conspicuously pronounced in cv. Tulaipanji while cv. TN-1 was least affected under As (V) challenged environment. In addition to that genomic template stability and band sharing indices were qualitatively measured by DNA profiling of all tested cultivars treated with 25 µM, 50 µM, and 75 µM As(V). In rice cv. Tulaipanji genetic polymorphism was significantly detected with the application of random amplified polymorphic DNA (RAPD) tool and characterized as susceptible cultivar of As compared to cvs. TN-1, IR-64 and IR-20 that is in correlation with data obtained from cluster analysis. Hence, identified As tolerant cultivars viz., TN-1, IR64 and IR-20 especially TN-1 could be used in As contaminated agricultural field after appropriate field trial. This study could help to gather information regarding cultivar-specific tolerance strategy to avoid pollutant induced toxicity.

Keywords Arsenate · Arsenate reductase · Translocation · Oxidative stress · Genomic template stability · Band sharing index

Introduction

Arsenic (As) is a naturally occurring, non-essential environmental toxicant (Mirza et al. 2014; Armendariz et al. 2016). Arsenic toxicity is receiving increased awareness due to its adverse impacts on agronomic yield and ecosystem. Heavy metal accumulation in food chain is the root cause of undesirable ecological problem (Verstraeten et al. 2008; Thao et al. 2015). As contamination in Ganga-Brahmaputra basin is of considerable significance, posing serious health concern and endangering agricultural system. Major source of As exposure to economically important crops and human, especially in Bangladesh and West Bengal is As tainted water where As contents has been recorded upto 3200 µg/l (McCarty et al. 2011).

Increased concentrations of As severely affects plant growth by arresting biomass accumulation which can led to drop in productivity (Chandrakar et al. 2016a). Arsenic enters in plant-root system either as arsenate [As(V)] or arsenite [As(III)] of which latter one is considered as most harmful to all organisms. Nearly all plant species poses As (V) reduction ability through arsenate reductase (AR) enzyme, thereby, As (III) is found to be dominant species within the plant tissues under As(V) challenged

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Impact of insecticides on soil microbial biomass and its activity inegg plant (*Solanum melongena* L.) under field condition

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ABSTRACT

The effect of application of different insecticides either alone in repeated dose or in sequential combination on soil microbial biomass and its activity were assessed under eggplant cultivation in field conditions for three consecutive years (2015-2018) in both kharif and rabi seasons at Agricultural Experimental Farm, University of Calcutta, Baruipur, Kolkata. Four different insecticides namely Triazophos 40% EC, Cypermethrin 10% EC, Carbaryl 50% WDP and Azadiractin 10000 ppm were sprayed 35-45 days after transplanting and thereafter insecticidal applications were done at an interval of 15 days till harvest. Parallely, these four insecticides in sequences were sprayed 35-45 after transplanting and applied sequentially at an interval of 15 days till harvest at two possible sequences namely Triazophos, Carbaryl, Cypermetrin, Azadiractin or (S1) and Azadiractin, Cypermethrin, Carbaryl, Triazophos or (S2).Soil samples from treated and untreated plots were collected at the time of transplanting, before insecticide application (BIA), Two days after application of all the insecticide (AAIA), and at harvest in both the seasons. The results revealed that samples collected before insecticide application (BIA) showed non-significant ($p>0.05$) increase or decrease in different microbiological parameters i.e. Soil microbial biomass carbon (SMBC), Basal Soil Respiration (BSR), Substrate induced soil respiration(SIR), Fluorescein diacetate hydrolyzing activity(FDHA) with different treatments in both seasons as determined by Duncan's multiple range test (DMRT). However, two days after application of all insecticide in both seasons showed significant ($p<0.05$) inhibition in different microbiological parameters in comparison to untreated control with maximum inhibition in Triazophos treated plots and minimum in Azadiractin treated plots. Sequential treatments (S1) showed lesser inhibition than all the other treatments except the azadiractin plots while in (S2) the inhibition was found to be more than Cypermethrin and Azadiractin treatment in both the seasons. At harvest, all the microbiological parameters in the treated fields were statistically par with control fields.

Keywords: Insecticides, soil microbial biomass carbon, Basal soil respiration, Substrate induced soil respiration, Fluorescein diacetate hydrolyzing activity

INTRODUCTION

Soil is the first repository of different insecticides applied to different crops under field condition. It is reported that about 0.1%applied pesticides reaches the target organism whereas the soil environment is contaminated by the remaining bulk (Rajesh *et al.*, 2015).Soil harbors a variety of micro and macrofauna and flora *viz*., bacteria, actinomycetes, fungi, arthropods, crustaceans, earthworms etc. which forms the living dynamic system of the soil. Soil organisms, particularly micro-organisms play a myriad of essential processes in soil starting from organic residue degradation to cycling of nutrients. (Aislabie andDeslippe,2013). Insecticides used frequently ultimately reaches the soil as insecticidal "run off " from the crop plants and is accumulated usually in top 0-15 cm layer of soil where the microbial activities are found to be maximum (Bhavya*etal.* 2017). Pesticides in the soil affect the non target and beneficial microorganisms (Shao & Zhang,2017)and their activities that are essential for maintaining soil fertility (Bowles *et al.* 2014).The effect of pesticide on soil microorganisms is governed not only by the chemical and physical properties of the pesticide itself but also by soil type, soil properties, and prevailing environmental conditions (Kumar *etal.* 2017)**.**The microbial biomass is considered to be the living component of soil organic matter, having 1-5% of total organic matter content(Cardoso *et. al.* 2013,Ma *et.al.* 2016,Arora*et al.* 2019)and it react more quickly to the changes in soil conditions than the soil organic matter(Chaudhary*et al.* 2018).Soil respiration means that the living biomass of soil respires CO_2,where soil organisms gain energy from catabolizing organic matter to support life.

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Research Article

AN EASY SCREENING THROUGH*IN SILICO* STUDY FOR PREDICTIVE TOXICITY MECHANISMS OF DIFFERENT PHTHALATE COMPOUNDS BY USING ONLINE TOOL (PROTOX-II WEBSERVER)

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ABSTRACT

The phthalate compounds (PCs) are well-known plasticizers and easily exposed through environment. The present objective was an *in silico* study to detect toxicity mechanisms of common phthalates by using ProTox-II webserver. Different types of common PCs were selected as per recent literatures study. Total 14 nos. of PCs were selected for present predictive study. These PCs such as DEHP, DINP, DIDP, DPHP, DMP, DEP, BBP, MBP, PA, DNPP, DCHP, DAP, DNHP and DHP were studied. The prediction of different toxicity mechanisms was done by using ProTox-II webserver. The mechanism of toxicity of PCs indicated 10 compounds were obtained between the class of IV and V while 4 compounds were found class VI. The hepatotoxicity and immunotoxicity results were observed inactive for all compounds. All the compounds were found cytotoxic and mutagenic inactive, but 8 compounds obtained carcinogenic active.TheTox21-nuclear receptor signalling pathways revealed AhR, AR, AR-LBD, Aro, ER, ER-LBD, PPAR-Gamma were inactive except 1 compound active for ER and ER-LBD. For Tox21-stress response pathways, it was observed that 2 compounds were active for nrf2/ARE and HSE. The parameter MMP was active only for 1 compound. Other two parameters viz. p53 and ATAD5 obtained all the compounds were inactive. In conclusion, the present predictive results indicated that few PCs are harmful to animals and scattered information on toxicity mechanisms by few compounds found for human studies. This prediction may be suitable for further *in vitro* and *in vivo* research works in future to validate the present prediction.

Keywords: *In silico* study, Phthalate compounds, Plasticizers, Predictive toxicology, Mechanism of toxicity, Nuclear receptor signaling, Stress response pathways

1. INTRODUCTION

Phthalate derivatives are used for the manufacturing of plastic materials. On the other hand, in present days, plastics are used to make toys, container for blood and several liquid medicines, potable water, raw and cooked food materials, etc. [1-5]. According to the researchers, phthalates are not covalently bound to plastics and it has tendency to leach into the medium [4, 6-10].

It has been well-established that these phthalates cause several types of cancer, endocrine disruption, teratogenicity, etc. [5, 10-12]. An informative research work revealed that the higher energy intake in the overweight and obese due to higher di-2-ethylhexyl phthalate (DEHP) exposure, which indicated close relationship between body mass index and DEHP[13].In another study it was observed positive correlations between serum dibutyl phthalate (DBP) or mono(2-ethylhexyl) phthalate (MEHP), and serum estradiol (E2) and/or luteinizing hormone (LH) in prepubescent children while serum monobutyl phthalate (MBP) levels were found to be negatively correlated with serum triiodothyronine (T3) or thyroxine (T4) in male participants, and serum DEHP levels with serum thyroid stimulating hormone (TSH) in female adolescents. Low-density lipoprotein (LDL) levels were positively correlated with serum phthalic acid (PA) levels in children and adolescents. DEHP, DBP or its metabolites may be associated with altered hormone levels in Korean children and adolescents [14].

In earlier research work, researchers have been studied individual phthalate or multiple phthalates to determine health impact in relation to particular parameter such as toxicity, carcinogenicity especially particular cancer type, teratogenicity, endocrine disruption, etc. on human and/or mammals, which was observed long duration, financial burden as well as animal harming, etc.

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সম্পাদক
সৌরভ বর্মন

বিষয়ে কয়েকটি জ্ঞাতব্য বিষয়

বষণাধর্মী প্রবন্ধ পাঠাতে হবে। অনধিক ৩০০০
০০ শব্দের সারাৎসার পাঠাতে হবে।
াখা পাঠানো যাবে। ১৪ ফন্টে লেখা পাঠাতে
সফট কপি (লেখা নির্বাচিত হলে) পাঠাতে
সহ পরিচ্ছন্ন লেখা পাঠাবেন।
না হবে না। লেখার কপি রেখে লেখা পাঠাবেন।
প্রকাশ করা হয় না।
র্বাচিত হয়েছে কিনা তা জানতে ৩/৪ মাস

পাঠানোর ঠিকানা

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প্রাপ্তিস্থান

াতিরাম বুকস্টল, কলেজ স্ট্রিট / ধ্যানবিন্দু,
/ এবং পত্রিকা দপ্তর

সূচিপত্র

গীতগোবিন্দ ও শ্রীকৃষ্ণকীর্তন : একটি তুলনামূলক সমীক্ষা

মৌসুমী বিশ্বাস*

সারসংক্ষেপ : ভারতীয় তথা বিশ্ব সাহিত্যের অমূল্য সম্পদ জয়দেবের 'গীতগোবিন্দ' কাব্য। জয়দেব দ্বাদশ শতকের গৌড়াধিপতি লক্ষ্মণ সেনের সভাকবি ছিলেন। তিনি সংস্কৃত ভাষায় 'গীতগোবিন্দ' কাব্যটি রচনা করেছিলেন। আদি মধ্যযুগের বাংলা সাহিত্যের নিদর্শন বড়ু চণ্ডীদাসের 'শ্রীকৃষ্ণকীর্তন' কাব্যে জয়দেবের 'গীতগোবিন্দ' কাব্যের বিশেষ প্রভাব লক্ষ করা যায়। বড়ু চণ্ডীদাস জয়দেবকে অনেক ক্ষেত্রে অনুকরণ ও অনুসরণ করলেও তাঁর নিজ মৌলিক প্রতিভার গুণে কাব্যটিকে কালজয়ী হয়ে ওঠেছে। তুলনামূলক আলোচনার মধ্য দিয়ে দুই কবির প্রতিভার পরিচয় তুলে ধরারই প্রয়াস রয়েছে আমাদের।

সূচক শব্দ : জয়দেব, গীতগোবিন্দ, বড়ু চণ্ডীদাস, শ্রীকৃষ্ণকীর্তন, রাধা, কৃষ্ণ, বড়াই, অনুসরণ, অনুকরণ স্বতন্ত্রতা, রাসলীলা।

'গোবর্দ্ধনশ্চ শরণো জয়দেব উমাপতিঃ।
কবিরাজশ্চ রত্নানি পঞ্চৈতে লক্ষ্মণস্য চ ।।'

ঐতিহ্যানুসারে এবং প্রাপ্ত তথ্যাদির সদ্ব্যবহারে বলা যায় , দ্বাদশ শতকের গৌড়াধিপতি লক্ষ্মণ সেনের পঞ্চরত্নের অন্যতম শ্রেষ্ঠ রত্ন ছিলেন কবি জয়দেব গোস্বামী। তিনি সংস্কৃত ভাষায় 'গীতগোবিন্দ' কাব্যটি রচনা করেছিলেন। জয়দেবের 'গীতগোবিন্দ' গ্রন্থটি ভারতীয় তথা বিশ্ব সাহিত্যের এক অমূল্য সম্পদ। জয়দেবের এই কাব্যগ্রন্থটি সমসাময়িক বা পরবর্তী কালের সাহিত্যে বিশেষ প্রভাব ফেলেছে। আদি মধ্যযুগের বাংলা সাহিত্যের নিদর্শন বড়ু চণ্ডীদাসের 'শ্রীকৃষ্ণকীর্তন' কাব্যে জয়দেবের 'গীতগোবিন্দ' কাব্যের যথেষ্ট প্রভাব লক্ষ করা যায়। বড়ু চণ্ডীদাস জয়দেবকে অনেক ক্ষেত্রে অনুকরণ ও অনুসরণ করলেও তাঁর নিজ সৃজনশীল প্রতিভার গুণে 'শ্রীকৃষ্ণকীর্তন' কাব্যটিকে কালজয়ী করে তুলেছেন।

জয়দেব ও বড়ু চণ্ডীদাস দুজনেই চৈতন্য পূর্ববর্তী কালের কবি। দুজনেই অঞ্চলগত দিক থেকে 'রাঢ়ের কবি'। যদিও উভয়ের জন্মস্থান নিয়ে নানা বিতর্ক আছে। তবে সর্বসম্মত পণ্ডিত মণ্ডলীদের অভিমতে বলা যায় , জয়দেবের জন্মস্থান বীরভূমের কেন্দ্রবিন্দু বা কেঁদুলিতে এবং বড়ু চণ্ডীদাসের জন্ম কেউ কেউ বলেন, বাঁকুড়া জেলার ছাতনা। কারো মতে, বীরভূমের নানুর। আবার উভয় কবির কাব্যের বিষয় রাধাকৃষ্ণের প্রেমলীলার কাহিনী। ফলে একই

*অধ্যাপক, বাংলা বিভাগ, নেতাজীনগর কলেজ ফর উইমেন।

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Article

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Microstructure and Dielectric Properties of Naturally Formed Microcline and Kyanite: A Size-Dependent Study

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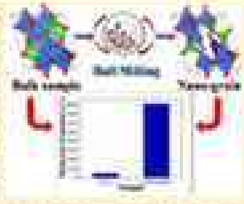
Supporting Information

ABSTRACT: The present article reports the crystal defect-mediated changes in electrical characteristics, especially, dielectric properties, of naturally formed microcline and kyanite in two different size fractions. A facile top-down synthesis approach has been adopted to achieve the nanosized samples. Structural and morphological studies have been carried out using X-ray diffraction, field emission scanning electron microscopy, and Fourier transform infrared spectroscopy. Phase purity and microstructural characteristics of the samples were investigated by performing the Rietveld refinement method. Microstructural analysis reveals that the sample size has been greatly reduced to the nano-region after the mechanical ball-milling process, and the milling process eventually introduced some defects in the nanosized samples. UV−vis spectroscopy reveals the optical absorption characteristics and the band gap values of the samples. A major outcome of the present study is the enhancement of the defect states naturally formed samples using the mechanical milling method and the defect-mediated electrical response with varying temperature and frequency. Remarkably high dielectric permittivity values (77.3 × 10[illegible] for AP2 and 8456 × 10[illegible] for KY2) in the nanosamples along with low tangent losses and good industrial feasibility of synthesis make the nanosized samples a potential material for fabricating low-cost energy storage devices.



1. INTRODUCTION

Naturally formed minerals are continually disintegrating in nature due to their exposure to various environmental stresses, such as corrosion, ice, temperature changes, and oxidation conditions along with dissolution and crystallization of minerals.[1] They are found in various size ranges in nature, which may be coarse (1−2 μm) or colloidal or of finer sizes (<0.1 μm), depending on the duration of exposure to the mechanical disintegration of the parent rock.[2]

Materials show radically different physicochemical properties such as optical, electrical, magnetic, catalytic behavior, etc. as compared to the corresponding bulk counterparts in the nanoregime due to enhanced surface to volume ratios.[3−5] New methods are employed that utilize these properties of solids and colloids to fabricate cost-effective devices such as solar cells, supercapacitors, sensors to increase their functionalities.[6−10] Moreover, in recent times, scientists are giving more emphasis to ecofriendly, biocompatible, economical, and easily accessible natural materials for fabrication of new technologies such as supercapacitors, solar cells, etc.

Silicates are the most abundant mineral found on the earth's surface, especially feldspar minerals.[11] Generally silicates, aluminosilicates, and feldspar materials are reported to have a low dielectric constant value of approximately in the range of 3−6, and hence they are extensively used in semiconductor devices, microelectronics, and integrated circuits.[12−14] Various studies revealed that the dielectric constant considerably decreases with the increase in the silicate content within the structure.[15,16] Moreover, the presence of modifying cations such as K^+, Na^+, Mg^{2+}, Ca^{2+}, etc. and their consecutive migration within the structure determines the electrical properties of the aluminosilicates.[17] Feldspars are aluminosilicates comprising AlO_4 and SiO_4 linked structures and also may contain cations having ionic radii larger than 1.0 Å such as Na^+, K^+, and Ca^{2+} that stoichiometrically balance the aluminum in the structure.[18,19]

Although they are abundant in nature, an insufficient amount of interest has been paid to study the electrical properties of naturally obtained silicates as a function of both size and crystallinity. Besides, it is a challenge to bring naturally formed minerals to usable form, mainly due to the presence of impurities. Being a natural compound, it has various useful properties as well as major applications in industries, but no such studies have been carried out to understand the size- and crystallinity-mediated electrical properties of these naturally formed materials. Besides the size factor, the presence of alkali

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Nanoparticle Size-Dependent Antibacterial Activities in Natural Minerals

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The size-dependent antibacterial activities of three minerals namely: alkali feldspar, calcite and siderite are reported as examined individually against *Escherichia coli* and *Staphylococcus aureus* by evaluating minimum inhibitory concentration (MIC) with colony counting method, along with cell survivability assay (MTT). Each of these minerals were grinded into fine-size fractions—S1 (bulk), S2 (ball milled) and S3 (nanosized) and spectroscopically characterized using X-ray diffraction (XRD), field emission scanning electron microscopy (FESEM) and ultraviolet-visible (UV-Vis) spectroscopy. Antibacterial activity was found to be highest in the nanosized (S3) minerals. Interaction between bacteria and nanosized mineral samples produce intracellular reactive oxygen species (ROS), which might cause higher bacterial mortality. The penetration due to nano-dimension is another significant observation as evidenced by bacterial FESEM micrographs. The current findings thus provide a pathway for future research on antibacterial products retrievable from widely available geological materials. The size-dependent antibacterial activity of naturally formed minerals is a new insight to reduce bacterial contamination in living systems.

Keywords: Nanoparticles, Bacteria-Mineral Interaction, MIC, ROS, FESEM.

1. INTRODUCTION

Minerals are essential natural resources that have huge impact on human health and have been used for medical and other purposes for thousands of year.[1] By linking the naturally available materials with biomedical aspects, the researchers and geoscientists are attempting to discover ways of mitigating environmental health problems.[2] The recognition of an intimate relationship between the environment, particularly geological materials and human health has led to the emergence of a new field of science called medical geology,[3] which deals with the relationship between geological materials such as rocks and minerals, with the health problems in humans, animals and plants.[4–6] New products are now developed from minerals due to their bactericidal properties, such as in minerals like Talc, Halloysite, Sericite[7,8] which are used in different medical and dermatological products. Antibacterial tiles and ceramics, antibacterial architectural coatings, etc. can also be made from commonly occurring minerals.[7,8] This is leading to the emergence of geomicrobiology which is an emerging frontier of interdisciplinary science.

The science of geomicrobiology focuses mainly on the studies of mineral-microbe interactions and their applications[9] since minerals and rocks are the most fundamental earth materials with which microbes interact at all scales, from macroscopic to microscopic.[10–12] Many rocks and minerals contain the essential nutrients and energy required for microbial growth, and microbes actively extract nutrients from solid materials to sustain their metabolism and growth.[13] The modern era is giving emphasis on researches on novel, active and eco-friendly antibacterial reagents,[14] as microbes are developing increasing resistance to multiple antibiotics. Thus demand of low cost, non-toxic natural antibacterial products have increased[15,16] beside various well known metal and metal oxide nanoparticles, such as CuO, ZnO, Ag^+, etc.[17–22]

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Gd(III)-Doped Boehmite Nanoparticle: An Emergent Material for the Fluorescent Sensing of Cr(VI) in Wastewater and Live Cells

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Supporting Information

ABSTRACT: This article reports the effect of Gd(III) doping on the structure, microstructure, and optical properties of boehmite nanoparticles. The bright-blue fluorescence along with a long lifetime makes our material an efficient candidate for optical applications. Our material particularly targets and eliminates hexavalent chromium ions [Cr(VI)] from aqueous media, which turns it into a multifunctional fluorescent nanosensor (MFNS). The development of an efficient hexavalent chromium ion [Cr(VI)] sensor to detect and quantify Cr(VI) ions is still a serious issue worldwide. Thus, this work will be very beneficial for various environmental applications. No such work has been reported so far which includes cost-effective and biocompatible boehmite nanoparticles in this field. Detailed synthesis and characterization procedures for the MFNS have been incorporated here. The biocompatibility of the MFNS has also been studied rigorously by performing cell survivability assay (MTT) and cellular morphology assessments. Our extensive research confirmed that the "turn-off" sensing mechanism of this sensor material is based on a collisional quenching model which initiates the photoinduced electron transfer (PET) process. High selectivity and sensitivity ([illegible] M) of the MFNS toward hexavalent chromium ions even in real-life wastewater samples have been confirmed, which makes this fluorescent probe a potential candidate for new age imaging and sensing technologies.

1. INTRODUCTION

The development of new-generation fluorescent sensors is currently of great research interest because they play a crucial role in detecting and quantifying various infections and diseases in biological systems.[1,2] Sometimes, they can locate and stamp an infection on the cellular level.[3] Not only biological systems but also these sensors can provide important information regarding any type of chemical contamination by modulating its fluorescence level.[4,5] Researchers and scientists are working to enhance the limit of detection (LOD) and the fluorescence properties of these sensors. Thus, the fabrication of biocompatible, efficient fluorosensors is an emerging research topic.

Recent studies on hazardous ion sensors such as heavy metal ions [Hg(II), Cd(II), Cr(III), etc.][illegible] and toxic anions (nitrate, dichromate, etc.)[illegible] dominate the studies on all other fluorosensors because of their huge applicability and excessive demand. Moreover, various diseases, such as congestive heart failure,[illegible] liver infection,[illegible] and lung cancer,[illegible] can occur in the presence of such toxic ions. Some essential metal ions, including Fe^{3+}, Cu^{2+}, Mn^{2+}, and Co^{2+}, can also be toxic at higher doses.[illegible] In addition, other heavy metal ions, such as Hg^{2+}, Cd^{2+}, Pb^{2+}, and As^{3+}, are extremely toxic to humans and aquatic species even in lower concentrations, and the bioaccumulation of these metal ions can culminate in severe health hazards.[illegible]

Hexavalent chromium [Cr(VI)] is a well-known carcinogen[illegible] that is rapidly spreading as a result of its wide applications in leather tanning, metallurgy, chromium electroplating, and pigment production.[illegible] Because of its enormously harmful nature to human health and the environment, its detection and segregation from water streams have become immensely challenging.[illegible] Apart from these, the accumulation of Cr(VI) in aquatic living varieties can cause biomagnification.[illegible] Therefore, developing selective and sensitive methods to detect and remove Cr(VI) ions for environmental monitoring, medical diagnostics, and food safety is of considerable importance.

We have synthesized a novel material, Gd(III)-doped boehmite nanoparticles, which has not been reported previously to the best of our knowledge. Thus, proper characterization has been done along with microstructural analysis by using the Rietveld refinement method to understand the effect of Gd doping into the boehmite matrix.[illegible] Interestingly, gadolinium incorporation enhances the optical

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Folic acid conjugated curcumin loaded biopolymeric gum acacia microsphere for triple negative breast cancer therapy in invitro and invivo model

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ABSTRACT

Among the different types of biomaterials, natural excipients gum acacia (GA) is economic and has the potential for controlled drug delivery. We have synthesized GA microspheres by co-precipitation method and characterized them by XRD, FESEM, ^{1}H NMR, FTIR, UV visible spectra and DLS. Despite its potential anti-cancer activity, solubility of curcumin is very low rendering its limit in application. We have used GA microspheres where curcumin can be loaded comfortably and thereby increases its bioavailability. The cytotoxicity of curcumin encapsulated GA microspheres was evaluated on triple negative breast cancer cell lines. They were found to induce apoptosis by perturbing the mitochondrial membrane potential. Folic acid was conjugated to curcumin encapsulated GA microspheres, for delivering it specifically to the cancer cells. The in-vivo study in BALB/C mice model exhibited more tumor regression in case of folic acid targeted curcumin encapsulated GA microsphere. Our results implicates that these microspheres can be an effective therapeutic agent to folate receptors over expressing cancer cells.

1. Introduction

Development of biopolymeric materials for gene and drug delivery has become an emerging and promising sector in the biomedical research field. At present, cancer is one of the most challenging diseases threatening human health and the occurrence of cancer continues to increase day by day. Breast cancer is the most commonly diagnosed cancer and it is responsible for 25% of all cancer cases and 15% of all cancer deaths among females across the globe [1]. Among the different sub-type of breast cancer, triple negative breast cancer (TNBC) refers to the most aggressive breast cancer phenotype where ER (Estrogen Receptor), PR (Progesterone Receptor) and HER2 (human epidermal growth factor receptor 2) are negative [2–4]. Till now, no effective treatment for metastatic TNBC is available following surgery, radiation and chemotherapy [5–6].

Recent findings showed that natural products play a promising role in cancer therapy [7–9]. A considerable number of anticancer agents, used in the clinic are either natural or derived from natural products from various sources such as plants as well as microorganisms [10]. Among them, curcumin derived from the plant Curcuma longa have great role in different type of disease including cancer, arthritis, atherosclerosis, diabetes and auto-immune diseases [11,12]. One of the potent medicinal properties of curcumin is its anticancer efficacy which enables it to induce apoptosis in various cancer cells like breast, lungs, prostate, and colon without causing any cytotoxic effect on other healthy cells [13]. This compound is known to activate cell death signals and induce apoptosis in pre-cancerous or cancer cells without affecting normal cells, there by inhibiting tumor progression [14–17]. Regardless of its benefits in cancer therapy, it has poor solubility in the aqueous solvent which restricts its therapeutic applications in cancer treatment [18,19].

In the past few years, multifunctional nano and micro carriers have been documented as great potential drug delivery system (DDS) for cancer medicine because of their various biomedical applications like diagnosis, therapy, cell imaging [20–22]. Gum Acacia (also known as Gum Arabic) is a natural gum procured from the hardened sap of various species of acacia tree, predominantly from two related species, namely *Acacia senegal* and *Vachellia* (*Acacia*) *seyal*. Gum acacia is a

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An *In Vivo* Study for Targeted Delivery of Curcumin in Human Triple Negative Breast Carcinoma Cells Using Biocompatible PLGA Microspheres Conjugated with Folic Acid

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Among the different types of polymeric vehicles, (PLGA) is biodegradable and has emerged as promising tool for the delivery of cancer therapeutics. The salient features of PLGA micro carriers include prolonged circulation time, increased tumor localization and biodegradability and effectiveness of the therapeutics. We have synthesized PLGA microspheres where curcumin can be loaded and thereby increases its bioavailability. The cytotoxicity of curcumin (PLGA@CCM) microspheres was evaluated on triple negative breast cancer (TNBC) cell lines. They were found to induce apoptosis by perturbing the mitochondrial membrane potential. PLGA@CCM@FA induces apoptosis in human triple negative breast cancer cells by up-regulating Cleaved caspase-3 and down regulates p-AKT. The *in-vivo* study in BALB/C mice model exhibited more tumor regression in case of PLGA@CCM@FA microspheres. Our results suggests that these microspheres can be an effective vehicle for delivery of hydrophobic drugs to the folate over expressed cancer cells.

Keywords: PLGA, Curcumin, Enhanced Bioavailability, Folic Acid, Animal Model.

1. INTRODUCTION

Polymeric materials for gene and drug delivery in combating challenging diseases have become an emerging and promising sector in the biomedical research field.[1] Presently, cancer is one of the most challenging diseases threatening human health and the occurrence of cancer persists to increase by leaps and bounds. Breast cancer is the most threatening and commonly diagnosed cancer and it is responsible for 25% of all cancer cases and 15% of all cancer deaths among females across the globe.[2] Among the different sub-type of breast cancer, triple negative breast TNBC refers to the most aggressive breast cancer phenotype where ER (Estrogen receptor), PR (Progesterone receptor) and HER2 (human epidermal growth factor receptor 2) are negative.[3] Till date date no such effective treatment has been implemented successfully for metastatic TNBC following surgery, radiation and chemotherapy.[4–7]

Recent findings showed that natural products play a pivotal role in cancer therapy. A considerable number of anticancer agents, used in the clinic are either natural or derived from diverse sources such as plants as well as microorganisms.[8] Among them, curcumin derived from the plant *Curcuma longa* have great role in different type of disease including cancer, arthritis, atherosclerosis, diabetes and auto-immune diseases.[7,8] This compound is known to activate cell death signals and induce apoptosis in pre-cancerous or cancer cells like breast, lungs,

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Annexure-5A/1

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IMPACT OF SELF-HELP GROUPS IN RURAL LIVELIHOOD: A CASE STUDY IN HOOGHLY DISTRICT IN WEST BENGAL

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ABSTRACT

Self Help Groups (SHGs) have helped in the economic betterment of the rural poor, especially the women, in India. This paper, based on the primary data collected from the field survey in Pandua Block of Hooghly district in West Bengal, aims to examine the socio-economic impact of Self-Help Groups on the livelihood of the rural poor. Self Help Group programmes have helped the rural poor, particularly rural woman, to gain access to credit from various financial institutions. Farther, the SHGs have become a vital tool to alleviate poverty to some extent and also improve the socio-economic conditions of the rural poor. The economic development of India and the socio-economic upliftment of the rural poor will largely depend on the entrepreneurship, employment and mobilization, utilization and generation of capital by this section of the society.

Keywords: Self Help Groups, Rural poor, Sustainable livelihood, Microfinancing

1. INTRODUCTION

The rural poor generally have restricted access to sustainable financial services. The conventional financial institutions do not often cater to the needs of these low-income rural families as the income of these households is often unstable and they do not possess collateral with a clear title. The banks also consider the low-income rural households a bad risk, thereby imposing high information monitoring cost in operation. In order to address the needs of the poor, especially the women, a participative model of microfinancing like Self Help Group can be of great help.

A Self-Help Group (SHG) is a village-based financial intermediary usually composed of 10–20 local members, who can be either only men, or only women, or only youth, or a mix of these, preferably from the same socio-economic background. A SHG is formed independently without

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Functionalised biomimetic hydroxyapatite NPs as potential agent against pathogenic multidrug-resistant bacteria

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Abstract

The persistent dissemination of resistant bacterial strains is a grave contemporary global impediment in hospital-acquired infections which needs to be mitigated with immediate effect. In particular, infections from pathogenic multidrug-resistant (MDR) Gram-positive bacteria (like *Enterococcus faecalis*) which are resistant to conventional antibiotic therapy are attracting immediate global attention. Here we report the synthesis of nanoscale hydroxyapatites (HAPs), which are the well known biomimetic ceramic material having needle shaped morphologies. We have encapsulated vancomycin (VAN) within these nanoparticles and have conjugated the targeting ligand (folic acid) by a facile synthesis process in order to enhance the therapeutic efficacy against MDR *E. faecalis*. These functionalised HAPs are thoroughly characterised by employing field emission scanning electron microscopy (FESEM), powder x-ray diffraction (PXRD), ultraviolet-visible spectroscopy (UV-Vis) and dynamic light-scattering (DLS) techniques. Our results suggest that these functionalised HAPs could successfully transport vancomycin across the cell wall of MDR *E. faecalis* through endocytosis. The determination of selective antibacterial activity has been envisaged with the help of extensive *in-vitro* assays like the minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC) and the generation of reactive oxygen species (ROS). This study vividly establishes that this folic acid conjugated HAPs are promising antibacterial agents against MDR *E. faecalis* and related pathogenic resistant bacterial strains.

Keywords: hydroxyapatite nanoneedle, vancomycin, folic acid targeting, multidrug-resistant, enterococcus faecalis, antibacterial drug delivery
Classification numbers: 2.04, 2.05, 5.00, 5.08, 5.09

1. Introduction

The emergence of drug-resistant bacteria has posed a grave threat to the modern society. The antibiotic-resistant bacteria are the primary driving force behind millions of deaths that occur every year worldwide as mentioned in the previous reports [1, 2]. Furthermore an incessant decline in approved antibiotics in the past decade is responsible for aggravating this issue. This has given rise to the need of the development of alternate strategies that would help in overcoming the resistance in bacterial strains. Numerous active strategies including the development of novel antibiotics have been implemented for the treatment of multidrug-resistant (MDR) bacteria. The functionalisation of nanomaterials is a very effective process to develop antibacterial agents for the treatment of MDR bacteria. The fluorescent-carbon quantum

