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Optimization of anti-corrosion performance of novel magnetic polyaniline-Chitosan nanocomposite decorated with silver nanoparticles on Al in simulated acidizing environment using RSM

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Keywords:
Ag@PANI-CS-Fe_3O_4
Corrosion inhibitor
Response surface optimization

ABSTRACT

The suitability of newly synthesized magnetic polyaniline-Chitosan nanocomposite decorated with silver nanoparticles (Ag@PANI-CS-Fe_3O_4) as a robust corrosion inhibitor for Aluminum (Al) in a 5 M HCl environment has been investigated via Weight Loss (WL), Alternating Current (AC)-Impedance Spectroscopy (IS), Potentiontiodynamic polarization (Tafel plots), and Scanning Electron Microscopy (SEM) techniques. The protection efficiency (PE) was mathematically modeled using the Response Surface Methodology (RSM) to fit an empirical relation in terms of temperature, nanocomposite concentration, and time using the face-centered central composite design. The model was accurate with a coefficient of determination (R^2 = 99.27%). The negative Gibb's free energy of adsorption (ΔG_{ads}) values confirmed the spontaneity of Freundlich adsorption isotherm process on Al in 5 M HCl solution. The optimization simulation yielded maximum protection efficiency (of 97.88%) at 5 mg/L nanocomposite concentration, 1 h time, and an intermediate temperature of 304.8 K. Furthermore, the sensitivity of PE was evaluated to find that the low temperature 303 K is favorable for PE, whereas higher temperature will act adversely on PE. The results obtained by the RSM model are in agreement with the experimental observations.

1. Introduction

Corrosion of Aluminum (Al), Mild Steel (MS), Copper (Cu), Stainless Steel (SS), and Brass is responsible for a variety of losses, especially in industrial sections. These metals are having an immense value in defense, household, and industrial sectors at the universal level. Aluminum metal is universally used in many industrial sections such as chemical batteries, machinery, valves, and reaction vessels due to its corrosion resistance nature (oXide layer on Al surface) [1]. But, Al undergoes corrosion in an acidic pickling environment. Al corrosion is a constant progression and cannot be completely reduced. However, some robust corrosion control techniques can mitigate the Al disintegration rate and prevent losses [2–5]. Among the many corrosion control techniques, corrosion inhibitors are preferred because, it is easy to use, low cost, and no special apparatus is needed. Inhibitors are the substances that, when introduced into the corrosive liquids retards the Al corrosion rate by forming a barrier layer on the Al surface. The electronic characteristics and molecular structures of inhibitor molecules are the key parameters that enhance the capability of corrosion inhibitors to get adsorbed on the surface of Al. Organic species are recognized as competent corrosion inhibitors for Al in the acidic pickling system as they possess N, S, P, and O atoms along with pi electrons which participate in physical or chemical adsorption process owing to which corrosion inhibitor molecules effectively binds on Al surface and generates invisible protective layer [2]. Different types of corrosion inhibitors are toXic to the aquatic lives and environment. Therefore, this justification greatly frustrates the use of imported inhibitors in process chemical industries. The species such as ionic liquids, natural polymers, bio extracts, and amino acids are less harmful to the environment and humans have been employed for the mitigation of Al corrosion [6–10]. The green approach received good attention due to its low cost, availability, and zero or little negative environmental effect has been acknowledged [11–13].

The nanoscience scientist focused on an exploration of the synthesis of new nanocomposites and related phenomena for the mitigation of Al

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WAVES IN RANDOM AND COMPLEX MEDIA
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Numerical study of Reiner-Rivlin nanoliquid flow due to a rotating disk with Joule heating and non-uniform heat source using Bulirsch-Stoer algorithm

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ABSTRACT

The flow of a Reiner-Rivlin hydromagnetic nanoliquid due to rotating disk in the presence of Joule heating and a non-uniform heat source is investigated. To control the volume fraction of nanoparticles on the surface of a disk, a realistic passive control strategy is used, taking the thermal jump condition into account. Nonlinear governing differential equations are solved numerically using the Bulirsch-Stoer technique and a parametric analysis is performed using graphical representations. Using the Response Surface Methodology (RSM), the interaction effects of the influential parameters on the rate of heat transfer are visualized via three-dimensional surface graphs and contours. Further, the optimum rate of the heat transfer is estimated through the RSM analysis. It is found that the surface drag demotes due to enhancement in the cross-viscosity coefficient. A rise in the space-dependent heat source augments the temperature profile. The heat transfer rate is negatively influenced by the Eckert number. Further, when thermal slip is augmented, the sensitivity of the heat transfer towards the Hartmann number decreases at the rate of 0.2267%, and the sensitivity towards the Reiner-Rivlin fluid parameter decrements at the rate of 0.0554%.

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KEYWORDS
Reiner-Rivlin fluid; nanofluid; sensitivity analysis; Joule heating; irregular heat source

Nomenclature

u, v, w	Velocity components (m/s)
T	Fluid temperature (K)
C	Volume fraction of nanoparticles
M	Hartmann number
B_0	Magnetic field of uniform strength
r, ϕ, z	Cylindrical coordinates
T_w	Temperature of the material near the disk (K)
T_∞	Temperature of the ambient fluid (K)
B	Temperature dependent heat source/sink parmeter
C_∞	Ambient nanoparticle volume fraction

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WAVES IN RANDOM AND COMPLEX MEDIA
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Bulirsch-Stoer computations for bioconvective magnetized nanomaterial flow subjected to convective thermal heating and Stefan blowing: a revised Buongiorno model for theranostic applications

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ABSTRACT

Theranostics is a novel procedure that integrates therapy and diagnosis in a single platform. For its application in theranostic and photothermal therapy for melanoma skin cancer, the hydromagnetic bioconvective flow of a nanomaterial over a lengthening surface is investigated. Realistic nanomaterial modeling is achieved by incorporating passive control of the nanoparticles at the boundary. The impact of the Newtonian heating and Stefan blowing constraints are also accounted. Apposite transformations are employed and then transmuted nonlinear ODEs are resolved using the Bulirsch-Stoer and Newton-Raphson methods. The influence of Stefan blowing parameter $(-3 \leq Sb \leq 3)$, the magnetic field parameter $(0.8 \leq M \leq 1.2)$, and the Biot number $(0.2 \leq Bi \leq 0.4)$ on the heat transfer rate has been scrutinized and optimized utilizing the response surface methodology (RSM). The sensitivity of heat transport rate is computed. It is found that the Newtonian thermal condition intensifies the nanomaterial temperature that serves as a crucial role in the termination of cancerous cells or tumors. The maximum drag coefficient is experienced for the insignificant intensity of the magnetic field and Stefan blowing. Further, the heat transfer rate is maximum when the Stefan blowing and Biot numbers are at a high level and the Hartmann number is at a low level.

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KEYWORDS
Nanofluid; MHD; bioconvective flow; response surface methodology; Stefan blowing; convective boundary condition; theranostic applications

Nomenclature

N_∞	ambient microbial concentration
u_w	stretching velocity (ms^{-1})
b	chemotaxis constant (m)
Q_t^*	coefficient of thermal heat source $(Jm^{-3}K^{-1}s^{-1})$
x, y	Cartesian coordinates (m)
C_∞	ambient nanoparticle volume fraction
q_r	radiative heat flux

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Cattaneo-Christov Theory to model heat flux effect on nanoliquid slip flow over a spinning disk with nanoparticle aggregation and Hall current

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ABSTRACT

The heat transport of a nanoliquid on a spinning disk with velocity slip and thermal jump boundary conditions is modeled. The effects of external magnetism and the aggregation of nanoparticles are analyzed. The Cattaneo-Christov heat flux model and the Joule heating phenomenon are incorporated in the thermal analysis. The central composite design (CCD) of the response surface methodology is implemented to optimize heat transfer in the nanoliquid. The sensitivity of the heat transport is analyzed. The partial differential governing model is converted into a system of ordinary differential equations using a novel von Karman's transformation, the consequent system is solved numerically. The significance of physical operating parameters is analyzed through a detailed parametric study. Optimal levels of Hall parameter, Hartmann number, and Eckert number, that optimize the heat transport are determined. The Lorentz force expands the structure of the thermal layer and subsequently reduces the heat transport of the system. The Hall current improves the thickness of the velocity layer in the radial direction, while the thickness of the thermal layer is reduced. Viscous dissipation improves the thickness of the thermal boundary layer. The isothermal boundary condition causes less heat transport in the system than the temperature jump condition.

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KEYWORDS
Nanofluid; Cattaneo-Christov heat flux; rotating disk; aggregation of nanoparticles; response surface methodology; sensitivity analysis

Nomenclature

B_0	Magnetic field strength
D	Fractal index
d	Desirability
Ec	Eckert number
f	Face count in the design

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Theoretical and experimental validation of thermal and heat transfer performance of novel ethylene glycol - Cr_2AlC nanofluids

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Nanofluids
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Cr_2AlC MAX phase
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Functional ceramics
Modeling of materials

ABSTRACT

Synthesizing stable nanofluids with favourable thermal properties that can cater to practical applications is a challenge over the past few years. This paper presents the preparation and analyzes the thermal efficiency of the novel nanofluid prepared by the suspension of nanocrystalline Cr_2AlC MAX phase powder in ethylene glycol (EG). Incorporation of *h-BN*, MoS_2, Al_2O_3, and Cr_2AlC showed a thermal conductivity enhancement at 303 K when compared to EG. Accurate experimental models for the thermal conductivity and the viscosity of *EG + Cr_2AlC* nanofluids are estimated. The theoretical analysis of the flow profiles of *EG + $Cr_2AlC/Al_2O_3/MoS_2$/h-BN* nanofluids is carried out with Blasius and Sakiadis flow models. The Cr_2AlC MAX phase possesses both ceramic and metal properties that help these nanofluids to show high heat transfer performance. The results show that 0.50 wt% *EG + Cr_2AlC* nanofluid displays maximum improvement in heat transfer performance. There is a substantial rise in the thermal conductivity when both temperature and weight fraction increase. The simulated flow of the nanofluid past a plate indicated superior heat transfer and thermal profiles for the *EG + Cr_2AlC* nanofluids. For the flow past a moving plate, the nanofluid possesses less skin friction at the plate, which is favourable for various practical applications.

1. Introduction

During the past few decades, nanofluids have gained momentum due to their various applications, such as drug delivery, oil recovery, and heat transfer fluid. Over the previous few years, considerable research was performed to solve the challenges like stability, heat transferability, and operational performance so that the nanofluids can be industrially and commercially acceptable. Several techniques have been considered for the advancement in the coefficient of heat transfer among the surfaces and the working fluids [1,2]. Choi and Eastman, in 1995 developed a new class of nanofluid having improved heat transferability and thermal conductivity in which nanoparticles of metallic origin were suspended in a base fluid [3]. The enhancement in the thermal properties of these liquids resulted in the advancement of the evaluation of heat transfer fluids through nanoscale particle addition. The base liquid shows an increase in the energy transmission after the addition of solid materials, which results in enhanced properties of thermal conductivity and heat transfer characteristics [4]. Also, the resulting liquids were observed to have advanced thermal conductivity values [5].

Nanofluids have been the focus of rigorous research and development worldwide since the anomalous thermal behaviour of these fluids was discovered [6]. In existing studies, nanofluids were originated to have improved thermophysical properties, including thermal diffusivity, viscosity, thermal conductivity, and coefficients of convective heat transfer as associated with that of base liquids such as oils/water [6–10]. Metallic (metals: Fe, Al, Au, Cu, Ag; metal oxides: CuO, Al_2O_3, SiO_2, Fe_3O_4, ZnO, TiO_2, etc.) and non-metallic (carbides: TiC, SiC; carbon materials: SWCNT/MWCNT, graphite, graphene, diamond, etc.) are the types of nanofluid materials [11]. There are two key ways of producing nanofluids: the one-step process (the method by jointly producing the base fluid and nanomaterials) and the two-step process (by separately producing the nanofluid components and then mixing them) [12,13]. When the nanoparticles are dispersed in fluids, they become more stable and improve the thermal properties of the fluids. Other properties such as the particle/fluid nanolayers, Brownian motion of nanoparticles, and the reduced pump power of nanofluid help to achieve strengthened heat

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Nanoparticle aggregation kinematics on the quadratic convective magnetohydrodynamic flow of nanomaterial past an inclined flat plate with sensitivity analysis

AS Sabu[1], Joby Mackolil[2], B Mahanthesh[2] and Alphonsa Mathew[1]

Abstract

The study focuses on the aggregation kinematics in the quadratic convective magneto-hydrodynamics of ethylene glycol-titania (TiO_2) nanofluid flowing through an inclined flat plate. The modified Krieger-Dougherty and Maxwell-Bruggeman models are used for the effective viscosity and thermal conductivity to account for the aggregation aspect. The effects of an exponential space-dependent heat source and thermal radiation are incorporated. The impact of pertinent parameters on the heat transfer coefficient is explored by using the Response Surface Methodology and Sensitivity Analysis. The effects of several parameters on the skin friction and heat transfer coefficient at the plate are displayed via surface graphs. The velocity and thermal profiles are compared for two physical scenarios: flow over a vertical plate and flow over an inclined plate. The nonlinear problem is solved using the Runge–Kutta-based shooting technique. It was found that the velocity profile significantly decreased as the inclination of the plate increased on the other hand the temperature profile improved. The heat transfer coefficient decreased due to the increase in the Hartmann number. The exponential heat source has a decreasing effect on the heat flux and the angle of inclination is more sensitive to the heat transfer coefficient than other variables. Further, when radiation is incremented, the sensitivity of the heat flux toward the inclination angle augments at the rate 0.5094% and the sensitivity toward the exponential heat source augments at the rate 0.0925%. In addition, 41.1388% decrement in wall shear stress is observed when the plate inclination is incremented from 60° to 75°.

Keywords

Nanoparticle aggregation, nanofluid, magnetohydrodynamic flow, quadratic convection, inclined plate, sensitivity analysis

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Introduction

Nanotechnology forms a novel area of research due to the fascinating applications of nanofluids in medical, engineering, and industrial areas. A nanofluid is a colloidal suspension of nanoparticles of size 1 to 100 nm which was first introduced by Choi.[1] Nanofluid flow past a flat plate is of practical significance in heat exchangers and solar collectors. Thermal characteristics of base fluids are enriched by utilizing nanoparticles.[2] Nanofluids enhance the heat transfer rate which improves the performance of the heat exchangers.[3–5] Thermal performance of nanofluids with various nanoparticles are experimentally investigated by various researchers.[6–8] Choudhary et al.[9] evaluated the efficiency of iron oxide nanofluid over a flat plate solar collector (FPSC). It was found that the efficiency of FPSC enhanced by using iron oxide nanofluid. Moravej et al.[10] studied FPSC using TiO_2-water nanofluid and observed an augmentation in FPSC efficiency by incrementing the nanoparticle loading without affecting the stability of the nanofluid. Sheikholeslami et al.[11] scrutinized the effect of alumina nanofluid in FPSC with a concentration of 0.03%. The researchers found that the nanofluid lowers energy loss. Some more studies that evaluate the efficiency of solar collectors utilizing nanofluids are reported in the literature.[12,13]

Furthermore, nanoparticles tend to form clusters known as nanoparticle aggregates. Rapid and moderate aggregation occurs depending on the interparticle characteristics of the nanoparticles and the chemistry of the base fluid. Aggregated nanoparticles possess different

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REVIEW

Genetically modified foods: bibliometric analysis on consumer perception and preference

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ABSTRACT

In this study, we present the bibliometric trends emerging from research outputs on consumer perception and preference for genetically modified (GM) foods and policy prescriptions for enabling the consumption using VOSviewer visualization software. Consumers' positive response is largely influenced by the decision of the governments to ban or approve the GM crops cultivation. Similarly, the public support increases when the potential benefits of the technology are well articulated, consumption increases with a price discount, people's trust on the government and belief in science increases with a positive influence by the media. Europe and the USA are the first region and country, respectively, in terms of the number of active institutions per research output, per-capita GDP publication and citations. We suggest research-, agri-food industries-, and society-oriented policies to be implemented by the stakeholders to ensure the safety of GM foods, encourage consumer-based studies, and increase public awareness toward these food products.

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KEYWORDS
Bibliometric analysis; consumer perception; consumer preferences; GMOs; GM food; industry implications; policy imperatives; future research thrust

1. Introduction

Feeding the burgeoning population, estimated to reach 11 billion by 2100 AD, will undoubtedly be a herculean task.[1] It is estimated that a vast majority of this population growth will occur in developing countries, home to more than two-thirds of those suffering from hunger. The Food and Agriculture Organization (FAO) estimated that 653 million people were undernourished in 2015 and the number rose to 690 million in 2019. It is expected that the number will continue to rise hence the difficulty in realizing an end to hunger and malnutrition by 2030.[2] Timely policy intervention is required to liberate these economies from the shackles of hunger and poverty. With the finite arable land being exposed to high rates of soil and water degradation, cultivation of our future crops will be increasingly challenging. Sustainable food production under such circumstances, demands agricultural scientists across the globe to develop improved cultivars with enhanced productivity using modern tools of plant- breeding, production and protection. It is through the scientific efforts and farmers' endeavors, that the annual average increase in yields to the tune of 1.2% has been achieved for the four staples, i.e., wheat, rice, maize and soybean, which together contribute to 66% of calorie intake in the global diet.[3] This gain in yield still is lower than the normative growth rate of 2.4% per annum required to support the predicted global population.[4] What lies ahead is a tumultuous path with challenges like climate change with frequent extreme weather events, emergence of new insect-pests and diseases, weeds, and yield plateau. This necessitates a multi-pronged strategy aiming at development of cultivars with increased productivity which are climate resilient, nutritionally superior, resistant to biotic stresses and leave a reduced 'carbon' footprint on the environment.

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ORIGINAL ARTICLE

Modelling and optimization of Rhodamine B degradation over Bi_2WO_6–Bi_2O_3 heterojunction using response surface methodology

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Abstract

The Bi_2O_3/Bi_2WO_6 heterostructures of various compositions are prepared via the surfactant-assisted sol–gel method, which exhibits enhanced and synergistic photocatalytic activity towards the degradation of Rhodamine B (Rh B) using visible light irradiation. Characterization of these heterostructures has been done using X-ray diffraction, microscopic and spectroscopic methods. The 50% tungstate in bismuth oxide (BWO) nanocomposites having band gap of 2.85 eV and an average size of 40–80 nm shows maximum dye removal up to 87% in 4 h compared to pure Bi_2O_3 and other heterostructures of Bi_2O_3/Bi_2WO_6. The reusability studies demonstrate the excellent retention of photocatalytic activity without much loss in activity, implying the stability and efficiency of the prepared catalyst. The degradation of the Rh B dye is modeled mathematically to analyze the interactive effects of the key parameters like the time, amount of catalyst, and dye concentration, and to determine the optimal setting of these parameters to optimize the degradation process using the face-centered Central Composite Design (FC-CCD) of the Response Surface Methodology (RSM) analysis. An accurate full quadratic model has been developed with R^2 = 99.41%. The sensitivity of the degradation was evaluated at all levels of the key parameters. At 0.1 g of catalyst amount, it was found that the increment of the catalyst amount would be suitable for improved degradation as compared to allowing more time for the degradation. The maximum degradation was obtained for a dye concentration of 5 ppm, and 0.1 g catalyst for 4 h.

Keywords Bismuth tungstate · p-n heterojunction · Water pollution · Photodegradation · Response surface optimization · Sensitivity analysis

Introduction

Semiconductor photocatalysis for energy conversion and environmental remediation applications has drawn a lot of interest among researchers worldwide (Peng et al. 2014). Advanced oxidation processes (AOPs) through oxidation and reduction of pollutants play a major part in economically remediating the environment (Lan et al. 2014). The light penetration into water bodies is blocked by organic pollutants like dyes which affect the biological process like photosynthesis and multiplication of autotrophs (Jahan et al. 2012). Rhodamine B (Rh B) dye is widely used in the textile industry and is one of the major effluents released into the environment (Kornbrust and Barfknecht 1985).

Semiconductor photocatalysts use abundantly available solar energy to drive chemical reactions and other applications, such as mineralization of organic pollutants, water splitting, and organic conversion reactions (Hoffmann et al. 1995; Mills et al. 2010), sonophotocatalysis (Theerthagiri et al. 2021), electrocatalysis (Yu et al. 2021), energy applications (Lee et al. 2021), sensors (Naik et al. 2021). Several metal-based materials have been successfully used as photocatalysts, titanium dioxide (TiO_2) and zinc sulfide (ZnS) being classic examples (Hoffmann et al. 1995; Zhao et al. 2004). Most single component metal semiconductors, however, absorb predominantly in the UV region, and their electron-hole pairs recombine very fast, adversely affecting

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RESEARCH ARTICLE

HEAT TRANSFER WILEY

A study on heat transfer in three-dimensional nonlinear convective boundary layer flow of nanomaterial considering the aggregation of nanoparticles

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Abstract

Thermal systems of solar collectors, electronic cooling, nuclear reactors, and combustion operate at high thermal conditions, and in such circumstances, the density relation of the working fluids with the thermal field may not be linear. The working fluid features are significantly affected by nonlinear density temperature fluctuations. Therefore, a theoretical study of the quadratic Boussinesq approximation (with quadratic density temperature [QDT] variation) and quadratic Rosseland radiation on the three-dimensional boundary layer dynamics and heat transport of ethylene glycol-based titania nanomaterial is carried out. The phenomenon of the kinematics of nanoparticle aggregation is also analyzed by considering modified models proposed by Maxwell–Bruggeman and Krieger–Dougherty for thermal conductivity and dynamic viscosity. The flow is induced by the elongation of a flexible flat plate in two directions. A comparison of heat transfer features of linear elongation of the plate and nonlinear elongation of the plate is conducted. The Rosseland radiative heat flux is studied in three different forms. The governing nonlinear equations are treated using apt nondimensionalization,

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CO_2-solvated liquefaction of polyethylene glycol (PEG): A novel, green process for the preparation of drug-excipient composites at low temperatures

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ABSTRACT

Polyethylene glycol (PEG), MW = 1500 D, a solid excipient approved by the US FDA, is commonly used in organic solvent as well as hot melt-based, pharmaceutical processes with importance in increasing the solubility of hydrophobic drugs for processing. We demonstrate here, for the first time, a novel use of this benign excipient in a near-ambient temperature, CO_2-based process to produce drug-excipient composites. We show that PEG 1500 undergoes deliquescence in contact with gaseous CO_2 at 40 bar eventually forming a biphasic liquid system that allows homogeneous mixing of an active pharmaceutical ingredient (API). Acetone- and CO_2-processed composites of PEG with two model drug systems, viz., paracetamol and aspirin, were prepared, characterized, and drug release kinetics reported. Release kinetics from these composites resemble those of composites prepared using acetone. The results demonstrate a new, green, near-ambient temperature pharmaceutical process eliminating the use of organic solvents and compatible with thermally labile drugs, unlike thermal processing methods.

1. Introduction

Green chemistry aims at the development of safer and environmentally acceptable solutions through diverse applications in chemical industry. Among these, the use of carbon dioxide (CO_2), in its liquid and supercritical (sc) states (T_c= 31.1 °C; P_c =73.8 bar), as an alternative solvent platform has been of utmost interest in recent years by virtue of its non-toxicity, abundance, low cost, non-flammability, and the tunable solvent parameters of $scCO_2$ [1–10]. In fact, $scCO_2$ could be one of the safest and most versatile solvents for the pharmaceutical industry, due to the ease of solvent removal, ensuring that not even a trace of residual solvent is left behind in the final pharmaceutical preparations. Several techniques utilizing supercritical fluids such as rapid expansion of supercritical fluid solutions (RESS), particles from gas-saturated solutions (PGSS), supercritical anti-solvent (SAS) precipitation, solution-enhanced dispersion by supercritical fluids (SEDS), and precipitation using compressed anti-solvent (PCA), have already been employed in the pharmaceutical industry, based on the CO_2 solvent platform [11–16]. Numerous efforts have also been reported earlier using $scCO_2$ as a highly diffusive carrier medium to incorporate the drug molecules into highly porous excipient scaffolds, for sustained drug release [17,18].

Preparation of homogeneous drug-excipient systems is one area that has much significance in the pharmaceutical industry. The most commonly used methods for this purpose are thermal melt mixing and solvent-assisted mixing. In the former method, the drug and the excipient are mixed and heated above their melting temperatures, followed by mechanical mixing of the melt to get a homogeneous melt of the composite and subsequently this is cooled to ambient temperature [6,19–22]. This method has the disadvantage that, at higher melting

Abbreviations: $scCO_2$, supercritical carbon dioxide; PEG, polyethylene glycol; Ac, acetone; Pc, paracetamol; Asp, aspirin.

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RESEARCH ARTICLE

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Super tough interpenetrating polymeric network of styrene butadiene rubber-poly(methyl methacrylate) incorporated with general purpose carbon black (N660)

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Abstract

A classic set of polymeric interpenetrating polymeric network (IPN) microcomposites has been fabricated using an elastomer—styrene butadiene rubber [SBR], a thermoplastic poly(methyl methacrylate)-PMMA and with carbon black (CB)-N660 as a filler and reinforcing agent. This synthesized IPN composite can be promisingly employed as a toughened plastic and vibrational damper in a wide service range with excellent thermal stability, optimum storage modulus, and co-continuous morphological pattern. transmission electron microscopy, scanning electron microscopy, atomic force microscopy, and Raman imaging are successfully employed for the morphological characterization. Mechanical, thermal, viscoelastic, and damping features of IPN composites have been carefully studied in detail and compared with parent polymers, corresponding IPN, and composites. The double network formation of filler CB and plastic component PMMA form an intercalated morphological pattern in the SBR matrix with 20 times enhancement in toughness value compared with neat SBR. The fabrication and characterization adopted in this work can definitely act as a platform for the design of new toughened material with excellent performance and cost-effectiveness.

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Deep learning algorithms for intrusion detection systems in internet of things using CIC-IDS 2017 dataset

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ABSTRACT

Due to technological advancements in recent years, the availability and usage of smart electronic gadgets have drastically increased. Adoption of these smart devices for a variety of applications in our day-to-day life has become a new normal. As these devices collect and store data, which is of prime importance, securing is a mandatory requirement by being vigilant against intruders. Many traditional techniques are prevailing for the same, but they may not be a good solution for the devices with resource constraints. The impact of artificial intelligence is not negligible in this concern. This study is an attempt to understand and analyze the performance of deep learning algorithms in intrusion detection. A comparative analysis of the performance of deep neural network, convolutional neural network, and long short-term memory using the CIC-IDS 2017 dataset.

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1. INTRODUCTION

Internet of things (IoT) can be considered as the boon of the latest century. The adoption of this technology in various walks of life and in every business, medical and engineering field showcases the extent to which this technology is being embraced by all. Since the concept of artificial intelligence (AI) is also incorporated into it, IoT devices become smarter and can take better decisions. According to International Data Corporation (IDC), IoT device-generated 73.1 ZB of data in 2025, and the estimated number of IoT devices will be 41.6 million [1]. Even though IoT helps to automate many applications and thereby reduce human interventions, security is the primary concern to be addressed. So, the identification of varying attacks is a significant concern among the researchers.

From the beginning of the design of the IoT network and smart devices, there were also attempts to protect data and devices from intruders. Security of the data collected and stored is always a major concern for researchers working in this area as the mode and type of attacks vary every moment. There are different approaches for attack detection such as filter packets—with firewalls and proxies, adopting encryption—with cryptographic protocols, data storage encryption or virtual private networks, password authentication method, audit and log activities—for web servers, database servers, and application servers, attack identification using intrusion detection system, intrusion prevention system [2].

An intrusion detection system (IDS) is a technique that can track network traffic and identify malicious traffic or any kind of attack and give alerts [3]. It is a combination of software and hardware. The idea of the IDS was started in 1970 [2]. The IDS are categorized into four based on the occurrence, placement strategies, and detection method. Based on occurrence strategy, the collection of information can be host-based, network-based, network node-based or hybrid mode. In the placement category, the placement

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Chemical vapour deposited graphene-mediated enhanced SERS performance in silver nanostructures

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ABSTRACT

This work demonstrates how chemical vapour deposited monolayer graphene enhances the SERS activity in a conventional plasmonic substrate. The single-layer graphene is evidenced by various spectroscopic analyses. A thin coating of silver on graphene/SiO_2/Si substrate serves as the graphene-mediated SERS (GSERS) platform, which offers a detection limit (LOD) of 10^{-14} M and an enhancement factor of 9.48×10^8 for the R6G molecule. The performance of the GSERS substrate is superior to that of the substrate without graphene, which has a LOD of 10^{-10} M only. The detection of low concentrations of Sudan-I is also demonstrated with the GSERS substrate. A highly sensitive simple two-stage SERS substrate made of high-quality graphene film is the crowning achievement of this study.

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CVD; graphene; surface-enhanced Raman scattering; GSERS substrate

Introduction

With the rising demand for advanced technologies in electronics and medical fields, integrating new materials for advanced applications is becoming common. Graphene is the prime member that has shown exciting potential since its discovery. The production and processing of graphene have significant roles in bridging the gap between graphene growth and its practical applications. Chemical vapour deposition (CVD) is the widely accepted synthesis method based on the pyrolysis of a hydrocarbon on suitable transition metal substrates. The CVD of graphene on copper is a highly self-limiting process, and the deposition follows graphene transfer from the copper to the desired substrates. Graphene has attracted great attention in surface-enhanced Raman scattering/spectroscopy (SERS) for ultra-sensitive sensing applications [1–5]. SERS is a molecular detection technique relying on enhanced Raman scattering of molecules adsorbed on or near the plasmonic substrates [6,7]. SERS performance is mainly attributed to two mechanisms: the chemical mechanism (CM) and the electromagnetic mechanism (EM). Electromagnetic enhancement results from surface plasmon resonance and offers a high enhancement factor of up to 10^{14}–10^{15} [8–10]. Chemical enhancement arises from the charge transfer between the analyte molecule and the SERS substrate, and it gives very low enhancement when compared to EM [11]. Hence, CM gains less attention in conventional SERS.

Graphene was initially introduced as a fluorescent quencher in SERS [12]. In the first report on the enhancement of Raman intensity of molecules on graphene, the chemical enhancement in SERS could be studied solely by separating it from electromagnetic enhancement [1]. The study says that the enhanced interaction with the analyte molecule results from graphene's unique chemical structure, which can enrich the controlled arrangement of analyte molecules through its $\pi - \pi$ stacking or electrostatic interaction [13]. Graphene-entwined SERS can be classified into two types: graphene-enhanced Raman scattering (GERS) and graphene-mediated SERS (GSERS). In GERS, graphene is the SERS substrate, while in GSERS, graphene is used with a plasmonic SERS substrate. Monolayer graphene is expected to adsorb more metallic particles in comparison with multi-layered graphene [14]. Also, maximised electromagnetic field generation is found in the interface between metal and monolayer graphene [15]. Thus, enhancement can be improved by increasing the amount of charge transfer and modifying the hot spots (regions with the enhanced electric field) in the SERS structure. It is reported that the coupling between charge carriers in the first layer of graphene and the surface plasmons of metal nanoparticles is considerably stronger than individual nanoparticles' localised surface plasmon resonance (LSPR) [16]. GSERS substrates are a good platform for suppressing fluorescence and photoluminescence so that they

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Article

Green Synthesis of Silver Nanoparticles Using the Leaf Extract of the Medicinal Plant, *Uvaria narum* and Its Antibacterial, Antiangiogenic, Anticancer and Catalytic Properties

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Abstract: Silver nanoparticles (AgNPs) made by green synthesis offer a variety of biochemical properties and are an excellent alternative to traditional medications due to their low cost. In the current study, we synthesised AgNPs from the leaf extract of the medicinal plant *Uvaria narum*, commonly called narumpanal. The nanoparticles were characterised by ultraviolet-visible (UV-Vis) spectroscopy, Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). SEM analysis showed AgNPs are highly crystalline and spherical with an average diameter of 7.13 nm. The outstanding catalytic activity of AgNPs was demonstrated by employing the reduction of 4-nitrophenol to 4-aminophenol. The AgNPs showed antiangiogenic activity in the chick chorioallantoic membrane (CAM) assay. AgNPs demonstrated anticancer activity against Dalton's lymphoma ascites cells (DLA cells) in trypan blue assay and cytotoxicity against three fish cell lines: *Oreochromis niloticus* liver (onlL; National Repository of Fish Cell Lines, India (NRFC) Accession number—NRFC052) cells, *Cyprinus carpio* koi fin (CCKF; NRFC Accession number—NRFC007) cells and *Cyprinus carpio* gill (CyCKG; NRFC Accession number—NRFC064). Furthermore, the AgNPs demonstrated their ability to inhibit pathogenic microorganisms, *Staphylococcus aureus*, and *Escherichia coli*. The results from the study displayed green synthesised AgNPs exhibit antiangiogenic activity, cytotoxicity, antimicrobial and catalytic properties, which are crucial characteristics of a molecule with excellent clinical applications.

Keywords: *Uvaria narum*; antiangiogenic activity; antibacterial activity; anticancer property; catalytic property; silver nanoparticles

1. Introduction

Today we are living in an era of nanoscience, which has a significant role in all spheres of life. Silver nanoparticles (AgNPs) are studied extensively when compared with other noble metal nanoparticles due to their optical, antimicrobial, anticancer, antioxidant and larvicidal properties, as well as their affordability [1–3]. In addition, they have a wide

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ORIGINAL PAPER: SOL-GEL AND HYBRID MATERIALS FOR CATALYTIC, PHOTOELECTROCHEMICAL AND SENSOR APPLICATIONS

Chitosan-co-acrylic acid microgel fabricated with green synthesized silver nanoparticles for the sensing of hydrogen peroxide

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Abstract

A novel, fast, stable, and cost-effective colorimetric hydrogen peroxide (H_2O_2) sensor was prepared by the incorporation of silver nanoparticles (AgNPs) in chitosan-co-acrylic acid (CS-co-AAc) microgel. AgNPs were synthesized by green method by using Euphorbia Maculate (EM) leaf extract. Chitosan-co-acrylic acid/silver nanaoparticle (CS-co-AAc/AgNPs) hybrid microgel can be characterized by various analytical techniques. CS-co-AAc/AgNPs hybrid microgel exhibited UV-visible absorption band 436 nm. X-ray diffraction spectrum reveals that CS-co-AAc/AgNPs hybrid microgel are amorphous in nature and the crystalline nature of synthesized AgNPs. The hybrid microgels are highly selective towards H_2O_2 and the absorption band intensity is proportional to the concentration of H_2O_2 in solution. Over the concentration range of 0−50 nM, the intensity of the absorption peak decreases linearly,and the corresponding correlation coefficient is R^2 -0.9063. The limit of detection is determined to be 3.2 nM. Antibacterial activities of the hybrid microgel were also observed against aquatic bacteria such as *Escherichia coli (E.coli) and Staphylococcus aureus (S.aureus)* isolated from river water samples taken from Kerala. Practical applicability of the hybrid microgel for the sensing of H_2O_2 in real milk samples was also investigated. AgNPs themselves can show similar behaviors, but they are destabilized because it undergo rapidly agglomerate. This hybrid microgel system offers numerous advantages, such as sample processing and extreme stability. This technique is ideal for assessing diverse biological and environmental materials since it is easy to use, inexpensive, and adaptable to complex matrices.

Graphical Abstract

The integration of green synthesized AgNPs in CS-co-AAc microgels resulted in a unique, rapid, stable, and cost-effective colorimetric sensor for H_2O_2. EM leaf extract was used to synthesize AgNPs. Analytical tests of the CS-co-AAc/AgNPs hybrid microgel show that AgNPs are successfully incorporated into the microgel. Hybrid microgel exhibits a UV−vis. absorption peak at 436 nm and selective for H_2O_2, with a level of detection of 3.2 nM. Its shows excellent antibacterial activities are more effective against *S. aureus* bacteria than against *E. coli* bacteria. The practical application of hybrid microgel for H_2O_2 sensing in actual milk was also explored. The results show that the sensors have a higher selectivity toward H_2O_2 at low concentrations and a higher sensitivity than previously reported H_2O_2 sensors.

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