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Development of silk fibers decorated with the in situ synthesized silver and gold nanoparticles: antimicrobial activity and creatinine adsorption capacity

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ABSTRACT

In this study, to impart silk fibers with excellent coloration, UV-protection, antimicrobial activity, as well as creatinine adsorption from artificial blood, silk fibers were designed *via* facile fabrication approach. These diverse properties were introduced by in-situ incorporation of nanoparticles based on either silver (AgNPs) or gold (AuNPs) as well as bimetallic (Ag-AuNPs) onto silk fibers using an eco-friendly, effective one-pot process. The proteins present in the silk fibers acted as a redox-active bio-template to reduce the Ag(I) and Au(III) ions to their zero-valent state with simultaneous deposition of the generated nanoparticles onto the silk fiber surfaces. The obtained results clearly indicated that both AgNPs and AuNPs colored the silk fibers with brown and red color, respectively, thereby affirming the deposition of these metallic NPs onto and inside the surface of silk fibers as S/Ag-AuNPs. Significantly, the prepared colored silk fibers exhibited excellent antimicrobial and cytotoxicity activities against different pathogenic microbes as well as very good UV protection properties. Moreover, the results attested that the as prepared S/AgNPs and S/AuNPs fibers have good adsorption potential with maximal adsorption capacity of creatinine in artificial blood was found to be 94.2 mg/g for S/AuNPs sample, which is 1.55 times greater than that of silk fibers.

Introduction

Silk is a biopolymer with high molecular weight spun by the Lepidoptera larvae with silkworms, mites, spiders, and scorpions in the form of fibers. The silk developed from Bombyx mori has indeed been substantially identified and is used in the fields of textiles and biomedicine. Thanks to its antiparallel β-pleated structure [1–3], Mori silk fibers have excellent mechanical properties [4]. It is an essential biopolymer for therapeutic applications due to the specific features of silk, i.e. biocompatibility, biodegradability, high tensile strength and, lack of toxicity [3]. Thus, silk fibers are being used to close wounds as non - absorbable wound dressing [3,5–14]. Furthermore, the existence of sutures at the site of injury can increase the susceptibility of wound infections after surgery. For the prevention of such infections, the functionalization of silk fibers with antimicrobial agents is therefore crucial [3,15–17]. Similar nanoparticles and nanoemulsions have been employed in medical fields in recent years to diagnose several diseases [18–27].

Thanks to their remarkable ability to boost the action of many drugs, certain materials are used. In various medical fields, many metal nanoparticles, nanocomposite and natural product have been used [18,28–46], but silver, copper, gold, zinc, and platinum are the most extensively utilized in a broad array of applications in the fields of biotechnology, nano-medicine, and bio-pharmacy [18,25,47–70]. Thus, different physical and chemical methods employing large volumes of solvents are needed to acquire pure and well-defined nanoparticles [71–76]. These could create multiple environmental

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Development of the electrochemical performance of zinc via alloying with indium as anode for alkaline batteries application

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ABSTRACT

Zinc is one of the predominantly utilized metals in alkaline batteries. The addition of a trace amount of indium as an alloying element to zinc retards the rate of corrosion and promotes the sacrificial protection of zinc. The corrosion behavior of Zn and Zn−In alloy at various In content (0.5% and 1%, In/Zn mass fraction) in 6 M KOH solution was electrochemically studied. Tafel plots, electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV), and charge-discharge methods were all employed. The morphology, chemical composition, and phases of the corrosion layers formed on the surfaces of Zn and Zn−In alloys were thoroughly investigated utilizing scanning electron microscopy (SEM) equipped with an X-ray of dispersed energy (EADX) and X-ray diffraction (XRD), respectively. The polarization results revealed that the corrosion protection efficiency of the Zn−1%In alloy has the highest value of 97.3% at 45 °C. The steady-state of open circuit potential ($E_{corr.}$) for the investigated alloys is shifted to a more negative value compared to that of zinc. This indicates that the alloying of zinc with indium has a positive effect on charge efficiency, suppression of hydrogen evolution reaction, and the capacitance. Moreover, the discharge time increases with the increase of the indium percentage in the bimetallic solid solution of Zn−In. The synthesized alloy is considered a promising material for long life alkaline batteries.

1. Introduction

Rechargeable batteries (secondary batteries) have become an essential demand for modern technologies. Generally, the high-power rechargeable batteries can be improved regarding the cost of energy density by replacing some of the active material with conductive fillers of larger pores for ion transport [1–6]. However, for many applications, the substantial loss of energy density was unfavorable. Some of those applications, automotive and portable power, need high energy density. Alkaline batteries still occupy a significant position in the scope of electrical energy systems for over a century, starting from the accumulator of the nickel-iron system and the nickel-cadmium battery invented [7,8]. Therefore, a great number of invented energy systems have participated in the development of alkaline rechargeable systems for better applicability. This is predominantly adequate for the huge market needings which are affected by new and emerging technology, especially in the field of electronics. The attitude appears totally unlike a lot of markets [9]. Zinc batteries were providing the maximum accessible energy density for the primary battery systems, which are frequently utilized for many electronics, including cell phones and hearing devices. Moreover, zinc batteries are featured with safety, balanced discharge voltage, and long life peculiarities. Besides, the zinc/air battery system is characterized by high specific energy, low cost, environmental compatibility as compared with other battery systems, and the ability to work at a wide range of temperatures [10].

Nevertheless, the use of zinc/air battery is complicated with an unfavorable short life of charge-discharge cycle due to the dissolution of the anode (zinc) and KOH carbonation. This is correlated with zinc which characterized by its activity, and tendency to corrodes quickly in aqueous solutions [11]. The poor cycle life of these zinc/air batteries is previously correlated with shape change, passivation of zinc, and the evolution of hydrogen (HER) [12]. Change of shape can be attributed to the continuous decrease of the active surface area of the zinc electrode during the repeated cycling of the battery. These problems have been mostly fixed by enhancing separators [13,14] or by using various additives to minimize the dissociation of zinc such as Bi_2O_3 [15–17], $Ca(OH)_2$

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Article

Dietary Chitosan Nanoparticles: Potential Role in Modulation of Rainbow Trout (*Oncorhynchus mykiss*) Antibacterial Defense and Intestinal Immunity against Enteric Redmouth Disease

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Abstract: Bio-nanotechnology employing bio-sourced nanomaterial is an emerging avenue serving the field of fish medicine. Marine-sourced chitosan nanoparticles (CSNPs) is a well-known antimicrobial and immunomodulatory reagent with low or no harm side effects on fish or their human consumers. In this study, in vitro skin mucus and serum antibacterial activity assays along with intestinal histology, histochemical, and gene expression analyses were performed to evaluate the impact of dietary CSNPs (5 g kg^{-1} dry feed) on rainbow trout resistance against 'enteric redmouth' disease. Two treatment conditions were included; short-term prophylactic-regimen for 21 days before the bacterial challenge, and long-term therapeutic-regimen for 21 days before the challenge and extended for 28 days after the challenge. Our results revealed higher antibacterial defense ability and positive intestinal histochemical and molecular traits of rainbow trout after dietary CSNPs. The prophylactic-regimen improved trout health while the therapeutic regimen improved their disease resistance and lowered their morbidity. Therefore, it is anticipated that CSNPs is an effective antibacterial and immunomodulatory fish feed supplement against the infectious threats. However, the CSNPs seem to be more effective in the therapeutic application rather than being used for short-term prophylactic applications.

Keywords: antibacterial defense; chitosan nanoparticles; ERM; intestinal immunity; prophylactic-regimen; rainbow trout; serum; skin mucus; therapeutic-regimen; *Yersinia ruckeri*

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1. Introduction

Yersiniosis or the enteric redmouth disease (ERM) is a systemic bacterial disease of salmonids, mainly in farmed rainbow trout (*Oncorhynchus mykiss*). It is caused by the Gram-negative bacterium *Yersinia ruckeri* and leads to cumulative mortality and high economic losses [1,2]. It is an acute to chronic infectious disease accompanied by systemic hemorrhages [3] along with serious histopathological changes in gills, kidneys, and spleen [4,5]. *O. mykiss* is one of the most widely farmed salmonid species owing to its fast growing and its extraordinary adaptation ability [6]. It can resist the hard farming or the wildlife in the surface and the underground water sources of the mountainous regions; however, it is the most susceptible species to ERM disease [7,8].

Effective vaccines had been reported to elevate rainbow trout immunity against ERM disease via oral, bath or injection treatments [9,10]. However, disease control using antibiotics or vaccines leave harmful side effects on fish immunity and environment. Nanoparticles of high antimicrobial activity are currently considered as one of the most advanced and promising avenues to compete usage of antibiotics for disease control in aquaculture [11].

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ORIGINAL RESEARCH
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Eco-Friendly Synthesis, Biological Evaluation, and *In Silico* Molecular Docking Approach of Some New Quinoline Derivatives as Potential Antioxidant and Antibacterial Agents

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A new series of quinoline derivatives **5–12** were efficiently synthesized *via* one-pot multicomponent reaction (MCR) of resorcinol, aromatic aldehydes, β-ketoesters, and aliphatic/aromatic amines under solvent-free conditions. All products were obtained in excellent yields, pure at low-cost processing, and short time. The structures of all compounds were characterized by means of spectral and elemental analyses. In addition, all the synthesized compounds **5–12** were *in vitro* screened for their antioxidant and antibacterial activity. Moreover, *in silico* molecular docking studies of the new quinoline derivatives with the target enzymes, human NAD (P)H dehydrogenase (quinone 1) and DNA gyrase, were achieved to endorse their binding affinities and to understand ligand–enzyme possible intermolecular interactions. Compound **9** displayed promising antioxidant and antibacterial activity, as well as it was found to have the highest negative binding energy of -9.1 and -9.3 kcal/mol for human NAD (P)H dehydrogenase (quinone 1) and DNA gyrase, respectively. Further, it complied with the Lipinski's rule of five, Veber, and Ghose. Therefore, the quinoline analogue **9** could be promising chemical scaffold for the development of future drug candidates as antioxidant and antibacterial agents.

Keywords: multicomponent reaction, chromenoquinolines, antioxidant, antibacterial, molecular docking

INTRODUCTION

Quinolines are very important compounds used for new drug development. They are reported as highly selective cytotoxic (Luo et al., 2009; Bawa et al., 2010; Meshram et al., 2012; Sidoryk et al., 2015), broad-spectrum antimicrobial (including activity against *Mycobacterium tuberculosis* as well as HIV-1 integrase inhibition activity) (Wang et al., 2019), antileishmanial (Asif, 2014), anticonvulsant, anti-inflammatory, cardiovascular activity (Acharyulu et al., 2008; Kumar, Bawa, and Gupta, 2010), and have antidiabetic effect (Shang, et al., 2018a).

Moreover, natural and synthetic chromene moiety attached to quinolines has important biological activity such as anticancer (El-Maghraby, 2014), anticoagulant, antispasmolytic (El-Maghraby and Aboubakr, 2019), antiangiogenesis (Sangani et al., 2012), antimicrobial (Gómez and Vladimir, 2013), anti-inflammatory (Asif, 2014), anti-invasive (Sidoryk et al., 2015), antioxidant

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ORIGINAL RESEARCH ARTICLE

Effect of Cu Metallic Interlayer Thickness on Optoelectronic Properties of TiO_2-Based Multilayers Deposited by DC Pulsed Magnetron Sputtering

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The effect of interference on the optoelectronic properties of TiO_2/Cu/TiO_2 multilayers deposited by DC pulsed magnetron sputtering was scrutinized. The TCT multilayers were arranged with different thicknesses of the Cu metallic interlayer. The outcomes revealed that the band gap energy of TiO_2/Cu/TiO_2 multilayers decreased with increasing Cu metallic interlayer thickness. The E_g value for TiO_2 single layer recorded 3.49 eV and decreased to a value of 3.12 eV for the multilayer film deposited with a 30-nm Cu metallic interlayer. Moreover, the optical conductivity increased as the Cu interlayer thickness increased. Transmittance plots with reasonable numbers of interference fringes were employed to calculate the refractive index of the examined multilayers. The results indicated that the values of n gradually increased with increasing the Cu metallic interlayer thickness. The dispersion energy E_d and the single-oscillator energy E_o were determined using a WDD single oscillator model.

Key words: DC pulsed magnetron sputtering, dispersion energy E_d, energy band gap, optical properties, single-oscillator energy E_o, TiO_2/Cu/TiO_2 multilayer films

INTRODUCTION

Photonic devices have recently become an important field for investigations and applications, and there has been rapid development of such these devices for appropriate requirements. Transparent conducting electrodes (TCE) have different applications, such as solar cells, touch screens, light-emitting diodes, electro chromic devices, and flat panel displays.[1–3] The most used material to prepare TCE is indium tin oxide (ITO) due to its high transmittance and high conductivity.[4] ITO material possesses significant problems in preventing it when using it in several applications of photonic devices, such as its brittle nature, while the fabrication process of photonic devices by ITO is expensive. For this purpose, the search to find economical alternative materials that have high transmittance and low resistivity continues.

There are several types of TCO, such as WO,[4,5] TiO_2,[6,7] ZnO_2,[8,9] SnO_2[10–12] and Zn-Mg-Be-based oxides.[13] Titanium dioxide (TiO_2) is an intensively used metal oxide for photonic devices and is outstanding for its comparatively low cost and simple manufacture, and as high-performance dye-sensitized and perovskite solar cells-based-TiO_2.[14,15] In these applications, TiO_2 film acts not only as an electrode but also as an active layer in a process similar to photosynthesis.

Substituting FTO (fluorine-doped tin oxide) by TiO_2/metal/TiO_2 electrode in optoelectronic applications can have at least two advantages. The first is the deposition of the electrodes on large-area flexible substrates at low temperatures, while the

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Effects of spark plasma sintering on enhancing the thermoelectric performance of Hf–Ti doped VFeSb half-Heusler alloys

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ABSTRACT

This work presents a study on the thermoelectric properties of ultrafine grained Hf–Ti dual-doped VFeSb half-Heusler (HH) alloys treated by spark plasma sintering (SPS) at different temperatures. The concerned alloys were successfully synthesized by arc/induction melting and mechanical alloying (MA). Thermoelectric (TE) properties of $Fe(V_{0.8}Hf_{0.2})_{1-x}Ti_xSb$ ($x = 0.0, 0.2, 0.4$) HH samples were studied over the temperature range from 100 to 900 K. Hf and Ti as heavy elements were used as dopants to create point defects aiming to reduce the material's thermal conductivity by enhancing the phonon scattering. Since the transport properties of HH alloys are sensitive to heat treatment, the effect of sintering temperature is studied as well. It was found that the power factor is significantly improved by increasing the sintering temperature. As a result, the figure of merit was enhanced by ~10% for the $Fe(V_{0.8}Hf_{0.2})_{0.8}Ti_{0.2}Sb$ sample and by ~30% for the $Fe(V_{0.8}Hf_{0.2})_{0.6}Ti_{0.4}Sb$ sample which were sintered at 1123 K, compared to those sintered at 1023 K. The maximum value was recorded at 0.33 for the sample $Fe(V_{0.8}Hf_{0.2})Sb$. This value is higher than that of the singly doped $FeV_{0.9}Hf_{0.1}Sb$ sample with a maximum zT value of 0.08. Also, it is higher than the reported value of the FeVSb doped with Ti which shows maximum ZT of 0.174 calculated for $FeV_{0.7}Ti_{0.3}Sb$ at 658 K.

1. Introduction

In recent years, half-Heusler materials with the valence electron count of 18 have attracted the attention of researchers worldwide as promising thermoelectric (TE) materials. The huge interest of half-Heusler (HH) materials is due to their high Seebeck coefficient and relatively high electrical conductivity, beside they are environmentally friendly compounds [1]. VFeSb-based half-Heusler compounds are of great interest amongst the other half-Heusler alloys due to their good TE properties, which are expected to exhibit excellent TE performances [2]. The performance of a TE material is mainly described by dimensionless figure of merit $zT = S^2\sigma T/(\kappa_e+\kappa_l)$, where S, σ, T, κ_e and κ_l are the Seebeck coefficient, electrical conductivity, absolute temperature, electronic and lattice contributions to the thermal conductivity κ_t, respectively.

The TE properties of various half-Heusler alloys have been reported by many research groups. For example, half Heusler of TaFeSb and based alloys with high thermoelectric performance were recently studied [3–5]. Also, the effect of Sb and Bi doping on the TE properties of the $Ti_{0.3}Zr_{0.35}Hf_{0.35}NiSn$ half-Heusler alloys was investigated by Appel and Gelbstein [6]. Other research works on different half Heusler alloys were presented as well [7–11]. The results indicate that the efficiency of a thermoelectric material could be further improved via doping strategy [12–14].

The effects of levitation melting and spark plasma sintering (SPS) temperatures on the TE properties of VFeSb half-Heusler compounds were studied by Fu et al. [1]. In their work, a maximum power factor of

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Electrical resistivity and magnetic susceptibility of substoichiometric CdO and In doped CdO films

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Abstract
Undoped and In doped substoichiometric CdO nanostructured films were prepared via vapor transport method. Mixed phases of hexagonal Cd and cubic CdO were obtained. No peaks related to In or indium oxides were observed in the In doped CdO pattern. Net-like assembles of nanowires were observed for undoped CdO sample whereas a regular morphology of equally shaped grains was observed for In doped CdO sample. The evaluated room temperature electrical resistivity values for undoped and In doped CdO films were 1.56×10^{2} and 2.31×10^{-2} Ωcm, respectively. The temperature dependent resistivity measurements elucidated the semiconducting behavior for undoped CdO films, whereas a semiconductor–metal with a transition around 367 K was obtained for In doped CdO film. The magnetic susceptibility showed paramagnetic-antiferromagnetic transition with Néel temperatures of 266 and 308 for undoped and In doped CdO samples, respectively.

Keywords Undoped and In doped CdO · Crystal structure · Electrical resistivity · Magnetic susceptibility

1 Introduction

CdO is n-type semiconductor with optical band gap of about 2.2 eV, and it crystallizes into a rock salt face centered cubic structure [1]. CdO has high optical transmittance in the visible and near-infrared spectral regions and good electrical conductivity. CdO nanostructures and thin films are of particular increasing interest, as consequence to the industrial demand for gas sensor, liquid–crystal displays, solar cells with semiconductor photoelectric device and transparent conductive windows, ultraviolet semiconductor laser, supercapacitors, photocatalysis and electrochromic devices [1–8].

The electrical, optical and magnetic properties of CdO films can be enhanced by addition suitable dopants of same or smaller ionic radii than that of Cd ion therefor the dopants can easily replace Cd ions without distorting the CdO lattice or forming any impurity oxide phases in film [9]. Various kinds of dopants have been used to improve the properties of CdO films [10–17]. For example, Antosoly et al. [10] reported enhancement in optical transmittance and ferromagnetic behavior for Ba doped CdO films. Gülen et al. [11] and Desai [9] reported shift in optical absorption edge toward lower wavelengths for Pb and Yb doped CdO films which has been attributed to the Burstein-Moss effect as a result of increasing carrier concentration. Eskandaria and Jamali-Sheini [12] have reported high photocurrent response for Cu doped CdO samples as compared with the undoped sample. In addition, highly transparent and conductive Al, La, In, Mo and F doped CdO films for optoelectronic applications have been reported by [13–17].

It has been stated that In doping in CdO lattice supplies extra electrons thereby enhances the electrical conductivity and mobility, increases the carrier concentration, increases optical band gap and improves transmittance [15, 18–24]. Also, it has been verified that the surface properties, extinction coefficient and the refractive index are strongly dependent on the In doping ratio [24, 25]. Consequently, In doped CdO films have been wildly proposed as transparent electrodes in optoelectronic devices [15, 18, 19, 21–24], as optical modulators in optical communications [26] and as supporting layer in heterojunction solar cells [27].

Recently, there has been increasing interest in reducing the stoichiometry of metal oxides due to its effect on improving their electrical conductivity, electrochemical activity, magnetic properties as well as altering the optical properties

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molecules

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Article

Enhanced Conductivity and Antibacterial Behavior of Cotton via the Electroless Deposition of Silver

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Abstract: In this study, the surface-initiated atom transfer radical polymerization (SI-ATRP) technique and electroless deposition of silver (Ag) were used to prepare a novel multi-functional cotton (Cotton-Ag), possessing both conductive and antibacterial behaviors. It was found that the optimal electroless deposition time was 20 min for a weight gain of 40.4%. The physical and chemical properties of Cotton-Ag were investigated. It was found that Cotton-Ag was conductive and showed much lower electrical resistance, compared to the pristine cotton. The antibacterial properties of Cotton-Ag were also explored, and high antibacterial activity against both *Escherichia coli* and *Staphylococcus aureus* was observed.

Keywords: cotton; electroless deposition; SI-ATRP; conductive property; antibacterial property

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1. Introduction

Natural cellulose materials are used in a wide range of applications due to their low cost [1–3]. The modification of cellulose to obtain new functionalities has been a focus of both academic and industrial research. Modified cellulose is used for different applications, including electromagnetic shielding [4,5], UV-protection [6], antifouling media [7], oil–water separation [8], antibacterial media [9,10], photocatalysis [11], supercapacitors [12] lithium–sulfur batteries [13] and flexible sensors [14].

As a natural cellulose material, the cotton possesses the advantages of low cost, large production volume and ease of surface modification. Highly conformal nanoscale metal coatings on cotton have been shown to improve the performance of cotton-based electronics [15]. A variety of methods can be used to increase the electrical conductivity of cotton, including in situ polymerization [16], spray assembly [17], metal plating [18], and dip coating [19]. In addition to these methods, electroless deposition (ELD) has high potential for the coating of metals on cotton fabrics, due to its low cost, ease of design and convenience for use on an industrial scale. ELD can be used to deposit different metals on various substrates, such as plastic, paper and metal oxides [18,20,21].

With the rapid industrial development and the improvement of living standards, antibacterial performance has attracted increasing attention. People are inevitably exposed to a variety of bacteria, fungi and other microorganisms. These microorganisms may rapidly grow and multiply under appropriate environmental conditions, spread diseases through contact and affect human health. In daily life, the cotton is often a suitable location for the survival of these microbes and an important source of disease transmission. Therefore, investigation of the antibacterial performance of cotton is of great significance.

The combination of conductivity and the antibacterial effect in a single multi-functional material has great potential for use in industrial, civilian, military and other fields [21,22].

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Research Article

Ensemble of Deep Learning Based Clinical Decision Support System for Chronic Kidney Disease Diagnosis in Medical Internet of Things Environment

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Recently, Internet of Things (IoT) and cloud computing environments become commonly employed in several healthcare applications by the integration of monitoring things such as sensors and medical gadgets for observing remote patients. For availing of improved healthcare services, the huge count of data generated by IoT gadgets from the medicinal field can be investigated in the CC environment rather than relying on limited processing and storage resources. At the same time, earlier identification of chronic kidney disease (CKD) becomes essential to reduce the mortality rate significantly. This study develops an ensemble of deep learning based clinical decision support systems (EDL-CDSS) for CKD diagnosis in the IoT environment. The goal of the EDL-CDSS technique is to detect and classify different stages of CKD using the medical data collected by IoT devices and benchmark repositories. In addition, the EDL-CDSS technique involves the design of Adaptive Synthetic (ADASYN) technique for outlier detection process. Moreover, an ensemble of three models, namely, deep belief network (DBN), kernel extreme learning machine (KELM), and convolutional neural network with gated recurrent unit (CNN-GRU), are performed. Finally, quasi-oppositional butterfly optimization algorithm (QOBOA) is used for the hyperparameter tuning of the DBN and CNN-GRU models. A wide range of simulations was carried out and the outcomes are studied in terms of distinct measures. A brief outcomes analysis highlighted the supremacy of the EDL-CDSS technique on exiting approaches.

1. Introduction

Internet of Things (IoT) aim is to interconnect and develop the connected things by computer network. Instead of utilizing higher energy consumption gadgets like phones, tabs, and machines [1], currently, some objects like air conditioners and room fresh units are computed by microcontroller utilizing sensing devices and provide the experimental result almost embedded in regular devices. IoT integrated with cloud computing (CC) method is highly beneficial while developing applications. A monitoring technique can be developed by incorporating cloud and IoT to monitor the infected people even if they are at distance that is highly employed by medical examiners [2]. Generally, IoT techniques keep on using cloud platforms for enhancing the efficacy in terms of data storage, programming abilities, computing, and utilization of resources efficiently. As well, cloud computing (CC) system attains superior experience

entropy

MDPI

Article

Entropic Uncertainty for Two Coupled Dipole Spins Using Quantum Memory under the Dzyaloshinskii–Moriya Interaction

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Abstract: In the thermodynamic equilibrium of dipolar-coupled spin systems under the influence of a Dzyaloshinskii–Moriya (D–M) interaction along the *z*-axis, the current study explores the quantum-memory-assisted entropic uncertainty relation (QMA-EUR), entropy mixedness and the concurrence two-spin entanglement. Quantum entanglement is reduced at increased temperature values, but inflation uncertainty and mixedness are enhanced. The considered quantum effects are stabilized to their stationary values at high temperatures. The two-spin entanglement is entirely repressed if the D–M interaction is disregarded, and the entropic uncertainty and entropy mixedness reach their maximum values for equal coupling rates. Rather than the concurrence, the entropy mixedness can be a proper indicator of the nature of the entropic uncertainty. The effect of model parameters (D–M coupling and dipole–dipole spin) on the quantum dynamic effects in thermal environment temperature is explored. The results reveal that the model parameters cause significant variations in the predicted QMA-EUR.

Keywords: quantum-memory-assisted entropic uncertainty; entanglement; mixedness; Dzyaloshinskii–Moriya interaction; dipolar system

1. Introduction

The Heisenberg uncertainty relation [1] has been extensively explored experimentally and theoretically because of its high ability to distinguish between the boundaries of classical and quantum mechanics. According to Heisenberg's uncertainty relation, it is impossible to know a particle's position and momentum with high precision at the same moment [2]. Therefore, an entropic-uncertainty relation was proposed [3–5]. However, the association between uncertainty relations and other essential qualitative features, entanglement and coherence was first discussed in the Einstein–Podolsky–Rosen (EPR) article [6], but there were no quantitative useful criteria at that time. Uncertainty violations were implemented as a signature of entanglement [7–9]. Recently, new entropic inequalities for the different quantum systems using the phase-space probability representation of quantum states have been reported [10].

Equipment Detection Based Inspection Robot for Industrial Plants

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Abstract. Industries move toward the replacement of labours engaged in dangerous tasks with fully automated systems. The sixth sense technology aims at achieving that by integrating different technologies in such a way that enables monitoring of industrial plants and predicting any faults that could happen. One important module of the sixth sense technology is inspection robots. This paper aims at providing the inspection robots with equipment-detection capability, resembling the human inspectors performing the customised inspection for a variety of equipment. The types of equipment, used in this study, are reactor, boiler, pump, isolated pipes, meter gauge, and valves. Given the complexity of the industrial environment, we propose a real-time deep-learning-based equipment detection model. The results show that the mean average precision is above 90%, which ensure the significant performance of the proposed solution. This work validates the practicality of our equipment-detection model and shows its potential to be employed on our inspection robot.

Keywords: Industrial inspection · Inspection robot · Equipment detection

1 Introduction

Industry 4.0 is transforming industrial processes into complex, smart cyber-physical systems that require intelligent methods to support safer operations. Under these conditions, it is extremely difficult to manage all available information, infer the desired conditions of the plant and take timely decisions to handle abnormal operations [1]. Thus, a technology that could help in preventing human error and stop chain reactions that can transform small incidents into catastrophic failure is required. The sixth sense, 6S technology aims to achieve that need by analysing the present data and generating a vision of the future.

Inspection is the practice of examining the condition of equipment to find out if it operates as intended. The implementation of routine inspection is an essential measure to ensure a safe and efficient production process. For the inspection tasks, checkpoints which mainly include key equipment, pipelines, key valves, gauges, and control points

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Full Length Article

Evolution and significance of clay minerals in the Esna Shale Formation at Dababiya area, Luxor, Egypt ☆

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ABSTRACT

The Esna Shale Formation is broadly distributed in Egypt and one of the most of its important clay deposits. These deposits in the Dababiya area, Luxor region were subjected to intensive laboratory investigations (XRD, IR, and SEM analyses). The bulk and clay mineralogy of this formation varies from one layer to the next and comprises the phyllosilicates, calcite as principal minerals with remarkable amounts of quartz, feldspars dolomites, and anhydrite. Fluorapatite, pyrite, schaurteite, despujolsite, goethite, and halite are present in some beds but minor quantities. The clay mineralogy consists of smectite (41%), sepiolite-palygorskite (28%), illite (13%), smectite/illite mixed layers (13%), and kaolinite (6%). Smectite was differentiated into three species**:** nontronite (21%), Na-and Ca-montmorillonites (13%), and beidellite (8%). Smectites are dioctahedral with a typical fully turbostratic stacking mode and crystallite sizes varying from 2 to 3 nm. The detrital input is the dominant aspect responsible for distributing clay minerals in these marine sediments. The presence of shallow Paleogene constrained basins between arose land areas in Egypt, favorable to the neoformation of palygorskite and sepiolite, It indicates that most of the fibrous clay minerals present in this part of the Tethys could have formed in these coastal basins and that their presence is an indication of aridity. By transcending global sea level that occurred at the end of the Paleocene, the nonappearance of kaolinite at the Dababiya area (southern Egypt) and its richness at the Wadi Nukhul Section (Sinai, Egypt) no relationship is shown between differences in kaolinite abundance and sea level fluctuations during this period. Six units of clay mineral species were distinguished throughout this formation reflecting their evolution.

1. Introduction

Based on the long-term grand program of the Geology Departments, Faculty of Sciences, of both of South valley and Sohag Universities, Egypt, for the precise characterization of clay minerals common in many rock units scattered in various areas of Upper Egypt, this study was undertaken to identify and quantify the clay minerals of the upper Cretaceous-lower Tertiary beds exposed at the Dababiya, Luxor, Egypt, as well as their physical and chemical properties. This objective was an echo and hope to clear the inconsistency in many of the visions of the interpretation of the components of these rock units [e.g. [1–4]] especially since many of these studies have been carried out in the past decades, where the clay mineral sciences did not hit on many of the advanced techniques available now that provided a lot of information in this regard. Therefore, this study was oriented to 1-Qualify and quantify precisely the bulk rock and clay fraction mineralogy of Esna Shale Formation, 2- identify its clay mineral species. 3-determine the physio-chemical characteristics of these species and lastly 4-to relate all these concluded data with its paleoenvironments and climatic conditions at its source areas

2. Geological setting

The study area is located on the eastern side of the Nile Valley in the southern Luxor region in Upper Egypt. The area is located between the eastern limestone plateau and the Nile flood plain between Lat 25° 30′ N, Long 32° 31′ 52″ E (Fig. 1: A and B). The surface geology of the studied area was the subject of a large number of studies since the beginning of the last century. Among the most

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Experimental and theoretical studies of $(CdS)_{1-x}$ $(ZnS)_x$ thin-films for second generation CdS/CdTe solar cells

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ABSTRACT

The current work focused on studying the optical and structural properties of $(CdS)_{1-x}$ $(ZnS)_x$ thin films fabricated by thermal vacuum evaporation approach. The evaporation was implemented at room temperature from bulk samples synthesis by sintering approach. The energy gap, index of refraction, extinction coefficient and absorption coefficient were estimated from the experiment and employed in our theoretical model to estimate quantitatively the solar cell efficiency and short-circuit current density of CdS:ZnS/CdTe structure. The calculations of cell efficiency as well as short-circuit current density were computed on the bases of the optical losses caused by reflection at interfaces and absorption process occurred in the frontal charge-collecting and window layers and the recombination losses at front and back surface of CdTe. The XRD analysis showed that the intensity and position of predominant peak of CdS gradually changes with increasing the ZnS content indicating a success of forming CdS:ZnS alloy. The films exhibited direct band-to-band transitions and the optical energy gap increased from 2.40 eV to 3.10 eV with increasing of ZnS content up to x = 0.50. The short-circuit current density increased from 16.50 mA/cm^2 to 21 mA/cm^2 and the cell efficiency increased from 13.10% to 17.10% due to the increase of the ZnS content from x = 0 to x = 0.50.

Credit author statement

Conceptualization, H. A. Mohamed and W. S. Mohamed; methodology, all authors; formal analysis, all authors; investigation, all authors.; resources, H. A. Mohamed; data curation, all authors; validation, all authors; writing—original draft preparation, H. A. Mohamed and W. S. Mohamed; writing—review and editing, Mahrous R. Ahmed, H. A. Mohamed; supervision, H. A. Mohamed; project administration, W. S. Mohamed.

1. Introduction

Since the last decade cadmium sulfide (CdS) thin film has attracted many interested researchers in the field of optoelectronics due to possessing unique properties such as wide direct gap energy, higher electron affinity value and phase stability as well as proper conductivity ranges with n-type [1,2]. CdS thin layers are widely used as a window substance and as a heterojunction co-partner in traditional solar cells such as CdTe [3], $CuInS_2$ [4], and $CuInGaS_2$ [5] heterojunction solar cells. The energy gap of CdS is comparatively low (2.42 eV), hence the photons with $(h\upsilon) > 2.42$ eV may be absorbed by the CdS thin layer before reaching the absorber layer. There are some suggestions to resolve this issue. The first is to reduce the thickness of CdS layer. Reducing the thickness of CdS layer directly may increase the short circuit current density, however the thickness must not be too thin to avoid a short circuit effects [6]. The second approach is to replace CdS layer by a large energy gap semiconductor such as ZnS [7]. The 3.70 eV bandgap of ZnS enables it to pass a large amount of photons to the absorbent layer without significant absorption loss [8]. Nevertheless, ZnS is not a suitable window material for some solar cells particularly those based on CdTe because ZnS has a higher doping density [7]. The final suggestion is to increase the band gap of CdS by making an alloy with wide band gap material [7]. From this point of view, many articles have been achieved, concerned with ZnS/CdS multilayer or $Cd_{1-x}Zn_xS$ alloy as a window material for thin film based solar cells [9,10].

In this study, firstly we studied the influence of ZnS content on the microstructural and optical properties of CdS thin films fabricated by thermal evaporation approach. The optical properties namely optical

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Facile synthesis and characterization of novel Gd_2O_3–CdO binary mixed oxide nanocomposites of highly photocatalytic activity for wastewater remediation under solar illumination

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ABSTRACT

In this study, pure cadmium oxide (CdO) nanoparticles and mixed gadolinium oxide (Gd_2O_3)–CdO nanocomposites with different Gd_2O_3 contents (0–15%) were synthesized by a facile precipitation technique followed by calcined treatment. The X-ray diffraction analysis illustrated that all samples had high cubic-phase purity and a good crystallinity. Further support for the formation of highly pure CdO and Gd_2O_3 phases was obtained via infrared spectroscopy. The morphologies of pure CdO and mixed Gd_2O_3–CdO nanoparticles were probed by scanning electron and transmission electron microscopy, which demonstrated that the collected samples consisted of individual semi-spherical shaped entities of different particle sizes (23–31 nm). The optical band gap of the developed samples was computed based on the Tauc equation and showed a decrease from 3.41 to 2.75 eV upon increasing the Gd_2O_3 content. The 3D fluorescence analysis showed that the quenching in the emission peak intensity with increasing Gd_2O_3 content was due to the high separation efficiency of photogenerated electron–hole pairs. Moreover, the Gd_2O_3(15%)–CdO nanocomposite showed superior photodegradation efficiency (89.1%) of methylene blue compared to 44.4% for pure CdO. At pH 11.5, >3-fold enhancement in degradation rate (0.044 min^{-1}) was obtained compared to natural pH 9.6. Reusability study showed stability of the Gd_2O_3–CdO photocatalyst in four cycles of methylene blue degradation. Trapping experiment of holes and electrons revealed extensive contribution of holes rather than electrons in producing active oxidizing species.

1. Introduction

Increased industrialization in many sectors has resulted in higher levels of environmental pollution. In textile-related industries, dyes are the primary effluents responsible for toxicity to aquatic life [1]. The commonly used blue cationic thiazine-dye methylene blue (MB) is often enriched in wastewater streams containing dyes [2]. The traditional techniques of flocculation, coagulation, ultrafiltration, and adsorption do not provide a sufficient solution to deal with industrial wastewater pollution [3]. Therefore, developing safe, easy, green, and cheap ways to deal with such severe environmental issues are needed. Advanced oxidation technologies provide an efficient approach in seeking green and sustainable ways to solve such environmental pollution. Photocatalysis is one avenue, and utilizes light to photosensitize catalysts in producing active oxidizing species and transforming hazardous pollutants to less detrimental substances [4,5]. Transition metal oxide semiconductors are pivotal catalysts in the suite of photocatalysts to deal with environmental hazards. In this context, mixed oxide nanocomposites have been studied intensively over the last decade, because of improved properties compared to single component materials [6,7]. Nanocomposites are defined as a combination or matrix of different materials combined on a nanometer scale to develop a new material with properties that depend on the contribution of each component in the mixture. Thus, the nanocomposite may have remarkable physical and chemical properties compared with the parent compounds [8–11].

Cadmium oxide (CdO) is an n-type semiconducting material with a

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Finite Element Analysis of Nonlinear Bioheat Model in Skin Tissue Due to External Thermal Sources

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Abstract: In this work, numerical estimations of a nonlinear hyperbolic bioheat equation under various boundary conditions for medicinal treatments of tumor cells are constructed. The heating source components in a nonlinear hyperbolic bioheat transfer model, such as the rate of blood perfusions and the metabolic heating generations, are considered experimentally temperature-dependent functions. Due to the nonlinearity of the governing relations, the finite element method is adopted to solve such a problem. The results for temperature are presented graphically. Parametric analysis is then performed to identify an appropriate procedure to select significant design variables in order to yield further accuracy to achieve efficient thermal power in hyperthermia treatments.

Keywords: biological tissue; thermal damage; bioheat transfer; finite element method

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1. Introduction

Recent research developments have shown that the problem of heating transfers in skin tissues is an incredibly complicated problem. There are many controversial parameters found in this field. To describe the current status [1], at temperatures above 60 °C, the time needed to check irreversible damages decreases rapidly, while, at temperatures around 40–45 °C, irreversible tissue damage happens after only prolonged exposures. A human body behaves differently under different environmental conditions (e.g., different air temperatures, humidity levels, and wind velocities). Thermotherapy operations, such as laser tissues welding [2], hyperthermy [3], and lasers operations [4], have been openly used in modern medicine. Since the temperature distribution in the living tissues depends on complex phenomena, like metabolic heating generations and blood circulation, investigators have expanded some formulations. In clinical therapy, various contemporary thermotherapeutic techniques have been widely used for microwave, laser, ultrasound, and radiofrequency technologies. First, using an objective thermal lens, the laser focuses on the tumor. One of the main challenges in the treatment process is to provide adequate thermal power to diseased tissue without affecting healthy tissue. Therefore, it is important to consider the impact of temperature and stress fields on heat treatment kinetics. Van and Gybels [5] demonstrated that deformation due to heating and cooling can also contribute to a feeling of discomfort. Therefore, exact predictions of the Sun, mechanical reaction, and thermal damage in organic tissues are required for the treatment planning and development of new clinical heating systems. In 1948, Pennes [6] investigated the thermal behavior of skin temperature in the forearm. The investigation included many phenomenological mechanizations, such as metabolic heat generation, radiation, blood perfusion, thermal conduction, and phases change. In biological tissues, the phase changes occur in wide ranges. The adjusted Penne's bioheat models are presented by various techniques of numerical approach available in the literature: the homotopy perturbation

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REMEDIATION TREATMENT

ENVIRONMENTAL PROGRESS & SUSTAINABLE ENERGY

Flood hazard assessment and characteristics of cement kiln dust in Ain Sukhna industrial area, north-western part of the Gulf of Suez, Egypt

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Abstract

This study investigated the geochemical and mineralogical characteristics combined with heavy elements concentrations of Cement kiln dust (CKD) in Ain Sukhna industrial area, North-western part of the Gulf of Suez, Egypt and the influence of flash floods in its stability. Flooding severity is moderate with several water erosional processes. The CKD characterized by very poorly sorted/very fine-sands to silt. CaO and SiO_2 are major components with enrichment of chloride/sulfate ions. High enrichment of Sr, Zn, Pb, Cd, Sb, and Se are related to variations in shale/limestone feeds during cement formation. The threshold effect level exceeds the standard value for Cd, Pb, and Zn at S3 that indicates adverse biological effects. Sylvite, calcite, and halite minerals were dominated. Three main principal components recognized the shale, calcium/magnesium carbonate dissolution, and the scavenging effect of sulfate for heavy elements. Monitoring the CKD leachability and proper management plans are prerequisite for environmental protection in the future.

KEYWORDS

Ain Sukhna industrial area, Egypt, cement kiln dust, heavy elements, leachability, principal component analyses

1 | INTRODUCTION

The health effects of high-risk industries such as cement manufacturing have become a principal issue both for employees and the surrounding environment. Also, due to the rapid techniques developed in cement manufacturing processes, risk assessment becomes a crucial for keeping the environment cleaner.[1] The process starting from mining the limestone and shales/clays raw materials followed by crushing, stacking, reclaiming, grinding, and homogenization processes. The modern cement industry needs pyro-processing that includes calcination and sintering processes in the rotary kiln. These processes develop a clinker (aggregation of alite, belite, and ferrite nodules) from the mix (pure limestone, argillaceous limestone, or marl mixed with shale).[2] The low moisture (~0.5%) raw mix feeds into the preheater and precalciner equipment. This will calcinate the mix before it comes to the rotary kiln (Figure 1).[2,3]

Carbonate materials are decomposed thermally into calcium oxide and carbon dioxide gas during the calcination process. The preheaters raise the temperature of the raw mix, using heat formed by combusting fuel fed from the kiln exhaust. Volatile solid alkalis, sulfates, and chlorides compounds of the cement kiln dust (CKD) are separated by centrifugal forces through a bypass system.[4] CKD is a spin-off material from the cement production industry. It is a fine powder material, having greyish white color resemble to the appearance of Portland cement.[4] The mix is then sent into a rotary kiln where it is sintered (thermo-chemical combustion process) to produce clinker. The waste gases resulted from the sintering process are ejected by the bypass.[5] The physical and chemical characteristics of

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ORIGINAL PAPER

Flood susceptibility prediction using four machine learning techniques and comparison of their performance at Wadi Qena Basin, Egypt

Bosy A. El-Haddad, et al. ***[full author details at the end of the article]***

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Abstract
Floods represent catastrophic environmental hazards that have a significant impact on the environment and human life and their activities. Environmental and water management in many countries require modeling of flood susceptibility to help in reducing the damages and impact of floods. The objective of the current work is to employ four data mining/machine learning models to generate flood susceptibility maps, namely boosted regression tree (BRT), functional data analysis (FDA), general linear model (GLM), and multivariate discriminant analysis (MDA). This study was done in Wadi Qena Basin in Egypt. Flood inundated locations were determined and extracted from the interpretation of different datasets, including high-resolution satellite images (sentinel-2 and Astro digital) (after flood events), historical records, and intensive field works. In total, 342 flood inundated locations were mapped using ArcGIS 10.5, which separated into two groups; training (has 239 flood locations represents 70%) and validating (has 103 flood locations represents 30%), respectively. Nine themes of flood-influencing factors were prepared, including slope-angle, slope length, altitude, distance from main wadis, landuse/landcover, lithological units, curvature, slope-aspect, and topographic wetness index. The relationships between the flood-influencing factors and the flood inventory map were evaluated using the mentioned models (BRT, FDA, GLM, and MDA). The results were compared with flood inundating locations (validating flood sites), which were not used in constructing the models. The accuracy of the models was calculated through the success (training data) and prediction (validation data) rate curves according to the receiver operating characteristics (ROC) and the area under the curve (AUC). The results showed that the AUC for success and prediction rates are 0.783, 0.958, 0.816, 0.821 and 0.812, 0.856, 0.862, 0.769 for BRT, FDA, GLM, and MDA models, respectively. Subsequently, flood susceptibility maps were divided into five classes, including very low, low, moderate, high, and very high susceptibility. The results revealed that the BRT, FDA, GLM, and MDA models provide reasonable accuracy in flood susceptibility mapping. The produced susceptibility maps might be vitally important for future development activities in the area, especially in choosing new urban areas, infrastructural activities, and flood mitigation areas.

Keywords Floods · Remote sensing · Data mining · Modeling · GIS · Susceptibility · Egypt

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ORIGINAL PAPER

Formation of improved activated carbons from sugarcane bagasse as environmental materials for adsorption of phenolic pollutants

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Abstract
Phenolic pollutants are very toxic and their removal from aquatic resources is very important. Adsorption by activated carbon, AC, is the best method for removal of phenols from solutions. However, the high cost of AC and difficulty of its regeneration after phenol adsorption puts high demand on low price AC materials. Therefore, sugarcane bagasse as a sustainable, bulky and fibrous biomass was selected for the purpose of low-price AC formation for phenols adsorption. Sugarcane bagasse derived activated carbon, BAC, was achieved via an environmental thermo-chemical activation process using $ZnCl_2$ followed by pyrolysis at different temperatures (400–600 °C). The formed BAC materials were characterized by elemental analysis, simultaneous TGA–DTA, ATR-FTIR, XRD, Raman spectroscopy, SEM, and nitrogen adsorption/desorption techniques. The BAC materials showed several enhanced characteristics including extra high specific surface area (up to 2046 m^2/g), improved meso-/microporosity dual system and nanostructured graphitic-like structure composed of few graphene layers. Adsorption removal of phenol as an industrial waste pollutant was investigated from solutions of wide range of concentrations (50–1000 mg/L). The adsorption processes were characterized by (L2) class of adsorption isotherm, Langmuir isotherm model, physical-adsorption thermochemical parameters and pseudo-second-order kinetics. Adsorptions of two other substituted phenols (resorcinol and pyrogallol) were investigated. The adsorption capacity was increased with increasing of intramolecular bonding of the adsorbate in the order of phenol < resorcinol < pyrogallol. The present results emphasized the versatility of the formed BACs as environmentally sustainable adsorbent for phenolic pollutants.

Keywords Activated carbon · Environment · Graphene layers · Contaminates · Pollutants

Introduction

Phenolic compounds belong to the group of common environmental contaminants produced in industrial effluents, which are very toxic and classified as priority pollutants (Priya and Sureshkumar 2020; Villegas et al, 2016; Girods et al. 2009; Dabrowski et al. 2005). The main industrial sources of phenols/phenolic compounds emission are discharged from manufacturing of pesticides, chemicals, pharmaceuticals, paper, wood, petroleum refining, and olive oil extraction units (Girods et al. 2009; Michailof et al. 2008).

In fact, phenols are not bio-degradable compounds, although the permissible concentration level of phenols in drinking water is about 1.0 µg/L according to the World Health Organization (WHO). Phenols/phenolic compounds are highly soluble in water; therefore, their presence leads to serious contamination of drinking water resources that causing unpleasant odor. Contamination with phenols lead to harmful effects to aquatic flora, fauna, aquatic organisms and prevent the regular acts of biological community (Hameed and Rahman 2008; Al-Malack and Dauda 2017; Lorenc-Grabowska et al. 2016). Phenol contamination may cause serious health problems that can be acute and chronic. Thus, from the medical point of view, phenols contamination may cause intensive risk to human kind health, such as kidney and liver damage, protein degeneration, tissue erosion, sour mouth, diarrhea, impaired

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REVIEW ARTICLE

Fungal biodegradation and removal of cyanobacteria and microcystins: potential applications and research needs

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Abstract

Harmful cyanobacterial blooms (HCB) have severe impacts on marine and freshwater systems worldwide. They cause oxygen depletion and produce potent cyanotoxins that have detrimental effects on human and environmental health and deteriorate the water quality. Biological treatment of the water for control of cyanobacterial blooms and removal of cyanotoxins can be a more economical and environment-friendly way, as they do not result in production of undesirable by-products. Most biological treatments of cyanobacteria and cyanotoxins have concentrated largely on bacteria, with little attention paid to algicidal fungi. Therefore, this review aims to provide an overview of the current status and the main progresses achieved in fungal biodegradation of HCB and cyanotoxin research. The available data revealed that 15 fungal species had high lytic activity against cyanobacteria, and 6 species were capable of degrading microcystins (MCs). Some fungal species (e.g., *Aurobasidium pullulans and Trichoderma citrinoviride*) have been identified to selectively inhibit the growth of cyanobacteria rather than beneficial species of other algal groups. Interestingly, some fungal strains (*Trichaptum abietinum*, *Trichoderma citrinoviride*) exhibited dual-functional trait, being efficient in lysing cyanobacteria and degrading MCs released from the cells after decay. Beyond a comprehensive review of algicidal and toxin-degrading activities of fungi, this paper also identifies and prioritizes research gaps in algicidal fungi. The review also gives insights to the potential applications of algicidal fungi for removal of cyanobacterial blooms and their cyanotoxins from the aquatic environment.

Keywords Algicides · Biocontrol · Harmful algal blooms · Cyanobacteria · Fungi

Introduction

Harmful cyanobacterial blooms (HCBs) have been recognized as a global environmental and health problem in freshwater and marine ecosystems (Schaeffer et al. 2018). HCBs may cause the asphyxiation of aquatic animals and deteriorate the quality of water used for recreational and drinking purposes (Paerl and Huisman 2008; Mohamed 2016). Moreover, HCBs can produce toxic metabolites including the hepatotoxins, microcystins (MCs) (Codd et al. 2005). These toxins have led to mortality of aquatic and terrestrial animals (Pham and Utsumi 2018), and human deaths upon consumption of contaminated water (Azevedo et al. 2002). HCBs are expected to increase and expand worldwide in the future as a result of eutrophication of aquatic ecosystems and global warming that promote the growth of these microorganisms (Paerl and Otten 2013; Visser et al. 2016). Additionally, MCs, the most frequent cyanobacterial toxins in freshwaters, are released from the cells into the water during natural senescence or physical/chemical treatment (Ross et al. 2006). As they are cyclic

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DGfM

ORIGINAL ARTICLE

High-throughput amplicon sequencing of fungi and microbial eukaryotes associated with the seagrass *Halophila stipulacea* (Forssk.) Asch. from Al-Leith mangroves, Saudi Arabia

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Abstract
This is the first high-throughput amplicon sequencing study of mycobiome associated with leaves of the seagrass *Halophila stipulacea*. Five leaf samples were collected from the Al-Leith mangroves along the Red Sea coast of Saudi Arabia. Total DNA was extracted from 250 mg of each sample, and the first 300 bp (contains D1-D2 variable regions) of the LSU rDNA amplicon was sequenced with the Illumina MiSeq (bTEFAP). A total of 928,626 reads were obtained from the five samples. The sequence reads belonged to Metazoa (48.1% of the total reads), Viridiplantae (41.1%), Eukaryota (8.8%), Fungi (1.96%), Bacteria (0.09%), and Archaea (0.0001%). Fungi represented between 1.1% and 5.8% of the total reads in the five samples. A total of 18,279 reads (representing 1.96% of the total reads) were recorded from the 5 samples representing 296 molecular species (OTUs) that belong to 13 fungal phyla. At the phylum level, Basidiomycota dominated the community (37.2–51.6%) in three samples, while Neocallimastigomycota (37.5%) and Mucoromycota (42.1%) dominated the community in the fourth and the fifth samples, respectively. High diversity of OTUs (28 molecular species) were recorded from the monokaryotic subkingdom with five unknown basal lineages that are not aligning with any known taxa. Total number of sequence reads of microbial eukaryote organisms (Stramenopiles) from the five samples ranged between 0.16 of total reads in the fifth sample (AL-Hs05) to 2.9% in the first one (AL-Hs01). Majority of the microbial eukaryote reads (93.6%) belong to the phylum Oomycota, followed by Opisthokonts (Fungi/Metazoa group) representing 6.4% of microbial eukaryote reads. Monokaryon phyla (i.e., Chytridiomycota, Mucoromycota, and Neocallimastigomycota) and microbial eukaryotes occupied a major portion of the sequence reads followed by Basidiomycota and Ascomycota. Our results support the findings that the majority of fungi and microbial eukaryotes communities are so far unknown with seven deep branching lineages remain to be cultivated.

Keywords Marine fungi · Molecular phylogenetics · Foliicolous fungi · Stramenopiles · Yeasts

Introduction

Seagrasses are flowering plants inhabiting marine environments and have a worldwide distribution, with 50 species reported that cover about 60,000 km^2 (Logan 1992; Phang 2000; Raghukumar 2017). Seagrasses provide food, habitats, and breeding grounds to a variety of marine species. In addition, meadows of seagrass are important carbon sinks and sequester between 10 and 18% of ocean's carbon reservoir for long-term storage (Pernice et al. 2016). Seagrasses prevent erosion by trapping and binding sediments and upon their death provide substantial amounts of nutrition to organisms living within the seagrass ecosystem, as well as to those in mangroves and corals and other ecosystems (Wilson 1998; Phang 2000; Raghukumar 2017). Primary productivity of seagrass meadows is among the highest of aquatic

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Original article

Identification and molecular study of medicinal *Plectranthus* species (Lamiaceae) from Saudi Arabia using plastid DNA regions and ITS2 of the nrDNA gene

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ABSTRACT

Plectranthus is a genus of the Lamiaceae family that includes many species of medicinal and agricultural importance. However, this genus has been the subject of taxonomic debate and contains species that are difficult to distinguish. The present study focused on six *Plectranthus* species commonly found in Saudi Arabia: *P. arabicus*, *P. tenuiflorus, P. barbatus, P. pseudomarrubioides*, *P. asirensis,* and *P. hijazensis*. *P. hijazensis* is endemic to Saudi Arabia. The capacities of five different plastid DNA barcodes (*matK*, *rbcL*, *trnH-psbA*, and *ITS1* and *ITS2* regions of the nrDNA gene) to identify and distinguish between *Plectranthus* species were evaluated. The following analytical methods were used to evaluate the efficiencies of the selected markers: BLAST, inter- and intraspecific distance, barcode gap, secondary structure of *ITS2*, and maximum likelihood (ML) phylogenetic trees. The results demonstrated that the nuclear *ITS2* region can be successfully amplified and sequenced (100%), leading to a strong ability to discriminate between species and a clear barcode gap. Furthermore, there were significant differences in the *ITS2* secondary structure among *Plectranthus* spp. Samples of *Plectranthus* formed monophyletic groups according to species in the ML tree, with high supported values. Our results establish that all *Plectranthus* species in Saudi Arabia can be classified into two groups within the Coleus clade. To our knowledge, this is the first time that local and endemic *Plectranthus* spp. have been identified and compared with *Plectranthus* samples of different geographical origins. Our results confirm the diversity of *Plectranthus* species growing naturally in southwestern Saudi Arabia. In addition, *P. hijazensis,* which is endemic to Saudi Arabia, was determined to be genetically distinct from other *Plectranthus* species and should, therefore, be the focus of future research, in addition to the preservation of the natural environment of these species.

1. Introduction

Plectranthus is one of the most important genera in the Lamiaceae family. The genus has been the subject of taxonomic debate for a variety of reasons, including the strong similarity between species and existence of multiple names for each species. In addition, it is difficult to identify species of genera that are closely related to *Plectranthus* (Musila et al., 2017). Initial classification attempts for *Plectranthus* were based on morphological characteristics, which resulted in many contradictions in the arrangement and number of subgenera and sections belonging to the genus. Morphological taxonomic classification of this tribe has not successfully classified the clades within the sub-tribe (Paton et al., 2004).

Paton et al., (2004) studied the molecular phylogenetics of the Ocimeae tribe based on three plastid DNA regions and argued that the *Plectranthus* genus is paraphyletic, supporting the hypothesis that Ocimeae is of Asian origin. Recently, (Paton et al., 2018) reviewed *Plectranthus* and *Coleus* based on the distribution and medicinal attributes of the phylogenetic plastid genes *trnL-F*,

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IDENTIFICATION AND PHYLOGENETIC STUDY OF *ARABIS ALPINA* L. FROM THE KINGDOM OF SAUDI ARABIA

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Abstract

The purpose of the current study was to determine the phylogenetic relationships between the *Arabis alpina* L. growing naturally in Afro-Alpina Mountains at south western regions of the Kingdom of Saudi Arabia (KSA) and its closely related species. A case study approach was applied to DNA barcode, secondary internal transcribed spacer (*ITS*2), chloroplast maturase-K (*mat*K), ribulose-1,5-bisphosphate carboxylase/oxygenase (*rbc*L) for the identification and determination phylogenetic relationship. An analysis of barcode data was conducted using the basic local alignment search tool (BLAST), pairwise genetic distances and the maximum likelihood (ML) methods. The results showed the clear superiority of the nuclear *ITS*2 loci and chloroplast *mat*K gene with a 100% success rate found for DNA amplification, sequencing, and 100% species resolution. A maximum likelihood ML tree of *ITS*2 and *mat*K strongly supported the presence of variations between *A. alpina* of Saudi Arabia and specimens of *A. alpina* of different geographical origins. This study represented the first inspection to *A. alpina* in KSA, and is useful in species identification, conservation and evolutionary studies. More studies are needed to verify if the A. Alpina of the KSA can be considered a subspecies.

Key words: DNA, Barcode, *ITS*2, *mat*K, *rbc*L, Taxonomy.

Introduction

The Brassicaceae family includes 51 tribes, 321 genera, and roughly 4000 species, (Al-Shehbaz, 2012; Al-Shehbaz *et al*., 2014; Nikolov *et al*., 2019). The family has been a controversial and widely disputed subject within the field of taxonomy due to the large number of species belonging to it in contrast to the limited number of diagnostic features accepted, which has led to conflicts between studies of this family (Koch *et al*., 2010). Recent developments in the field of DNA sequencing techniques have led to a renewed interest in understanding the ambiguity of Brassicaceae relationships.

DNA barcoding is a novel technique for identification and characterization of new plant species (Jamil *et al*., 2014; Shinwari *et al*., 2014; Khan *et al*., 2015; Zahra *et al*., 2016; Channa *et al*., 2018; Shinwari *et al*., 2018). Phylogenetic studies have contributed to the introduction of many acceptable interpretations and to the drawing of phylogenetic relations within the Brassicaceae family and between tribes and genera. Such studies have been applied using different chloroplast genes (Chase *et al*., 1993; Steele & Vilgalys, 1994; Abdel-Khalik, 2002), and nuclear region (Heenan *et al*., 2002: Warwick *et al*., 2008). Tribal limits and relationships among and between tribes have been studied using chloroplast region *ndh*F (Beilstein *et al*., 2006), *mat*K (Koch *et al*., 2001) and the ITS region (Warwick *et al*., 2008). The most recent phylogenetic study of Brassicaceae (Nikolov *et al*., 2019) was based on sequence data of 1827 exons representing 63 species and 50 of the 52 recognized Brassicaceae tribes, using large set of herbarium material. Nonetheless, there remained doubts regarding the taxonomic status certain genera, which was not fully resolved.

Arabis is an important taxonomically complex genus in Brassicaceae with 70 species (Jordon-Thaden *et al*., 2010) and (Al-Shehbaz *et al*., 2005). It is characterized by the existence of branched trichomes, latiseptate siliques flattened parallel to the septum (German & Al-Shehbaz, 2008). *Arabis alpina* grows naturally in montane and alpine habitats and is widely distributed in Anatolia and adjacent regions (Ansell *et al*., 2011). Assefa *et al*., (2007) suggested the migration of *A. alpina* from the Middle East to the Arabian Peninsula, and then to eastern Africa via the mountains bordering the Red Sea.

Nuclear ribosomal *RNA* and chloroplast genes *trn*L-*trn*F have been tested to detect relationships of *Arabis* species of North America and eastern regions (Koch *et al*., 2010). Koch & Grosser (2017) examined Phylogentic analysis of East Asian Arabis species, using chloroplast gene trnL-F and nuclear loci ITS1 and ITS2. Tracing of Ancestors was difficult to detect, because related species were either extinct or their relatives were distributed in Europe and Asia Minor. Furthermore, in a study complete chloroplast genomes of East Asian *Arabis* species were analyzed, it was inferred that multiple hybridization, and that the two organelles genomes were co-transferred (Kawabe *et al*., 2018).

The adaption changes experienced by *Arabis alpina* species over the past decade in relation of the environment remain poorly understood. *Arabis alpina* serves as a good model for studying the impacts of harsh climatic conditions related speciation, genetic differentiation, and long-term adaptations to different geographical conditions (Karl *et al*., 2012).

No phylogenetic molecular studies were conducted on *Arabis alpina* of the KSA, despite the many similarities, derived species, hybrids and taxonomic conflicts observed in the genus *Arabis*. The purpose of this study is to examine the relationship between *Arabis alpina* native to the southwestern highlands of the KSA and its closest relatives by measuring phylogenetic features using a molecular approach based on DNA barcodes *ITS*2, *rbc*L, and *mat*K.

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Impact of pangolin bootleg market on the dynamics of COVID-19 model

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ABSTRACT

In this paper we consider ant-eating pangolin as a possible source of the novel corona virus (COVID-19) and propose a new mathematical model describing the dynamics of COVID-19 pandemic. Our new model is based on the hypotheses that the pangolin and human populations are divided into measurable partitions and also incorporates pangolin bootleg market or reservoir. First we study the important mathematical properties like existence, boundedness and positivity of solution of the proposed model. After finding the threshold quantity for the underlying model, the possible stationary states are explored. We exploit linearization as well as Lyapanuv function theory to exhibit local stability analysis of the model in terms of the threshold quantity. We then discuss the global stability analyses of the newly introduced model and found conditions for its stability in terms of the basic reproduction number. It is also shown that for certain values of R_0, our model exhibits a backward bifurcation. Numerical simulations are performed to verify and support our analytical findings.

Introduction

Corona virus disease (COVID-19) is the current outbreak, which is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This disease was reported for the first time in the Wuhan city of China. The respiratory track of the infected person is badly affected. Common symptoms of this disease include difficulty in breathing, dry cough, sever pain and fever. This horrible outbreak has infected more than three million people all over the world [1–4]. The virus is zoonotic in nature, i.e., it can be transmitted from animals to human and cause disease. Several studies indicate that ant-eating pangolin (Manis Pentadactyla) is the common vector of CoVID-19 [1]. Similar studies have also been recorded in the past, the pandemic of SARS Virus back in 2003 which had been transmitted from Bats to a Civet [3]. Some data shows that the DNA sequence of the Corona virus discovered in the lung sample of pangolin was found to be similar to SARS CoV-2, known as CoVID-19 and both of these viruses have specific type of proteins on their surface known as spike proteins [5,6].

Pangolins are amongst those animals that are heavily trafficked in the world, which has resulted in the extension of this animal. After the out break of Covid-19 pangolins are considered to have a great link with its initial out break in China. Though the evidences are not adequate, still Chinese government has propagated this message and is working to pass legislation for banning the use of this animal. More attention is required for the conservation of pangolins; therefore, governments need to take more serious actions against the wildlife trade. The main question that arises about Covid-19 is to know from where it emerged? Evidence shows that several animals are the source of Covid-19. Addressing this question is very essential for public health authorities and policy makers because it will help us to prevent out breaks in future. Many theories have been initiated, but potentially the most noticeable cause is pangolin. There are two reasons behind illegal trade and hunting of pangolin. The first reason is the delicacy of its meat and is mostly used in China and Vietnam. The second one is that pangolin scales is mostly used in traditional remedies of China [11]. Due to these two main factors pangolin is considered as the world's most trafficked animal. In press conference held on 7th February 2020 by 'South China Agriculture University, Guangzhou, it was stated that Covid-19 came from pangolin.

Pangolin is genetically similar to human's corona virus at 99.1 per cent where it is related to a specific site known as receptor binding domain (RBD) [7]. The pangolin feeds on the excreta and saliva of the bats, which is the source of Corona virus and due to this feeding pangolin was found to be infected by the virus. It has been revealed from the whole genome sequences comparison that pangolin shows similarity of 90.3 with human corona virus. Corona virus inserts its crucial part, known as RBD, to

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plants

MDPI

Review

Impacts of Microcystins on Morphological and Physiological Parameters of Agricultural Plants: A Review

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Abstract: Cyanobacteria are a group of photosynthetic prokaryotes that pose a great concern in the aquatic environments related to contamination and poisoning of wild life and humans. Some species of cyanobacteria produce potent toxins such as microcystins (MCs), which are extremely aggressive to several organisms, including animals and humans. In order to protect human health and prevent human exposure to this type of organisms and toxins, regulatory limits for MCs in drinking water have been established in most countries. In this regard, the World Health Organization (WHO) proposed 1 µg MCs/L as the highest acceptable concentration in drinking water. However, regulatory limits were not defined in waters used in other applications/activities, constituting a potential threat to the environment and to human health. Indeed, water contaminated with MCs or other cyanotoxins is recurrently used in agriculture and for crop and food production. Several deleterious effects of MCs including a decrease in growth, tissue necrosis, inhibition of photosynthesis and metabolic changes have been reported in plants leading to the impairment of crop productivity and economic loss. Studies have also revealed significant accumulation of MCs in edible tissues and plant organs, which raise concerns related to food safety. This work aims to systematize and analyze the information generated by previous scientific studies, namely on the phytotoxicity and the impact of MCs especially on growth, photosynthesis and productivity of agricultural plants. Morphological and physiological parameters of agronomic interest are overviewed in detail in this work, with the aim to evaluate the putative impact of MCs under field conditions. Finally, concentration-dependent effects are highlighted, as these can assist in future guidelines for irrigation waters and establish regulatory limits for MCs.

Keywords: harmful algal blooms; eutrophic waters; microcystins; agricultural plants; phytotoxicity; irrigation; agriculture; regulatory limits

1. Introduction

Harmful algal blooms (HABs) constitute a real threat to aquatic ecosystems. In freshwater ecosystems, HABs are often composed by cyanobacteria and can be designated

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Influence of different types of substrates on the physical properties of CdSe films

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ABSTRACT

Cadmium Selenide, CdSe, thin films deposited on different substrate types; FTO/glass,/glass, and ITO/glass substrates were produced by thermal evaporation method in the room temperature. The influence of different types of substrates on the structural, optical and electrical properties of the films was studied by X-ray diffraction and absorption photo spectroscopy respectively. X-ray diffractions revealed that all the CdSe films have a polycrystalline with cubic structure having preferred orientation (111) at $2\theta \approx 25.1^{\circ}$. The optical energy band, E_g, values support the fact that the films have semiconductor behavior which can be attributed to the quantum confinement effect. It was observed that the optical properties such as transmittance, reflectance, optical bandgap, and refractive index and some another parameters of CdSe films were strongly affected by types of substrates. The electrical properties were measured at room temperature using two probe methods.

1. Introduction

Thin films of the II-VI semiconductors elements are attracting many interests nowadays because of their interesting optical properties [1–3]. They have many important applications, such as photo-detector [4], gas sensors [5], solar cells [6], and Photo-catalysis [7]. Colloidal semiconductor nano-crystals establish these days an important class of materials for nanotechnology. Up to now, the most studied nano-crystals are made of CdSe which is covered with an epitaxially grown ZnS shell as a passivation layer [8]. CdSe nanocrystals are now known as highly efficient fluorescent light sources.

Zubair et al. [9] have deposited CdSe thin films on glass substrates using the thermal evaporation method. They have studied the effect of the film's thickness on the optical and structural properties. They also have obtained the optical constants, refractive index (n), and film thickness (d) by the Swanepoel method and noticed the dependence of the optical energy band shift on the thickness of the film.

Many papers have been published in investigating the CdSe thin films depositing on the same substrates, namely, glass substrates but they were interested in the effect of some parameters, such as film thickness [10], nanocrystalline size [11], different techniques [12], annealing temperature [13], and $CdCl_2$ thermal treatment [14] on the optical properties and the possible applications.

Zhao et al. [15] have investigated the synthesis and characterization of CdSe thin films in nanostructure size. They have been deposited the thin films using chemical bath as a function of the sodium selenosulphate concentrations or ammonia concentrations. They have been found that, the films have cubic structure phase with nano-crystal size 3–10 nm. The obtained optical band gap, E_g, increased with increasing the sodium selenosulphate or ammonia concentrations.

CdSe nanoparticles were synthesized [16] by the method of thermal treatment at different calcination temperatures from 450 °C to 700 °C. It has been shown that these films have an amorphous phase with nanoparticle size which increased from 11 to 32 nm and the optical energy gap decreased from 2.36 to 1.80 eV with calcination. However, some publications have studied the effect of deposing their thin films on different substrates, such as glass and Fluorine doped Tin Oxide (FTO) coated glass substrates [17]. They have investigated the effect of substrates variety on the structure, optical, corrosion, and Photocatalysis Properties.

Our intention is to employ this material for the fabrication of photovoltaic devices, and therefore as a part of our continuing program we concentrated on our bifocal interest: to investigate the effect of substrates type on the structural, optical and electrical properties of

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Influence of the dissipation on the N-level atom interacting with a two two-level atoms in presence of qubit–qubit interaction

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The interacting of two qubits and an N-level atom based on su(2) Lie algebra in the presence of both qubit–qubit interaction and dissipation term is considered. The effects of the qubit–qubit interaction and the dissipation term on the dynamics of the proposed system are discussed in detail for certain values of the number of levels. The dynamical expressions of the observable operators are obtained using the Heisenberg equation of motion. The population inversion and linear entropy, as well as the concurrence formula as a measure of entanglement between the two qubits are calculated and discussed. The roles of the number of levels, the qubit–qubit coupling parameter and the dissipation rate on these quantities are also discussed. We explore the sudden birth and sudden death of the entanglement phenomena with and without the dissipation term.

The open quantum systems have abundant scientific applications such as[1–3]. A system cannot be found alone. Rather, it is with other degrees of freedom that are indicated as the environment. Due to the large number of applications, the study of the open quantum system under various types of damping effect has attained great attention concerning the impacts of the dynamical behavior of different quantum phenomena[3] . To explore the impact of the environment on quantum phenomena, especially quantum correlation the operator-sum representation is adopted. Although we innately suppose that the environment can spoil the quantum signature and the correlation of the system, studying the dynamics of this process in detail to process realistic information is significant. Memory impacts the dynamics of open quantum systems in the light of the quantum Zeno effect play a role[4]. It is demonstrated that the exploitation of the analogy between quantum and dissipation measurements and the interaction between the system and the matter promote quantum Zeno dynamics. Furthermore, the change of the measurement parameters may tune the dissipation strength that the system experiences. The open quantum system with a nonequilibrated environment that consists of numerous non-Markovian reservoirs suggests an emergent thermal behavior pseudo under the thermalization influence was explored[5]. The obtained results clarified that having a dispersive environment or a saturable pumping breaks down the pseudo thermalization impact. Additionally, Iotti and Rossi discussed the effect of energy dissipation and decoherence in solid-state quantum devices in the framework of Markovian against non-Markovian treatment type schemes[6]. The effects of dissipation and thermal noise on hybrid open quantum systems via the ultrastrong-coupling system were examined by Settineri et al.[7].

A primary goal of quantum technologies is to control the quantum correlations between subsystems[8–10]. This quantum correlation was studied for each qubit in a system with two atoms and the environment concerning the interatomic distance[11]. Recently, various devices, e.g., beam splitters[12–14], nanoresonators[15], interactions in superconducting circuit-QED systems[16,17] and optomechanical interactions[18] have been developed to obtain quantum entanglement. All entanglement measures should be stable according to local operations in classical communication. The entanglement of formation is an entanglement measure for bipartite quantum states while

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RESEARCH ARTICLE

Investigating the effects of copper sulfate and copper oxide nanoparticles in Nile tilapia (*Oreochromis niloticus*) using multiple biomarkers: the prophylactic role of *Spirulina*

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Abstract

Copper has toxic effects in fish, whereas the cyanobacterium *Spirulina* reportedly has protective effects against metal toxicity in various animal species. The current study, therefore, aimed to investigate the prophylactic role of *Spirulina platensis* against the effects of copper sulfate ($CuSO_4$) and copper oxide nanoparticles (CuO-NPs) in Nile tilapia (*Oreochromis niloticus*). Biochemical, antioxidant, erthyron profile and histopathological endpoints were assessed after for 15 days of exposure in five separate treatment groups: (1) fish pre-fed the normal diet (control), (2) fish pre-fed the normal diet and exposed to 15 mg/L of $CuSO_4$, (3) fish pre-fed the normal diet augmented with 0.25% *Spirulina* and exposed to 15 mg/L of $CuSO_4$, (4) fish pre-fed the normal diet and exposed to 15 mg/L of CuO-NPs, and (5) fish pre-fed the normal diet augmented with 0.25% *Spirulina* and exposed to 15 mg/L CuO-NPs. Exposure to $CuSO_4$ or CuO-NPs significantly increased superoxide dismutase and catalase activities in fish, as well as serum total protein, glucose, aspartate aminotransferase, alanine aminotransferase, creatinine, and uric acid concentrations. In contrast, most hematological indices in fish significantly decreased after $CuSO_4$ or CuO-NPs exposure. Moreover, $CuSO_4$ and CuO-NPs caused a significant increase in the percentage of poikilocytosis and nuclear abnormalities of red blood cells, as well as histopathological changes in the brain, liver, intestine, and kidneys. Importantly, *Spirulina* supplementation mitigated against physiological disruption caused by $CuSO_4$ or CuO-NPs.

Keywords Copper oxide nanoparticles · Copper sulfate · *Oreochromis niloticus* · *Spirulina platensis* · Antioxidant · Histopathology

Introduction

Copper plays an important function as a cofactor in various enzymes; however, it is toxic to cells when present at elevated concentrations (Soliman 2015). Copper oxide nanoparticles (CuO-NPs) are utilized in many different applications, including in gas sensors, catalytic processes, solar cells, and lithium batteries, as well as in face masks, wound dressings, and socks (Soliman and Ragab 2018). These nanoparticles can also be toxic, which may be due to the particles themselves or the disintegration of ions from the particles (Griffitt et al. 2008; Heinlaan et al. 2011). To date, the toxic effects of CuO-NPs have been investigated in multiple fish species (Abdel-Khalek et al. 2015; Ates et al. 2014; Ganesan et al. 2016; Isani et al. 2013; Kaviani et al. 2019; Mansouri et al. 2017; Mansouri et al. 2015; Noureen et al. 2018; Soliman and Ragab 2018; Soliman 2015; Sun et al. 2016; Villarreal et al. 2014; Wang et al. 2015). These toxic effects, and those of metal and metal oxide nanoparticles in general, are typically investigated in fish using histopathological, biochemical, and hematological biomarkers (Gül et al. 2004). The toxic effects of copper in fish are thought to originate from the generation of reactive oxygen species (ROS) through the Fenton and Haber–Weiss reactions (Maria and Bebianno 2011; Regoli and Principato 1995).

The cyanobacterium *Spirulina platensis* (hereafter referred to as *Spirulina*) has been reported to protect against metal-induced toxicity in various animal species (Bangeppagari

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Investigation of the opto-magnetic properties of Co doped ZnO nanoparticles and thin films for spintronics

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$Zn_{1-x}Co_xO$ ($0 \le x \le 0.10$) nanocrystalline compounds with different compositions were prepared by ball milling, and thin films of these compounds were prepared by electron evaporation method. XRD patterns are used to study the structural properties of these films. All films showed a hexagonal wurtzite structure. Using XRD patterns, calculate crystallite. The optical constants *n* and *k* of the $Zn_{1-x}Co_xO$ nanocrystalline film are calculated in the range of 300-2500 nm based on *K-K* method. As Co is more doped, the refractive index also shows an increase. According to the Tauc relationship, the optical energy gap of the $Zn_{1-x}Co_xO$ film is calculated, which proves to be a direct transition.

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Keywords: $Zn_{1-x}Co_xO$ thin films, Zinc blend wurtzite, Spectrophotometer: *K-K* method, Optical constants, Energy gap, Hystersis loop

1. Introduction

Unlike non-oxide semiconductors, oxide semiconductors are known to have a wide band gap energy greater than 3.0 eV. With such a large semiconductor band gap, they are optically transparent in the visible light region and are suitable for short-wavelength light applications. The most common examples of such oxide semiconductors are ZnO, TiO_2, SnO_2, In_2O_3, etc. [1]. Diluted magnetic semiconductors (DMS) and special transition metal doped semiconductors with a Curie temperature equal to or higher than room temperature ferromagnetism (RTFM) have recently attracted widespread interest due to their importance in spintronics and magneto-optical applications [2-4]. They are also the main candidates for various multifunctional applications, such as solar cells, sensors, liquid crystal displays (LCD) and transparent electronics. After adding spin function, they can be used to produce spin LEDs, spin FET and magnetic memory [5-7]. Therefore, it can provide optoelectronics for a new generation of spintronic devices. The transmitted ferromagnetic DMS can be achieved by doping transition metal (TM) ions into wide band gap semiconductors, sea cations [8, 9], especially zinc oxide, with wide band gap (3.3 eV) and high exciton binding energy (60 meV).) Extracted from ZnO) [10]. ZnO has good mechanical properties, is environmentally safe and inexpensive. Therefore, in addition to its potential applications as nanowire lasers, field-effect transistors, nonlinear optical materials, and high-sensitivity chemical sensors, it is also recommended for many ZnO-based DMSs [11] for ferromagnetic prospects above room temperature [12-14]. In the past few years, as reported by Radovanovic [15], Norberg [16] and Ueda [17], TM (Co, Mn, Fe, Ni, Cr) exhibits RT

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L-proline catalyzed green synthesis and anticancer evaluation of novel bioactive benzil bis-hydrazones under grinding technique

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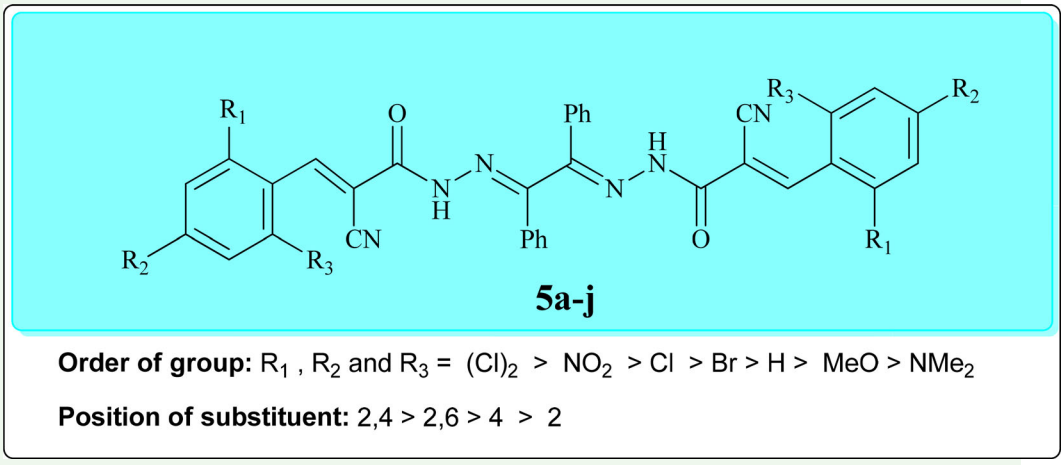
ABSTRACT

L-Proline organocatalyst was investigated as an efficient and environmentally benign catalyst for synthesis of some novel bioactive benzil *bis*(2-cyano-3-aryl-2-propenoylhydrazone) derivatives from reaction of the benzil *bis*(cyanoacetylhydrazone) with the respective aldehydes. The reusability of the L-proline was tested and the results revealed that the recovered catalyst can be reused at least three additional times in subsequent reactions without significant decrease in product yield. The current protocol is very efficient as it provides mild reaction, cleaner reaction profiles, effortless work phase with outstanding purity, and with short reaction time, high performance of the desired products. IR, ^{1}H-NMR and MS and alternative methods, whenever available, have verified the chemical structures of the newly prepared compounds. Compared to the Doxorubicin reference drug using the MTT assay, the in vitro growth inhibitory activity of ten new compounds was investigated against the liver carcinoma cell line (HepG-2) and the findings revealed promising activities of six derivatives.



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Benzil; organocatalysis; L-proline; solvent free reaction; anticancer activity

1. Introduction

Green chemistry concentrates on research aimed at developing safe and environmentally sustainable chemical procedures for the design, in synthetic organic chemistry, of biologily active and industry-leading molecules (*1–3*). Green chemistry provides various alternatives, including the use of fewer solvents, high nuclear economies and selectivity, removal of hazardous wastes, the use of climate, simple methods for product separation and purification, as well as use of alternative energy sources, in order to carry out organic transformations on environmentally sustainable terms (*4–11*). 'Mechanosynthesis' using 'ball milling' or simple grinding methods (*12, 13*) is one of the protocols belonging to this sustainable and 'greener' definition. Due to its simple experimental setup, manual grinding

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