Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

THE 5TH INTERNATIONAL WORKSHOP/CONFERENCE ON NANOTECHNOLOGY ORGANIZED BY NANOTECHNOLOGY RESEARCH GROUP (*NANO*+), LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY, OGBOMOSO, NIGERIA

BOOK OF ABSTRACTS OF THE HYBRID CONFERENCE

NANOTECHNOLOGY IN AFRICA: CHANGING THE NARRATIVES FOR THE BENEFITS OF MANKIND

DATE: TUESDAY 26 - THURSDAY 28 OCTOBER, 2021

VENUE: THE GREAT HALL & ZOOM

Chairman
Prof. M.O. Liasu
Ag. Vice-Chancellor, LAUTECH, Ogbomoso, Nigeria

Chief Host
Prof. A.T.J. Ogunkunle
Dean, Faculty of Pure and Applied Sciences, LAUTECH, Ogbomoso, Nigeria

Host
Prof. A. Lateef
Head, Nanotechnology Research Group (*NANO*+), LAUTECH, Ogbomoso, Nigeria

LOC Chairperson
Prof. M.A. Azeez
Department of Pure and Applied Biology, LAUTECH, Ogbomoso, Nigeria

Special Guest of Honour
Dr. Engr. Ogbonnaya Onu
Honourable Minister of Science Technology and Innovation, Abuja, Nigeria

Senator Dr. AbdulFatai Buhari
National Assembly, Abuja, Nigeria

Speakers at the Conference

Prof. E.O. Dare, Department of Chemistry, Federal University of Agriculture, Abeokuta, Nigeria

Professor Chérif Dridi, Centre for Research on Microelectronics and Nanotechnology, Technopark of Sousse, Tunisia

Prof. N. Tabet, Department of Applied Physics and Astronomy, University of Sharjah, United Arab Emirates

Associate Professor Hassan Soleimani, Department of Fundamental and Applied Sciences, Universiti Teknologi PETRONAS 32610 Seri Iskandar Perak Malaysia

Associate Professor O. Darwesh, Department of Agricultural Microbiology, National Research Centre, Cairo, Egypt

Prof. E.B. Gueguim-Kana, Department of Microbiology, University of KwaZulu-Natal, Pietermaritzburg, South Africa

Prof. A.S. AbdulKareem, Department of Chemical Engineering, Federal University of Technology, Minna, Niger State, Nigeria

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SCHEDULE OF ACTIVITIES (GMT +1)

DAY ONE (OCTOBER 26, 2021)

WORKSHOP ON THE SYNTHESIS, CHARACTERIZATION, AND APPLICATIONS OF NANOPARTICLES

S/N	TIME	ACTIVITIES	VENUE/ANCHOR
1.	8:00 - 9:45 am	Arrival and registration	PAM Seminar Room
2.	10:00 - 10:40 am	Overview of nanotechnology, biosynthesis of nanoparticles and applications- Prof. M.A. Azeez	PAM Seminar Room
3.	10:40 - 10:50 am	Questions and Answer	Dr. J.A. Badmus
4.	10:50 - 11:10 am	**Tea Break**	
5.	11:10 - 11:50 am	Characterization techniques in Nanotechnology- Prof. M.O. Durowoju	PAM Seminar Room
6.	11:50 - 12:00 pm	Questions and Answer	Dr. O. Adedokun
7.	12:00 - 1:00 pm	**Lunch**	Botanical Gardens
8.	1:30 -6:00 pm	Practical Session & Interaction	Dr. E.A. Adebayo, Dr. J.A. Badmus & Dr. O. Adedokun; Nanobiotechnology LAB/CRL

DAY TWO (OCTOBER 27, 2021): OPENING CEREMONY

Time	Activities	Anchor/Presenter
10:00	Introduction	**Public and Alumni Relations Unit,** Office of the Vice-Chancellor, LAUTECH, Ogbomoso
10:05	National, State and LAUTECH anthems	**Public and Alumni Relations Unit**
10:10	Host's speech	**Prof. A. Lateef** Head, Nanotechnology Research Group, LAUTECH, Ogbomoso
10:25	Chief Host's speech	**Prof. A.T.J. Ogunkunle** Dean, Faculty of Pure and Applied Sciences, LAUTECH, Ogbomoso
10:35	Chairman's speech	**Prof. Mojeed Olaide Liasu** Acting Vice-Chancellor, LAUTECH, Ogbomoso
10:45	Minister's speech	**Engr. (Dr.) Ogbonnaya Onu** Honourable Minister of Science, Technology, and Innovation, Federal Republic of Nigeria.
11:00	Citation of Lead Speaker	**Prof. M.O. Durowoju**
11:05	**The narrative of transformation into a circular economy via sustainable nanotechnology**	**Prof. Enock O. Dare** Department of Chemistry, Federal University of Agriculture, Abeokuta
12:00	Closing Remark/Vote of thanks	**Prof. M.A. Azeez** Chairman, LOC
12:05	Photograph session	**Public and Alumni Relations Unit**
12:10	**Tea Break**	
12:30	**Lecture 2: Sustainable and Innovative NANOTECHNOLOGY based strategies for Sustainable Development**	**Prof. C. Dridi** NANOMISENE R&D Laboratory, Center of Research on Microelectronics & Nanotechnology (CRMN) of Sousse, Technopole of Sousse, TUNISIE

1:30	**Comments, Questions, and Answers**	**Prof. Y.K. Sanusi**
1:40	**Lunch Break**	
2:30	**BREAK-OUT SESSIONS (OCTOBER 27, 2021)** **SESSION A (PHYSICAL/ENGINEERING)**	
	Moderators	**Prof. O.O. Ogunleye; Dr. A.O. Ajayeoba**
	ABSTRACT NUMBER/TITLE	**AUTHORS/PRESENTERS**
2:30	**2021/P002:** Simulating bending behavior of zirconia nanotubes using finite element analysis	Muhammad, I.D and Awang, M
2:40	**2021/P003:** Effect of copper nanoparticles on centrifugal pump	Issa, W.A
2:50	**2021/P005:** Recent development in nano scratch testing characterization and applications- A review	Momohjimoh, I., Bakare, A.O., and Zimit, A.Y
3:00	**2021/P006:** Conjugated polymer/multi-walled carbon nanotubes composite characterisation for application in volatile organic compounds sensors	Ibrahim, Y.M., and al-Atraqchi, S.B
3:10	**2021/P008:** Facile hydrothermal and solvothermal synthesis and characterization of nitrogen-doped carbon dots from palm kernel shell precursor	Yakubu, N.M, Abdullah, J., Yusof, N.A, Abdul Rashid, S., and Shueb, R.H
3:20	**2021/P009:** Influence of periwinkle shell ash and selected nano chemicals on durability of lateritic bricks	Agbale, P.O., Olaniyan, O.S., and Abogunde, O.L
3:30	**2021/P010:** Effects of different shapes of nanoparticles on the efficiency of carboxymethyl cellulose (CMC) solution in drilling applications	Alabison, R.M., Oderinu, R.A., Olaleye, O.A., and Olalude, G.A
3:40	**Short Break**	
3:50	**2021/P013:** Numerical investigation of the performance of parabolic trough solar collector utilizing nanofluids as working fluids	Hamzat, A.K., Omisanya, M.I., Olawale, B.M., and Asafa, T.B
4:00	**2021/P015:** Preliminary design for development of nanocomposite 3-D printing filament from nano kaolin/polyethylene waste	Dye, M.C., Dagwa, I.M., Muhammad, I.D., and Tobins, F.H
4:10	**2021/P017:** Performance evaluation of nanocomposite substrate for microstrip patch antenna at 5G network frequency band	Ogundeji, ST, Awodele, M.K and Oyeshola, H.O
4:20	**2021/P019:** Nanotechnology: Applications in treatment of industrial wastewaters: A review	Aremu, M.O., Olowonyo, I.A., Salam, K.K., and Lateef, A
4:30	**Participants are to move to the general room for closing**	
	BREAK-OUT SESSIONS (OCTOBER 27, 2021) **SESSION B (BIOMEDICAL)**	
	Moderators	**Prof. O.T. Adedosu; Dr. O.N. Majolagbe**
	ABSTRACT NUMBER/TITLE	**AUTHORS/PRESENTERS**
2:30	**2021/B001:** Green synthesis of silver nanoparticles and their activity against bacterial biofilms	Akintokun, A.K., Adebajo, S.O., Ojo, A.E., Bankole, P.O., Oladotun, A.T., Ogunbiyi, E.O., and Adeleke, B.J
2:40	**2021/B004:** A review on nanotechnology: A preferred technological tool for eradicating COVID-19	Fasogbon, A.O., Bale, I.S., and Odewade, J.O

2:50	**2021/B007:** Relevance of physicochemical properties in predicting the toxicity of nanomaterials	Ibrahim, B., Sirajo, K., Dalhat, M.H., and Labbo, A.M
3:00	**2021/B011:** Drug release studies of prodigiosin from a polyblend of PLA/PCL microspheres and its application in breast cancer treatment	Dozie-Nwachukwu, S.O., Onwuazor, P.O., Falayi, M., Onodugo, C.N., and Odusanya, O. S
3:10	**2021/B012:** Comparative study of the antimicrobial activities of silver nanoparticles synthesized using neem (*Azadirachta indica*), maize (*Zea mays*), and yellow oleander (*Thevetia peruviana*) leaves	Onwuazor, O.P., Dozie-Nwachukwu, S.O., Onodugo, C.D., Usman, A.B., and Odusanya, O.S
3:20	**2021/B014:** Formulation and evaluation of a multi-drug loaded liposome for the management of non-small lung cancer (NSLC)	Oyeniyi, Y.J., Atata, R.F., and Shuaibu, B.A
3:30	**2021/B016:** Nano-silver, gold, and alloy fabricated using *Pleurotus ostreatus* (MK751847) extract and its antioxidant potential	Adebayo, E.A., Elkanah, F.A., Oke, M.A., and Oyeleke, O.O
3:40	**2021/B018:** Nanoformulation of silver, gold, and alloy using cell-free bioflocculant from domestic wastewater bacterial consortium and their antioxidant and anti-microbial potential	Adebayo, E. A., and Oke, M.A
3:50	**2021/B022:** Bio-fabrication and characterization of selenium nanoparticles of *Lactobacillus fermentum* and its antagonistic effect on food-borne pathogens and formulation of nano-food	Alao, S.O., Fashogbon, R.O., Adeyemo, M.O., and Adebayo-Tayo, B.C
4.10	**Participants are to move to the general room for closing**	
DAY TWO (OCTOBER 28, 2021): GENERAL		
9:00	**Invited Lecture 3: Prospects and Challenges of Nanotechnology for fuel cell development** **Abdulkareem, A.S** Nanotechnology Research Group, Africa Centre of Excellence on Mycotoxins and Food Safety, Federal University of Technology, Minna, Niger State, Nigeria	
BREAK-OUT SESSIONS (DAY THREE – OCTOBER 28, 2021) **SESSION A (PHYSICAL/ENGINEERING)**		
	Moderators	**Prof. A.A. Raheem; Dr. A.O. Arinkoola**
9:30	**ABSTRACT NUMBER/TITLE**	**AUTHORS/PRESENTERS**
9:40	**Invited Lecture 4:** Perovskite solar cells: Nanoengineering the device efficiency	**Tabet, N** Department of Applied Physics and Astronomy, University of Sharjah, UAE
10:20	**Invited Lecture 5**: Pore-scale investigation of velocity and viscosity of fluids on capillary pressure for enhanced oil recovery	**H. Soleimani** Department of Fundamental and Applied Sciences, University Teknologi PETRONAS, Malaysia
11:00	**Comments, Questions, and Answers**	
11:30	**Tea Break**	
11:40	**2021/P020:** Microbial-nano-remediation of wastewater: Approaches, challenges, and prospects	Aremu, A.D., Aransiola, E.F., and Solomon, B.O
11:50	**2021/P021:** Copper/polymer composite as a hole transport layer of organic solar cell	Azeez, S.O., Olasunkanmi, N.K., Adewale, A.A., and Sanusi, Y.K

12:00	**2021/P025:** Impact of nano clay on the water barrier property of *Momordica augustisepala* reinforced polyester composite: modeling and sensitivity study	Adeyi, A.J., Durowoju, M.O., Ogunsola, A.D., and Adeyi, O
12:10	**2021/P026:** Effects of nanoparticle on heat characteristics and fluid flow in a moving isothermal cylindrical pipe	Sangotayo, E.O., and Itabiyi, O.E
12:20	**2021/P027:** Investigation of electrical conductivity of polymer composite using artificial neural network (ANN)	Makinde, O.S., and Aremu, O.A
12:30	**2021/P030:** Sequestration of Mn (II) and Pb (II) ions from mine site wastewater using silver oxide pillared alumino-silicate	Ajala, M.A., Abdulkareem, A.S., Kovo, A.S., and Tijani, J.O
12:40	**2021/P032:** Improving the performance of polymer solar cells using silver nanoparticles-based photoactive film layer device	Afolabi, B.A., Balogun, S.W., and Sanusi, Y.K
12:50	**2021/P035:** Corrosion inhibition performance of gloss paint incorporated with silver nanoparticles on carbon steel and aluminium substrates in 2.0 M H_2SO_4 solution	Asafa, T.B., Odusote, J.K., Olawore, A.S., Enone, G.A., Lateef, A., and Adeleke, A.A
1:00	**2021/P036:** Development of carbon nanotube-based charge transport layer for organic solar cells	Oyeshola, H.O., Atanda, O.S., Adejumo, B.K., Raheem, K.K., Atere, D.A., Ojeniyi, F.A., and Sanusi, Y.K
1:10	**Lunch Break**	
2:10	**2021/P037:** Synthesis characterization and application of graphene progress and challenges: A review	Lawal, M.K., Oyeshola, H.O.., Balogun, S.W., and Sanusi, Y.K
2:20	**2021/P040:** Impact and fatigue properties of recycled aluminium cans reinforced with graphene nanoparticles and rice husk ash: optimization of process parameters	Yekinni, A.A., Durowoju, M.O., Agunsoye, J.O., and Mudashiru, L.O
2:30	**2021/P041:** Application of nanotechnology in food packaging and safety: Perception, role, and regulation	Oyegbola, J.O., Lateef, A., Ade-Omowaye, B.I.O., and Olatidoye, O.P
2:40	**2021/P044:** Performance optimization of Perovskite photovoltaic solar cells by sandwiching magnesium manganese oxide in the Perovskite cell	Awodele, M.K., Ige, S.A., and Akinrinola, O
2:50	**2021/P045:** Synthesis and characterization of silver doped zinc oxide nanoparticles for application as photoanode in dye-sensitized solar cell	Lana, G.M., Lawal, K.O., Okezie, F.C., Oni, A.A., and Adedokun, O
3:00	**2021/P046:** Utilization of gum arabic capped magnetite nanoparticles in the removal of some divalent metal ions from wastewater	Okosun, J.E., Ikhuoria, E.U., and Omorogbe, S
3:10	**2021/P048:** Synthesis, characterization, and application of a composite adsorbent in remediation of bitumen-polluted water	Ayelabola, J.A., Babawale, E.A*., and Olabemiwo, O.M
3:20	**2021/P051:** Filtration and microbial removal studies of Cu nanoparticles-treated blended clays candle-like filter for water purification	Olowoyeye, O.O., Oluyemi, E.A., and Babatope, B
3:30	**2021/P052:** Interfacial polymerisation and optical characterisation of copper-doped ZnO- and NiO-polyaniline nanocomposites	Adetoye, B.O., Okelola, O.Z., Taleatu, B.A., Turoti, O., and Babatope, B
3:40	**Participants are to move to the general room for Polling**	
4:00	**Official closing of the conference**	

BREAK-OUT SESSIONS (DAY THREE – OCTOBER 28, 2021) SESSION B (BIOMEDICAL)		
	Moderators	**Dr. A.O. Afolabi & Dr. I.O. Omomowo**
9:30	**ABSTRACT NUMBER/TITLE**	**AUTHORS/PRESENTERS**
9:40	**Invited Lecture 6:** Nanotechnology for sustainability; Achievements, challenges, and perspectives	**Darwesh, O.M** Department of Agricultural Microbiology, National Research Centre, Cairo, Egypt
10:40	**Comments. Questions and Answers**	
11:00	**2021/B022:** Bio-fabrication and characterization of selenium nanoparticles of *Lactobacillus fermentum* and its antagonistic effect on food-borne pathogens and formulation of nano-food	Alao, S.O., Fashogbon, R.O., Adeyemo, M.O., and Adebayo-Tayo, B.C
11:20	**2021/B023:** Biosynthesis and characterization of selenium nanoparticles from plant growth-promoting rhizobacterial and their antifungal potential	Ajayi, O.S, and Olusola-Makinde, O.O
11:30	**Tea Break**	
11:40	**2021/B024:** Potentials of nanoparticle optimized biodiesel production using oleaginous microorganisms	Mohammed, M.O., Shobayo, O.B., Kekereogun, I.D., and Balogun, S.A
11:50	**2021/B028:** Mycosynthesis of silver, gold, and silver-gold nanoparticles using *Ganoderma lucidum* extract and its antioxidant potentials	Adebayo, E.A., Oyeleke, O.O., Oke, M.A and Elkanah, F.A
12:00	**2021/B029:** Phytochemicals, phytofabrication, and biological evaluation of *Abrus precarious* leaves and stem methanol extracts and their silver nanoparticles	Alao, S.O., Sanusi, J.F., and Adebayo-Tayo, B.C., and Ajani, T.F
12:10	**2021/B031:** Synthesis of silver nanoparticles and antimicrobial activities of methanolic extract of *Azadirachta indica* leaf against selected pathogenic organisms	Agbaje, A.B., Muhammed, M.M., Bello, S.A., Jimoh-Hamza, O.K., Azeez, Z.O., and Jibril, K.N
12:20	**2021/B033:** Synthesis and antimicrobial activities of silver nanoparticles from cold aqueous extract of *Aloe vera* leaf against selected pathogenic organisms	Bello, S.A., Jibril, K.N., Jimoh-Hamza, O.K., Agbaje, A.B., Muhammed, M.M., and Azeez, Z.O
12:30	**2021/B034:** Synthesis of silver nanoparticles and antimicrobial activities of aqueous extract of *Azadirachta indica* against *Escherichia coli, Staphylococcus aureus,* and *Candida albicans*	Jimoh-Hamza, O.K., Azeez, Z.O., Bello, S.A., Agbaje, A.B., Jibril, K.N., and Muhammed, M.M
12:40	**2021/B038:** Synergistic antibacterial and free radical scavenging potentials of phytosynthesized titanium dioxide nanoparticles from aqueous leaf extract of *Tetrapleura tetraptera*	Oladipo, I.C., Lateef, A., Azeez, M.A., Asafa, T.B., Yekeen, T.A., and Ogunsona, S.B
12:50	**2021/B039:** Phytochemical screening, synthesis of silver nanoparticles of root extract of *Landolphia owariensis,* and evaluation of their anti-trypanosomal activity	Abedo, A.J., Bala, S.I., Agbo, A., Abutu, S.R., Bala, N., and Ali, H
1:00	**2021/B042:** Phyto-synthesized titanium dioxide	Oladipo, I.C., Lateef, A., Azeez, M.A., Asafa,

	nanoparticles from *Lecaniodiscus cupanioides* stem aqueous extract: the biomedical and mycelial inhibitory potentials against toxigenic molds of stored grains	T.B., Yekeen, T.A., Ogunsona, S.B, Akintola, A.O, and Adewoyin, A.G
1:10	**Lunch Break**	
2:10	**2021/B043:** Phytotoxicity and bioaccumulation of nanomaterials in plant-soil mediated systems	Adebomojo, A.A., AbdulRahaman, A.A., Sagaya, A., and Tsoho, S.B
2:20	**2021/B047:** Purifying capabilities of titanium oxide (TiO_2) nanoparticle in wastewater treatment	Adeyemi, O.A., Funmilayo, M.O., and Fasiku, S.A
2:30	**2021/B049:** Anti-diabetic plant products and their nanoparticle-based delivery	Alabi, T.D., and Badmus, J.A
2:40	**2021/B050:** Antioxidant, anti-inflammatory and lipid peroxidation inhibition of photosynthesized silver, gold, and silver-gold nanoparticles using *Peperomia pellucida* aqueous extract: A preliminary study	Badmus, J.A., Anwo, C.O., Egbeola, C., Olagbaju, D., Adelakun. O., Salaudeen, F.O., Adebayo, E.A., Azeez, M.A., and Oke, M.A
2:50	**2021/B053:** Preliminary biomedical assessment of silver, gold, and gold-silver nanoparticles synthesized using *Euphorbia lateriflora* extract	Badmus, J.A., Adeyemo, R.O., Egbeyode, T.A., Olanrele, H., Olagbaju, V.O., Hassan, B.O., Afolabi, A.A., Yekeen, T.A., Lateef, A., and Adebayo, E.A
3:00	**2021/B054:** Effects of crude extracts and *Petiveria alliacea*-mediated silver nanoparticles on insect infestations and nutritional values of okra (*Abelmoschus esculentus* L.)	Alao, F.O., Elegbede, J.A., Olaniran, O.A., Lateef, A., and Adebayo, T.A
3:10	**2021/B055:** Evaluation of toxicological effects of chicken feather-mediated silver nanoparticles using *Clarias gariepinus*	Yekeen, T.A., Akintayo, G.O., Fawole, O.O., Azeez, M.A., Lateef, A., Badmus, J.A., Oladipo, I.C., Abodunrin, A.E., Moruf, M.A., Abere, A.O., Adeniyi, T.M., and Oloyede, G.F
3:20	**2021/B056:** Field evaluation of crude extracts and nanoparticles synthesized by *Petiveria alliacea* against insect pests of leafy vegetable (*Amaranthus caudatus*) and their effects on nutritional contents of *Amaranthus* leaves	Alao, F.O., Elegbede, J.A., Olaniran, O.A., Lateef, A., and Adebayo, T.A
3:30	**2021/B057:** Preliminary effects of silver nanoparticles bio-fabricated using aqueous extract of *Citrus sinensis* peel on acetic acid-induced ulcerative colitis in male Wistar rats	Ige, S.F., Badmus, J.A., Adeloye, A.A., Anifowose, P.E., and Akinola, O.B
3:50	**Participants are to move to the general room for Polling**	
4.00	**Official Closing of the conference**	

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WELCOME ADDRESSES

Prof. A. Lateef
Host and Head, Nanotechnology Research Group (NANO⁺), LAUTECH, Ogbomoso, Nigeria

It is with great joy that I welcome you to the 5th international conference on nanotechnology (LAUTECH NANO 2021) on behalf of the LAUTECH Nanotechnology Research Group (*NANO⁺*), the organizers of the hybrid conference. Permit me to briefly enumerate some of the achievements of the multidisciplinary research group that came into existence in 2014 to advance the course of nanotechnology R&D in Nigeria and beyond. Specifically, the group has achieved the following:

1. Organized well-attended workshops/conferences on nanotechnology in 2017, 2018, 2019, and 2020. Some of the papers presented at previous conferences have been published in Nigeria (*Science Focus; Nano plus: Science and Technology of nanomaterials*) and United Kingdom (*IOP Conference Series: Materials Science and Engineering*).
2. Mentoring of students and academics in more than twenty universities and other institutions in Nigeria and beyond, as well as expanding the outreach of nanotechnology discourse to students of primary and secondary schools.
3. We have deepened nanotechnology discourse in several electronic and print media in culminating in more than 35 press releases/interviews. Our website (www.lautechnanotech.com) is robust, informative, and regularly updated. Since its launch in 2016, it has received more than 115,000 visitors.
4. Members of *NANO⁺* remain the most prolific in nanotechnology R&D in Nigeria having published more than 125 articles in various areas of nanotechnology since 2015. In fact, in a recent scientometric analysis of Nigeria's contributions to nanotechnology (2010-2020) that was published in 2021 by *Journal of Nanoparticle Research* **23**: 211, five members of the group emerged among the top 12 nanotechnology researchers in Nigeria.
5. Series of nano-based products that include nanopaints, nanotextiles, nanopesticides, nanobiocides, nanofertilizers, nanoadsorbents, nanofilters and DSSCs among others have been developed by members.
6. Establishment of the first specialized journal on nanotechnology in sub-Saharan Africa, '*Nano Plus: Science and Technology of Nanomaterials*'.

The LAUTECH NANO 2021 conference with the '**Nanotechnology in Africa: Changing the Narratives for the Benefits of Mankind**' seeks to provide a platform for African nations to explore nanotechnology to engender the much-desired growth and development on the continent, and to also bridge the gap of nanotechnology divide

between Africa and the developed nations. In this regard, some of the active players and seasoned scholars in nanotechnology R&D in Africa and other countries will share their experiences and visions with participants. Additionally, more than sixty papers will be presented at technical sessions in diverse areas of science, engineering, agriculture, and biomedicine with participants from more than 45 institutions, agencies and the private sector taking part in the hybrid conference.

With the humongous worth of more than US$3 trillion in its contribution to the world economy and the cosmopolitan applications in all fields of human endeavours, nanotechnology can be deployed by the developing nations to solve myriads of problems of insecurity, food security, and safety, environmental degradation, water, energy and health crises. It is also a vital tool to leverage on to achieve the sustainable development goals (SDGs) of the United Nations, while it acts as the fulcrum of emerging technologies that will drive future industrial revolutions and innovations, and expand the scope of knowledge-based economic growth. In these senses, Africa and indeed our dear country, Nigeria must not be left behind to reap from the bounties that nanotechnology offers. Therefore, the time to act is now; to offer national and regional platforms to advance the course of nanotechnology through policy drive and establishment of an agency to promote and regulate its exploitation for national growth.

The group appreciates the supports of successive management of LAUTECH (under the leadership of Prof. A.S. Gbadegesin, Prof. M.O. Ologunde, and Prof. M.O. Liasu) for our activities on nanotechnology, and looks forward to a time when a befitting centre of excellence in nanotechnology will be established in the University. Equally, we are grateful to the ministry of science, technology, and innovation under the able leadership of Engr. (Dr.) Ogbonnaya Onu for the recognition that has been accorded to us. The participation of the group through an invitation extended to it at the 19th meeting of the National Council on Science, Technology and Innovation (NCSTI) held on 20-24 September 2021 is a further leap in the enduring partnership with the ministry of STI in exploring nanotechnology in Nigeria. It is our fervent hope that LAUTECH through the contributions of *NANO*$^{+}$ will continue to enjoy support and interventions of the ministry of STI and other relevant government agencies in matters of nanotechnology.

To our numerous senior colleagues, mentors, collaborators, distinguished scholars, policymakers, sponsors, students, friends, participants at our programmes, gentlemen of the press, members of our families, and LAUTECH community, we are grateful for your kindness and support for our activities at all times.

Once again, I welcome you to LAUTECH NANO 2021 and wish us fruitful deliberations and a rewarding experience at the conference.

Thank you and God bless.

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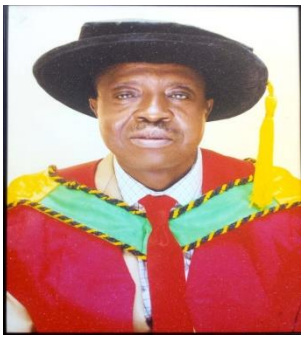


Prof. A.T.J. Ogunkunle
Chief Host and Dean, Faculty of Pure and Applied Sciences, LAUTECH, Ogbomoso, Nigeria

On behalf of the Faculty of Pure and Applied Sciences, LAUTECH, Ogbomoso Nigeria, I offer fraternal greetings to the Nanotechnology Research Group (*NANO*+) of the University on this auspicious occasion of its fifth International Conference on nanotechnology. It is an honour of great dimension for me to be associated with the achievements and aspirations of your group since its inception.

I take special interest in this year's *NANO*+ programme as it is the first in my tenure as the Dean of Faculty and it started yesterday 26th October 2021 which coincided with my birthday, so I share a chunk of the congratulatory messages being offered by everyone on the occasion of this conference. I also congratulate the Faculty of Pure and Applied Sciences and LAUTECH Community for being counted worthy to host men and women intellectuals from all walks of life. While the University administration has been magnanimous in providing the enabling environment for LAUTECH *NANO*+ to flourish, the faculty has, and shall continue to play the fatherly role for this 'worthy child'. On this note, it may interest my listeners to note that Volume 23 (issue 2) of *Science Focus*, the official Journal of the faculty was dedicated to publishing the papers presented at the 2nd edition of nanotechnology conference of the group. For this feat, I give kudos to my predecessor in office, Professor A.T. Oladipo.

This year's *NANO*+ conference with the theme "Nanotechnology in Africa: Changing the Narratives for the Benefits of Mankind" is both historic and timely, being on the same page with our current national policies which emphasize environmental management for sustainable development and national integration. All over the world, Nanotechnology is not only an emerging field of research; it is also an important tool in many other fields such as agriculture, life, physical and environmental sciences, and engineering and medicine.

It is gratifying to note an array of achievements credited to your group within only a few years of its existence. I am exceedingly glad that even before I got elected as the Dean of this great Faculty, I had been part and parcel of the success story of LAUTECH *NANO*+. The rich academic and technical profiles of the members of the group, and the network of competent partners within and outside Nigeria, have made me come to the conclusion that the future of Nanoscience in Nigeria is bright, and our sustainable development is guaranteed. I, therefore, wish to appreciate the efforts of the Head and members of your highly esteemed group, and the organizing committee of this unique and solemn occasion.

I thank you all for your patience and wish you happy and fruitful deliberations.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

WELCOME SPEECH DELIVERED BY THE ACTING VICE-CHANCELLOR, PROFESSOR MOJEED O. LIASU DURING THE OCCASION OF THE 5th INTERNATIONAL CONFERENCE ON NANOTECHNOLOGY ORGANIZED BY THE LAUTECH NANOTECHNOLOGY RESEARCH GROUP (*NANO*+) HELD ON OCTOBER 26-28, 2021

The Honourable Minister, Science, Technology and Innovation, Federal Republic of Nigeria, Dr. (Engr.) Ogbonnaya Onu,
Principal Officers, Ladoke Akintola University of Technology, Ogbomoso
***The Lead Speaker,* Prof. Enock O. Dare,**
Invited Lecturers and all other attendees from across the globe,
Ladies and gentlemen,

It is my pleasure to welcome all and sundry to LAUTECH *NANO*+ Workshop/Conference, the 5th of its kind from the stable of the Nanotechnology Research Group of our great University. The fourth edition of LAUTECH NANO workshop/conference was held last year in the middle of Covid-19 pandemic with huge success, an indication of resilience on the part of our scholars and their determination to promote research and development. It is also crystal clear that LAUTECH Nanotechnology Research Group is fully prepared to be transformed into a hub of Knowledge at the cutting-edge to be explored by scientists within and beyond the shores of our country. With the theme of this year 'Nanotechnology in Africa: Changing the Narratives for the Benefits of Mankind', there is no doubt that the stage is set for another top-notch event in the life of our University and I, therefore, advise the members of the research group not to relent in their efforts to take the University to greater heights.

The multidisciplinary nature of Nanotechnology has turned it into a bride to be adorned by scientists that cut across various fields, from material sciences to physical sciences, engineering to environmental sciences, life sciences through biomedical sciences to medicine, and agricultural sciences. It is a body of knowledge that has afforded scientists the capability to create molecules at a nanoscale i.e. 1-100 nm, manipulate and engineer the molecules so created for the manifestation of innovative potential that can be directed towards delivery of goods and services. The novelty of nanoparticles which are the primary product of nanotechnology resides basically in two important phenomena: 1. Acquisition of large surface area, which makes them more chemically reactive thus changing their strengths and electrical conductivity; 2. acquisition of quantum effects that provoke their optical, electrical, and magnetic properties, resulting in exceptional electrical conduct or resistance, capacity storing and transferring of heat and modified biological properties.

No wonder the scope of the application of the technology is very wide and still expanding; from solar cell technology to production of clean, secured, and affordable energy to combustion efficiency, Production of lighter, stronger and durable materials, low-cost filter for clean water, and trapping of environmental and industrial contaminants. This is not all; innovative ideas in applications of nanotechnology have revolutionized the field of medical sciences, especially in the production of medical devices and drugs for detection and treatment of diseases, and use of this technology in safe drug delivery, bioimaging, organ printing, and tissue engineering. In addition, scientists in the field of electronics and information technology have acquired technological know-how to produce nanolayers and dots for recording with high capacity for data storage and processing at inordinate speed, biosensor, and fuel cell technology, 'smart' clothes, and wearable electronics in textile.

To cap it all is the aspect of 'smart' agriculture, where it is now possible to practice precision agriculture using sensors to monitor and control growth factors, and the potential for production of nanopesticides, nanofertilizers, and nanofeeds to mention but few. All these are lofty areas of nanotechnology applications that can turn around human existence for good.

I am exceedingly happy about the progress and fleet achieved so far by the Nanotechnology Research Group of LAUTECH and I strongly believe that the group will not rest on its oar till it metamorphoses into a formidable research team that will pioneer research and products development to take our country out of woods. Since its formation in September 2014, the research group has produced more than 125 published articles in peer review journals with products development. The activities of the group have greatly impacted researchers in more than twenty (20) institutions in Nigeria, with the training of Nanotechnologists at undergraduate and postgraduate levels. Furthermore, *NANO*$^{+}$ has succeeded in the development of a curriculum in nanotechnology and also established the 1st Journal on Nanotechnology '*Nano Plus: Science and Technology of Nanomaterials*' in sub-Saharan Africa. Just a few months ago, some members of the research group analyzed Nigeria's contributions to Nanotechnology using primary data from SCOPUS (2010-2020), with five (5) of its members among the top 12 Nanotechnology scholars in Nigeria, and LAUTECH ranked as the 3rd most productive University in Nanotechnology research in the country. All these are pointers to changing narratives in the landscape of nanotechnology with its strong footing in LAUTECH. Perhaps, these might be some of the reasons that informed the theme of this year's workshop/conference, 'Nanotechnology in Africa: Changing the Narratives for the Benefits of Mankind'.

Ladies and gentlemen, it is obvious that our great country is going through a turbulent time with the associated problems of the security challenge, power shortage, poverty, food insecurity, diseases, and environmental degradation. Nanotechnology has a greater role to play in overcoming these challenges and with the right policy formation,

proper funding, power, and political commitment, all these are surmountable. I, therefore, use this opportunity to appreciate the honourable minister of Science, Technology, and innovation, Dr. Engr. Ogbonnaya Onu and the agencies under his ministry, especially NABDA and NASRDA for standing with Nanotechnology Research Group of LAUTECH, and more importantly for the invitation extended to the Head of the research group to make a presentation at the 19th meeting of the National Council of Science, Technology, and Innovation technical session of the council. We hope that the interactions at that meeting will further strengthen the research group to deliver on its mission and vision statements with unprecedented technological and products development in the nearest future. We particularly hope that the ministry of science, technology, and innovation that is the driver of nanotechnology pursuit in this country will accord LAUTECH a centre of excellence in nanotechnology R&D with nanotechnology infrastructure in view of her enormous contributions to nanotechnology pursuits in Nigeria.

At this juncture, I want to praise the courage of the *NANO*+ team in their resolve to promote science and technology, and the image of the University at all times, despite their meager resources. I strongly believe that with this level of commitment, there is hope for the advancement of science and technology in Nigeria and Africa with quality dissemination of knowledge as being witnessed in the activities of the group. I, therefore, assure the group that the University on its part will continue to upgrade its resources in terms of infrastructure and equipment for enabling the environment to propel cutting-edge and translational research for the common good of all. I, therefore, congratulate Nanotechnology Research Group as the organizer of this great event and the participants from various walks of life and challenge them through their deliberations to provide pathways out of the cocoon of underdevelopment for the greatness of our country and service to humanity.

Thank you

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

GOODWILL MESSAGES

Prof. Beatrice I.O. Ade-Omowaye
Dean, Faculty of Food and Consumer Sciences and Chairperson, Committee of Provosts and Deans, LAUTECH, Ogbomoso, Nigeria

It is with great pleasure that I write this message of support and best wishes to the organizers and participants of the workshop with the theme 'Nanotechnology in Africa: Changing the Narratives for the Benefits of Mankind" in LAUTECH. My heartfelt congratulations to Nanotechnology Research Group, LAUTECH for achieving such an incredible milestone in these few years. The past conferences have been so remarkable and with great accomplishments.

The notable hard work, resilience and commitment to problem-solving research of the dynamic research group (*NANO*$^{+}$) under the able leadership of Prof. Agbaje Lateef have brought many gains to this University and the global world at large. You have engaged in constructive and innovative researches which have brought nexus between research and national development. This is reflected in the high caliber of publications featured from the research group which has projected the University's image into the global world.

I am so positive that this year's conference will address the global human challenges on academics, health sector, economy and the general global system using innovative and constructive research findings for lasting benefits to all and sundry.

Keep up the good work and best wishes.

Prof. J. G. Adewale
Ag. Provost,
College of Agricultural Sciences and Renewable Natural Resources, LAUTECH, Iseyin Campus

I hereby felicitate with the Nanotechnology Research Group of Ladoke Akintola University of Technology, Ogbomoso, Nigeria on the occasion of her 5th International Conference on Nanotechnology between 26th and 28th October 2021. The theme of the conference titled "Nanotechnology in Africa: Changing the Narratives for the Benefits of Mankind" is very relevant to the drive for Development. Nanotechnology deals with research and innovation concerned with building of materials and devices on a scale of atoms and molecules. Today, there is a growing need to carry out research that contributes to development and economy. In line with the theme for this year, Nanotechnology should help to improve technology and industry sectors. Specifically, in Medicine, Nanotechnology can be used for the benefits of mankind in several ways. The benefits include its use to analyze DNA in just few minutes and treat cancer patients. In the field of Agriculture and Rural Development, it is applicable in food safety, transportation, and homeland security. The latter is my area of interest. My colleagues and I hope to benefit from presentations at the conference. I therefore on behalf of the College of Agricultural Sciences and Renewable Natural Resources, congratulate the Nanotechnology Research Group for hosting the conference. I also wish you successful deliberations that will bring more benefits to mankind.

Congratulations!

Prof. A.W. Ogunsola
Dean, Postgraduate School, LAUTECH, Ogbomoso, Nigeria

It is with great pleasure and joy that I, on behalf of the Board and the entire staff of the Postgraduate School, LAUTECH, Ogbomoso, congratulate the leadership and the entire members of the Nanotechnology Research group for another time of record making as you organize this year's conference – the 5th International Conference on Nanotechnology with the theme: *NANOTECHNOLOGY IN AFRICA: Changing the Narratives for the Benefits of Mankind*', which shall be a landmark in the history of this great citadel of learning. It is my delight to observe that, one of the important responsibilities of a University like ours is to extend the frontiers of knowledge and bring research findings and academic discourse to the notice of

policymakers, industrialists and members of the public in their various sectors for the common good of mankind. The theme of this year's conference is proof of the big step *NANO*$^+$ is taking towards the fulfillment of the just highlighted important mandate of this University.

The Postgraduate School identifies with the *NANO*$^+$ research group and is in support of your programmes as we celebrate your past successes and achievements. We cannot over-emphasize the fact that Africa's technological development problems can be solved only by Africans, though with the support of the international community. Such needed innovations and sustainable developments always come from critical reasoning which is an important integral part of collaborative and result-oriented researches. And, it is one of our focuses at the Postgraduate School, that postgraduate researches be geared towards good results and products that would not just end on the shelves, but those, on which, the private sectors can collaborate with the University for the benefit of mankind and commercial purposes.

I wish to welcome and appreciate the invited speakers as well as participants, both the physical and the virtual ones at this conference, as I believe, it will be an ideal platform for academia to be fully informed and crossbreed ideas about the contemporary global and national issues. This year's conference shall be worthwhile and a huge success by the mercy of God almighty. I am delighted to wish you greater successes and achievements in all your future endeavours. Thank you.

Prof. A.A. Akingbade
Dean, Faculty of Agricultural Sciences, LAUTECH, Ogbomoso

LAUTECH NANO Team is a pride of LAUTECH. The LAUTECH Nanotechnology Research Group has been making remarkable landmarks in the field of Nanotechnology. The 2021 Conference will be another opportunity to showcase their breakthroughs and compare notes with other researchers in Nanotechnology.

Without any reservation whatsoever, kudos to the LAUTECH NANO Team; from all indications, LAUTECH NANO Team holds the ace towards steadfast, viable and sustainable Nanotechnology researches. Faculty of Agricultural Sciences, LAUTECH, Ogbomoso wishes the participants at the 2021 conference a fruitful presentation and robust deliberation in all the sessions of the conference.

Thank you.

Prof. A. Adetutu
Dean, Faculty of Basic Medical Sciences, College of Health Sciences, LAUTECH, Ogbomoso

I write on behalf of the Faculty of Basic Medical Sciences to congratulate LAUTECH NANO team on the 5th edition of the International Conference on Nanotechnology.

The Faculty of Basic Medical Sciences is happy to identify with your team in your effort towards effective showcasing of the enormous potential of Nanotechnology in Medicine and Health Sciences that could be seen in rapid and more sensitive methods of drug discovery, disease monitoring and diagnosis and host of others.

The faculty wishes you a successive conference.

Prof. S.O. Jekayinfa
Dean, Faculty of Engineering and Technology, LAUTECH, Ogbomoso, Nigeria

I write to congratulate the organizers of this annual event on the occasion of the LAUTECH NANO 2021 Conference taking place in our University, LAUTECH. It is an endeavor that needs to be appreciated. The need to appreciate this becomes compelling considering the fame other past conferences and seminars of *NANO*$^{+}$ group has brought to our University. Members of the *NANO*$^{+}$ group have collaborated with both local and international researchers in the area of nanotechnology as it affects almost all known disciplines.

This event, which is the fifth of its kind, would further promote the synergy and catalyze the growth of nanotechnology in Nigeria. The theme of this year's conference is '**Nanotechnology in Africa: Changing the Narratives for the Benefits of Mankind**'. The theme is particularly interesting because it will afford the participants and all other stakeholders the opportunity to synthesize research outcomes on specific nanotechnology topics and to translate these into implications for policy – and decision–making. This conference, I believe, will further stimulate collaboration and research interests among concerned experts (Engineers, Environmental Scientists,

Microbiologists, Medical Practitioners, Policy Makers, etc.). This conference/workshop will harvest the different approaches to making nanotechnology beneficial to mankind as will be evidenced by the research outcomes of participants and lead papers presenters.

I, therefore, congratulate the organizers and pray that God, in His infinite mercy, will continue to strengthen your group as it grows yearly with corresponding high-impact publications emanating from the research efforts of your members.

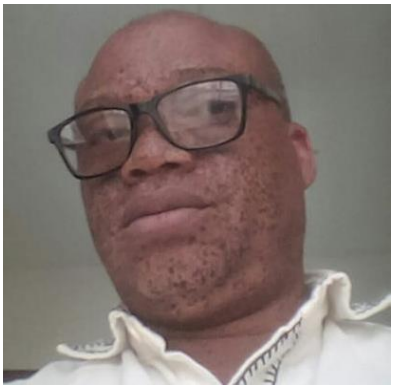
Thank you.

Prof. J.O. Emuoyibofarhe
Chair, Mobile e-services Research Group and Dean, Faculty of Computing and Informatics, LAUTECH, Ogbomoso, Nigeria

The mobile e-services research group of the Faculty of Computing and Informatics wishes to acknowledge your consistent efforts in hosting international conferences on Nanotechnology research in Africa.

We hereby wish you fruitful deliberations and positive significant research outputs.

Thank you.



Prof. L.O. Alamu
Ag. Dean, Faculty of Renewable Natural Resources, LAUTECH, Iseyin Campus, Nigeria

Nanotechnology takes care of unimaginable spheres of human endeavours and not until such contributions are researched into, the benefits of nanotechnology will not be appreciated in such spheres. The LAUTECH Nanotechnology Research Group is a driving force at achieving the full benefits of the field in Nigeria. Congratulations on the 5th International Conference on Nanotechnology titled '*Nanotechnology in Africa: Changing the Narratives for the Benefit of Mankind*'. This is a great title at a time like this. Kudos to the group, as I wish you a successful conference.

Prof. O.O. Fawole
Acting Dean, Faculty of Management Sciences, LAUTECH, Ogbomoso, Nigeria

Title: For the maximum benefits of nanotechnology, Africa must key in now

Nanotechnology is an emerging technology with immense benefits for mankind. It has a lot of applications in different aspects of human life and cut across various disciplines. African countries especially Nigeria needs to tap into this to improve the quality of life. Unfortunately, the commitment to the nanotechnology drive in Nigeria is still very low.

I salute the LAUTECH Nanotechnology Research Group for the consistency in organizing workshops and conferences on the synthesis of nanomaterials and applications of which this current one is the fifth. Through these, a lot of information is being disseminated and the level of awareness is on the increase. Besides this, they have a robust website and also launched a journal recently (*Nano Plus: Science and Technology of Nanomaterials*) which is assisting in reaching out to the community.

I strongly support the call for Centre of Excellence for Nanotechnology in LAUTECH which I believe will further assist in research using state-of-the-art equipment. The Research Group is hereby encouraged to intensify its efforts and ensure the roll-out of products of nanotechnology soonest.

Thank you

Prof. B.A. Akinwande
Director of Academic Planning, LAUTECH, Ogbomoso, Nigeria

It brings me great pleasure to write a goodwill message for the 5th international conference by LAUTECH Nanotechnology Research Group (*NANO*$^+$). The *NANO*$^+$ of this noble institution of ours has been a front-burner in advancing the national, regional and global recognition of our dear University. Publications of group members on nanotechnology-related research activities have paved the way for high citations which is a strong factor for

LAUTECH ranking. The recent interview on 'The Bugle' with the Nigerian Customs Broadcasting Network (NCBN) on the exposition of the importance of nanotechnology is highly remarkable and also commendable. This goes a long way in establishing the academic relevance of LAUTECH to the whole world. The leader and all the team members of *NANO*+ are mostly appreciated for their diligence and consistency in the organization of the annual international conference.

I wish the *NANO*+ all the best at the LAUTECH NANO 2021.

Hon. S. Onilede, *JP*
President, LAUTECH Alumni Association

I congratulate the organizers of this noble 5th international conference and workshop on nanotechnology tagged "LAUTECH NANO 2021". I heartily rejoice with the nanotechnology team under the amiable leadership of one of our scholars, Professor Agbaje Lateef, for showcasing our University, LAUTECH, to the world. It is indeed a remarkable feat bearing in mind that nanotechnology is a novel area of science and one of the new trends of research that aims to proffer lasting solutions to the myriads of challenges facing us as a people.

The concept of nano-science is a global phenomenon and I am highly delighted that scientists in this area of the world have also keyed into its exploits. As the 4th Alumni President of this great citadel of learning, it remains heartwarming and highly plausible that sizeable and notable numbers of scientists championing this cause of nanotechnology in Nigeria are alumni and staff members of this institution. To me, it gladdens my heart as am strongly hopeful that this year deliberations shall usher in new solutions that will be beneficial to mankind in sync with the theme of the conference 'Nanotechnology in Africa: Changing the narratives for the benefits of mankind'

I wish you all peaceful deliberations and a nice stay in the ancient city of Ogbomoso known for its serenity.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

PLENARY LECTURES

The narrative of transformation into a circular economy via sustainable nanotechnology

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Nigeria is endowed with abundant biodiversity which, however, remain under-utilized. Unfortunately, however, its poor waste management system led us to an unprogressive linear economy (LE). Humnnnn!! Singapore and Malaysia started equally with Nigeria as LE nations. As of today, Singapore has been transformed from LE to a circular economy (CE) due to its ability to transform waste generation to wealth and technological advancement. Indeed, Singapore now operates zero waste and CE policy via sustainable nanotechnology. **Sustainable nanotechnology is the development of science and technology within the 1 – 100 nanometer scale, with considerations to the long-term economic viability and sensible use of natural resources, while minimizing negative effects to human health and the environment. Sustainable nanotechnology remains a** green nanomaterial for a clean environment and a tendency towards waste reduction via reuse, repair and recycling with the view for CE (Figure 1). Nanotechnology came into the limelight in Nigeria in the year 2006 under the inauguration of Nigeria Nanotechnology Initiative (NNI) orchestrated by the former DG, NASENI, Late Prof. O. Adewoye. Since then, several nanotechnology concepts have evolved from research communities (Nano group, UNN; Nano group, LAUTECH, NASENI, EMDI, etc.). As one of the resource persons in the NNI of 2006 saddled with a national appointment to train Nigerian scientists on the rudiment of "Nanotechnology from experimental perspectives", I have continued to adopt sustainable nanotechnology as a model for sustainability [1-4]. It is not yet late for Nigeria as the hope to meet up with the so-called "ASIAN tigers" is a looming one if only we can change the narrative. Therefore, striving "win-win" for waste-to-wealth in sustainable nanotechnology cascade and a natural capital lens for a sustainable bioeconomy remain the "master narrative".

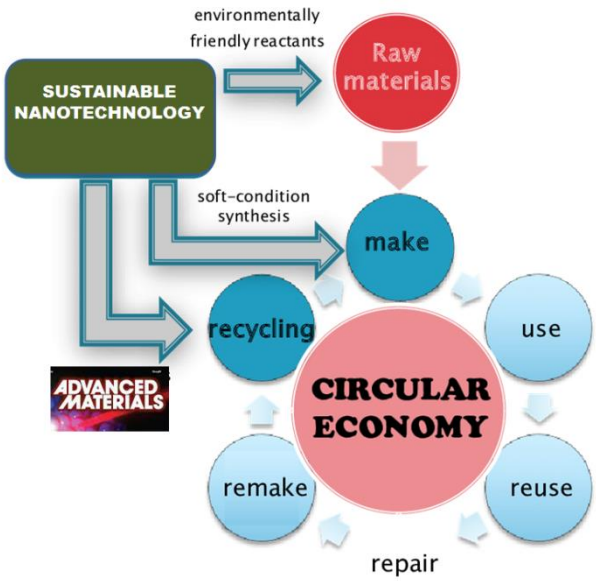

Figure 1: Roadmap to a circular economy (CE) via sustainable nanotechnology

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Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Sustainable and Innovative NANOTECHNOLOGY based strategies for Sustainable Development

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In the last two decades, we have been interested in sustainable development strategy based on green and Innovative Nanotechnology scientific research approaches to achieve several United Nations (UN) *Sustainable Development Goal*s (*SDG*s) to contribute to planet protection by 2030. Thus, in this talk we will present an overview of our recent results on the design and development of innovative:

- nanomaterials-based micro/nanosensors and biosensors for diagnosis and monitoring of chronic and emerging diseases, such as diabetes, cancers, neurodegenerative diseases and more recently Covid-19 contributing thus to the *SDG3: Good Health and wellbeing*. The early-stage warning of cancers for example by detection of their biomarkers is an essential issue to limit their impact;
- nanoparticles-based nanosystems as nano-biofertilizers and nano anti-fungicides for more sustainable agriculture as well as nanomaterials based chemical nano/microsensors of emerging contaminants (ECs) such as nanoplastics (potentially cancerogenic and/or endocrine disruptor compounds (EDCs)) for more food safety. Consequently, these nanotechnology-based nano/microsystems will contribute to *SDG2:* Zero *Hunger;*
- nano/microsystems for water quality monitoring and remediation by the fast analysis and, if possible, the degradation of emerging contaminants such as heavy metals, pharmaceuticals, nanoplastics, and pesticides which are present in our aquatic environment (river and dam water), and also in drinking (tap and mineral) water contributing thus to the *SDG6 : Clean water & sanitation* particularly by engineering of nanomaterials based simple, cost-effective, eco-friendly and portable nanoplatforms for fast analysis of water;
- Nanomaterials-based Nano/microsystems for energy harvesting, storage and saving such as low-cost solar cells, biomass-based supercapacitors and low consumption light sources (OLEDs). These cost-effective and eco-friendly devices are the aim of the *SDG7: Affordable and clean energy* giving rise in long-term to *sustainable cities and communities* (*SDG11*).

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Perovskite solar cells: Nanoengineering the device efficiency

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Recent bids for the installation of PV farms in the Middle East showed that solar energy has become cheaper than any other source of energy including fossil fuels. This paves the way for the large-scale deployment of solar energy without governmental subsidies. This is a defining moment in history and may be considered as the beginning of the end of the Oil Age. Yet, intensive efforts are still deployed to reduce further the cost of solar energy. Improving the efficiency of solar cells is one of the key drivers for Photovoltaic (PV) technology development since the design of the first device in 1954 at Bell Lab. Silicon has dominated the market as a material of choice for the fabrication of solar cells over decades because of its large natural abundance, non-toxicity, and good absorption of visible light. However, perovskite materials such as methylammonium lead iodide ($MAPbI_3$) are emerging as a very promising alternative for the production of solar cells of high efficiency at a lower cost. Thanks to their high absorption in the visible range, a perovskite layer of a few hundred-nanometer thickness absorbs most of the incident light while a 200 times thicker layer is needed in the case of silicon. Since 2009, the power conversion efficiency of perovskite solar cells (PSCs) has increased from 3.8% to 25.5% which is close to the record efficiency of silicon heterojunction cells of 26.7% achieved in 2017. This unprecedented increase of performance over a single decade has fuelled the research activity in the field. Yet, major challenges remain and need to be addressed before PSCs find their way to the market. These are the poor device stability due to the presence of organic components and the toxicity of lead. We will review the different approaches that have been adopted to address these two major issues including engineering of the composition of the absorbing perovskite layer, the use of inorganic materials for hole and electron transport, defect passivation and nanoengineering the interfaces.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Prospects and challenges of Nanotechnology for fuel cell development

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The need for alternative sources of energy is very high and the challenges are to develop a new technology that will produce an efficient and environmentally friendly energy source other than fossil fuel. Fuel cell is considered the most promising alternative method of converting and exploiting energy with many benefits including low pollutant emission, sustainability, and reliability. The catalyst and the membrane are parts of the basic unit of fuel cells which are bonded together into one component and referred to as Membrane Electrode Assembly (MEA), which is the heart of fuel cell. Despite the widespread acceptance of fuel cell as an ideal alternative energy source that can either replace or compliment fossil fuel, fuel cell is still not commercially available due to the sole copyright of the fuel cell technology by few companies, and high price of fuel cell compared to other sources of energy. For instance, the status of $61/kW for transportation fuel cell is more than the $30/kW target of the United States Department of Energy. In addition, the durability lifetime of 2500 operating hours that is obtainable now in PEMFC is also lower than the targeted 5000 operating hours. It is therefore important to further optimize the fuel cell technology to make it more cost-effective, and this can be achieved through the application of nanotechnology for fuel cell development. Nanotechnology is a technology that produces nanomaterial of unique structures and better properties. These properties include good structural arrangements, chemical stability, mechanical strength and electrical conductivity. Nanomaterials possess these properties and could serve as alternative support that can impact better durability to the MEA of a fuel cell. This presentation will therefore give an overview of the prospect and challenges of nanotechnology for fuel cell development.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Pore-scale investigation of velocity and viscosity of fluids on capillary pressure for enhanced oil recovery

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Enhanced oil recovery using nanofluids is a promising way to recover the residual oil from the pores of reservoir rocks. A pore-scale investigation of displacement of oil using nanofluids is important for understanding the recovery procedure. The structure of reservoir rocks and the flow rate creates an impact on the movement of oil in porous media. In this presentation, the effect of velocity and viscosity of nanofluids on the dynamics of nanofluid-oil displacement as a two-phase flow system will be discussed. 3D micro computational tomographic (micro-CT) technique was used for the extraction of pore geometries of sandstone, while finite element method (FEM) was used for the simulation of two-phase flow in porous media on micro-CT images. Relative permeability and velocity patterns of the non-wetting phase revealed that nanofluids with increased viscosity can play a vital role in enhanced pol recovery.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nanotechnology for sustainability; Achievements, challenges and perspectives

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Environmental application of nanomaterials to treat air, soil and wastewater pollutants has several advantages due to the unique properties of the nanoparticles. In the literature, there are many positive reports of effective treatment processes for different environmental pollutants based on nanotechnology. However, successful laboratory-scale experiments do not imply that there are no challenges and concerns for the environmental application of nanomaterials on a large scale. Here, in this presentation, we briefly discuss the sources and types of environmental pollutants, the problems associated with their existence, and the conventional and nanotechnological methods of addressing them. The challenges facing the environmental application of nanotechnology in the field of removing pollutants were also discussed, in addition to suggestions and recommendations to address these challenges.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

ABSTRACTS OF ORAL PRESENTATIONS

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Green synthesis of silver nanoparticles and their activity against bacterial biofilms

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NANO2021/P001 **Abstract**

Keywords
Aspergillus species
Silver nanoparticles
UV-vis absorption
FTIR
Bactericidal agent

Emergence of new resistant strains of microorganisms to current antibiotics has become a major issue in public health; therefore, it is imperative to develop new bactericides. This study, thus, aimed at synthesizing silver nanoparticles (AgNPs) and determining their antimicrobial activity. Water samples were collected from two wells around Gbonagun piggery house, from where isolation of microorganisms was carried out using standard techniques. Cell-free supernatants of the isolates were used to synthesize AgNPs and the potential to prevent the growth of biofilms was evaluated. The formation of silver nanoparticles in the cell filtrates was confirmed by the physical change of colour and absorption peak at 410-428 nm using UV-Vis spectroscopy. Further, the synthesized AgNPs were characterized by Fourier transform infrared spectroscopy (FTIR). Predominant bacterium and fungi are *Bacillus subtilis* and *Aspergillus* species. Peaks of transmittance of biosynthesized AgNPs from *Aspergillus flavus* as shown by the FTIR spectrum were located at 3276, 2924, 1026 and 1619 cm^{-1} representing the -NH of amine, -CH, C-O and -NH bend of amine while the FTIR peaks for *Aspergillus niger* include: 3375 (-NH of amine), 1697 (C=O), 1094 (C-O) and 1638 (-NH). The presence of the alkene, carboxyl and amine groups suggests a capping of the nanoparticles by the *Aspergillus* species after redox reaction. Synthesized AgNPs prevented the growth of biofilms by exhibiting highest zone of inhibition of 21.4 ± 0.53 mm and 10.0 ± 0.26 by *Aspergillus flavus* and *Aspergillus niger*-mediated AgNPs. The properties of AgNPs by *Aspergillus* species present the fungi as bioresources with good bactericidal activities.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Simulating bending behavior of zirconia nanotubes using finite element analysis

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NANO2021/P002

Keywords
Zirconia nanotubes
Chirality
Bending
Finite element analysis

Abstract

The bending behavior of single-walled cubic zirconia nanotube (SWCZNT) is studied based on three-dimensional (3D) numerical simulation using the concept of Finite Element Analysis. Molecular bonds of the SWCZNT were modeled as structural beam elements and positioned at the joints of beams as substitute of atoms. In order to simulate the bending behavior of SWCZNT, the free-end of a developed model was subjected to varying transverse displacements and the maximum force along the cross section at the fixed end was recorded to estimate the bending elastic modulus. 3D models of SWCZNT developed have larger diameter compared to carbon nanotube with similar configuration or chirality (n, m). Results obtained shows that the bending modulus (E_b) of SWCZNT is dependent on chirality and decreases with increase in diameter and displacement or loading. Thus, simulated bending modulus SWZNT fluctuates between 106 to 136 GPa; with zigzag type having higher value when compared to armchair (90 – 116 GPa). Similarly, bending rigidity (E_{BI}) stabilizes at 55 GPa and 45 GPa for armchair and zigzag types respectively.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Effect of copper nanoparticles on centrifugal pump

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NANO2021/P003

Keywords
Copper nanoparticles
Nanofluid
Centrifugal pump
Fluid flow
Pump efficiency

Abstract

This experimental study presents fluid flow characteristics obtained for a non-ferrous metallic water nanofluid, copper-water mixture, through a one-horsepower centrifugal pump. The results obtained for three different pressures rise of 3.8, 4.2, 4.8 (bar) by pumping copper-water nanofluid through a constructed pump test unit, with the addition of 5g of copper nanoparticles to 20L of water are Head (m); 0.17, 0.33, 0.41; Flow Rate (m^3/s); 0.463070155, 0.285632676, 0.076961558; Brake Power (Kw); 0.0723825, 0.1050225, 0.041503 and Efficiency; 0.6899997, 0.6399991,0.5999997, while for 10g of copper in 20L of water are Head (m); 0.15, 0.28, 0.37; Flow Rate (m^3/s); 0.4606172, 0.2175568, 0.0949577; Brake Power (Kw); 0.0814823, 0.0914652, 0.0591155 and Efficiency; 0.6099998, 0.5699993, 0.5199997. The pump flow rate was observed to decrease as a higher head is attained while the head gained increases with an increase in pumping pressure. The head attained due to pumping was observed to reduce as the copper nanofluid concentration increases, while the pump vibration increases as the particle concentration increases. There was an observed temperature rise in the components of the nanofluid pump testing machine due to a rising temperature of the copper nanofluid during the pumping operations. Lastly, this experimental research clearly shows the impact of copper nanofluid on the pumping power, flow rate, head gained, pump speed, and pump efficiency.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

A review on nanotechnology: A preferred technological tool for eradicating COVID-19

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NANO2021/P004

Keywords
COVID-19
SARS-CoV-2
Nanoparticles
Nanovaccines
Antiviral drugs

Abstract

The outbreak of coronavirus disease in 2019 (COVID-19) arising from Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), has posed a serious health threat worldwide. The World Health Organization (WHO) declared a global health emergency on January 30, 2020, due to the rapidly increasing cases of the disease and its severity while on March 11, 2020, it was declared a pandemic. As at September 10th, 2021, 223,022,538 confirmed cases of COVID-19, including 4,602,882 deaths were recorded. The disease spreads across the continents from Asia (China) to other parts of the continents. The variants form of the disease, factors obstructing the production of novel antiviral drugs, the preventive measures in controlling the transmission of COVID-19 as well as the effective antiviral nanovaccines can play vital roles in curbing COVID-19, which tends to militate against human health due to the increasing rate of transmission. The effectiveness of antiviral drugs could be enhanced with nanomedicine formulations. Therefore, nanoparticles associated with antiviral drugs and nanovaccines can promote pharmacokinetics and enhance bioavailability with little or no side effects.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Recent development in nanoscratch testing characterization and applications- A review

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NANO2021/P005

Keywords
Thin film
Coatings
Nanoscratch
Mechanical properties
Microstructure

Abstract

Thin-film coating at nanoscale is expected to have excellent performance due to its high surface area. The mechanical and functional properties of the thin film coatings are paramount as the failure of the coatings could result in the deterioration of the substrate functions. The integrity and performance of thin coatings are usually determined through the measurement of mechanical properties such as hardness, residual stresses, elastic modulus, coating fracture toughness and interfacial fracture toughness. Interestingly, thin coatings cannot be easily detached from the substrate to carry out mechanical testing on them as in the case of thick coatings; hence nanoscratch testing offers a means to determine the mechanical performance of thin coatings. Nanoscratch testing involves application of constant or progressive normal load on the surface of the coating with several cycles of passes before cracking and failure occur. It is becoming a promising characterization technique to study wear behaviour and nano-tribological properties of materials under static and dynamic states. In this study, various coating materials and application methods will be discussed. Nanoscratch procedure shall be explained including the equipment used for the test and area of applications. Finally, the properties measure with respect to microstructure influence and the advancement made in recent times will be thoroughly presented and explained.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Conjugated polymer/multi-walled carbon nanotubes composite characterisation for application in volatile organic compounds sensors

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NANO2021/P006

Keywords
MWCNTs
Nanocomposite
Polyimidazole
Impedance
Sensor

Abstract

Polyimidazole multi-walled carbon nanotubes (MWCNTs) nanocomposite films were synthesized by chemical oxidation of imidazole monomer and addition of MWCNTs to the conductive polymer (CP) solution in a 1:1 ratio. Chemical characterization using FTIR where there is an increased intensity of peaks in the control sample from 2823 and 2937 cm^{-1} to 2833 and 2947 cm^{-1} in Plm/MWCNTs composite respectively and Raman spectroscopy in which Plm/MWCNTs shows the so-called D-band (attributed to disordered sp^2 and non-sp^2 carbon defects in graphitic sheets) and G-band (attributed to the C–C vibration with the sp^2 hybridized orbital in graphene structures) peaks at 1355 cm^{-1} and 1593 cm^{-1}, but chemical analysis confirmed the mixing of the polymer and the MWCNTs. Electrical measurements using current voltammetry (CV) that shows a reversible wave that is the typical behavior of conductive surfaces in the presence of the redox couple and impedance measurements in which the largest semicircle was obtained with Plm/CNTs film that corresponds to a film resistance on the real axis of 350 MΩ which is an indication of a higher electron transfer rate in the redox probe and good electrical behaviour. The overall results have shown that the composite has a significant electrical conductivity and can be applied in sensing volatile organic compounds in the environment.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Relevance of physicochemical properties in predicating the toxicity of nanomaterials

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NANO2021/P007

Keywords
Nanomaterials
Toxicity
Size
Shape
Environmental health
Consumer products

Abstract

The increasing use of engineered nanomaterials in daily life raises concerns in both living organisms and environmental health. Accordingly, the hazards associated with nanomaterials exposure should be investigated. This study aims to analyze published data that become available in the past two years from multiple literature sources with a specific focus to investigate the impact of physicochemical properties in nanomaterials toxicity. The impact of surface charge, size, shape, electrostatics, aggregation and coating published data from 2018-2020 were extracted from the web of science (WoS), PubMed and Google Scholar. Concentration and exposure time were used to score the influence of these properties in nanomaterials toxicity. The outcome of this study revealed that particle size is the main attribute of nanomaterial toxicity. Hence, care has to be taken while synthesizing and formulating nanomaterials to avoid incorporating toxic ones into consumer products.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Facile hydrothermal and solvothermal synthesis and characterization of nitrogen-doped carbon dots from palm kernel shell precursor

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NANO2021/P008

Keywords
Carbon dots
Photoluminescence
Palm kernel shell
Dopants
Quantum yield

Abstract

Carbon Dots (CDs) is a nanomaterial synthesized from organic precursors rich in carbon content and exhibiting excellent fluorescent property. They are in high demand for many purposes, such as sensing and biosensing applications. This research focused on preparing CDs from natural and abundant waste material, palm kernel shells (PKS) obtained from palm oil biomass, aimed at sensing and biosensing applications. Ethylenediamine and L-phenylalanine doped CDs were produced via the hydrothermal and solvothermal methods using one-pot synthesis techniques in an autoclave batch reactor. The as-prepared N-CDs showed excellent photoluminescence (PL) and quantum yield (QY) properties of 13.7% for CDs doped with ethylenediamine (CDs-EDA) and 8.6% CDs doped with L-phenylalanine (CDs-LPh) with an excitation/emission wavelength of 360 nm/430 nm. Transmission electron microscope (TEM) images showed the N-CDs have an average particle size of 2 nm for both CDs. UV-Visible spectrophotometric results showed C=C and C=O transition. FTIR results showed and confirmed the presence of functional groups, -OH, -C=O, and -NH_2 on the N-CDs, while the X-ray diffraction pattern at 2Theta showed that the N-CDs were crystalline and depicted with sharp peaks. This work demonstrated that palm kernel shell biomass, often thrown away as waste, can produce CDs with excellent physicochemical properties.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Influence of periwinkle shell ash and selected nanochemicals on durability of lateritic bricks

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NANO2021/P009

Keywords
Nanochemicals
Lateritic brick
Periwinkle shell ash
Compressive strength
Water absorption
Low-cost housing

Abstract

This study assesses the influence of Periwinkle Shell Ash (PSA) with nanochemicals (Terrasil and Zycosil) on the durability of lateritic bricks. Periwinkle shells were washed, calcinated, sieved and the chemical composition (calcium, silicon, iron and aluminum oxides) were determined. Lateritic bricks of size 225 × 225 × 125 mm were produced by replacing cement and water with PSA and nanochemicals at 0, 5, 10, 15, 20 and 25% by volume. Compressive strength and water absorption test of brick at 3, 7, 14, 21 and 28 days were determined. Two-way Analysis of Variance (ANOVA) at 5% level of significance was used to determine the effects of varying percentages of PSA and nanochemicals on compressive strength and water absorption. Calcium, silicon, iron and aluminum oxide of PSA were 3.51, 60.87, 6.91 and 21.06%, respectively. The compressive strength of bricks with varying PSA ranged 2.24 - 3.49 N/mm^2. The corresponding value with admixture (PSA, Terrasil) and (PSA, Zycosil) ranged 2.32 - 4.77 N/mm^2, 1.95-3.16 N/mm^2, respectively. The water absorption ranged from 6.77 - 25.27%. There was a significant effect of varying percentages of admixture on compressive strength and water absorption ($P=0.2986 > 0.05$). Lateritic bricks with 15% PSA and Terrasil nanochemicals gave optimal strength and water absorption. The produced lateritic block can be used for a low-cost housing scheme.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Effects of different shapes of nanoparticles on the efficiency of carboxymethyl cellulose (CMC) solution in drilling applications

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NANO2021/P010

Keywords
Carboxymethyl cellulose
Casson fluid
Convective flow
Nanoparticles
Runge-Kutta scheme

Abstract

Efficiency of Carboxymethyl cellulose (CMC) solution in drilling processes cannot be overemphasized. However, the efficiency of this solution can be limited especially in regions of high temperatures. Nanoparticles like copper oxide (CuO) have distinctive properties such as enhanced thermal conductivity. This work aimed at modeling the problem to enhance the rheological and tribological lubricant as well as the heat transfer abilities of CMC solution using CuO nanoparticles. The impact of the non-spherical shape nanoparticles in the natural convective flow of CMC solution with Casson fluid model for drilling operations was investigated. The governing equations describing the flow of fluid with nanoparticles were modeled using partial differential equations with boundary conditions and solved numerically by the Runge-Kutta scheme of order four with the shooting method. Graphs of velocity and temperature profiles were plotted to compare the impact of the different shapes of the nanoparticles on CMC solution. The Skin friction coefficient and Nusselt number were theoretically computed for the fluid with and without nanoparticles to ascertain the rate of the heat generated when the surfaces move and the rate of heat transferred by the fluid. Results showed that the blade-shaped CuO nanoparticles have the greatest tendency to augment the efficiency of CMC solution. The rates of heat generated and transferred were enhanced by 12.4 and 15.3% respectively. Addition of CuO nanoparticles improved the flow velocity, lubrication and heat transfer abilities of the CMC solution.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Drug release studies of prodigiosin from a polyblend of PLA/PCL microspheres and its application in breast cancer treatment

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NANO2021/P011

Keywords
Microspheres
Polyblend
Encapsulation
Breast cancer
Prodigiosin

Abstract

In this work, we present the microencapsulation of Prodigiosin, an anti-cancer agent, in a polyblend of Polycaprolactone (PCL)-Polylactic acid (PLA), prepared by oil-in-water (o/w) emulsion solvent evaporation method. Three variables were evaluated i.e. different drug concentrations, different ratios of the polymer blend and the drug release rate. The polymers were mixed in 3 different ratios of 1:9, 2:8 and 3:7. The drug concentrations were also varied (0.5 mg, and 1 mg). The resultant microspheres were characterized using Scanning Electron Microscope (SEM), Fourier Transform Infrared (FTIR), and UV-visible spectroscopy. The encapsulation efficiency showed that the fraction with a ratio of 3:7 has the highest encapsulation efficiency of 94.2±4% while the 1:9 polyblend had the least encapsulation efficiency of 79.4±2%. The drug release profile was studied and finally, the drug was tested on breast cancer cells *in vitro* to ascertain the efficacy of the drug.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Comparative study of the antimicrobial activities of silver nanoparticles synthesized using neem (*Azadirachta indica*), maize (*Zea mays*) and yellow oleander (*Thevetia peruviana*) leaves

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NANO2021/P012

Keywords
Silver nanoparticles
Antimicrobial activity
Biosynthesis,
Azadirachta indica
Zea mays
Thevetia peruviana
Spectroscopy

Abstract

This work presents a comparative study of the antimicrobial activities of silver nanoparticles synthesized using *A. indica*, *Zea mays* and *Thevetia peruviana* leaves. Green synthesis of silver nanoparticles has been shown to be cost-effective and environmentally friendly, as well as ease of scale-up. The particle sizes varied, *Thevetia peruviana* synthesized AgNPs sizes ranged from 10 – 30 nm, *Zea mays* was 20 – 60 nm, while for *A. indica* the sizes were within 15-50 nm. The antimicrobial activities of the synthesized AgNPs against clinical isolates were tested. While *A. indica* synthesized AgNPs showed maximum activity against *Shigella* `spp., with a zone of inhibition of 15 mm, AgNPs synthesized by *Thevetia peruviana* showed more activity against *Salmonella typhi* (16 mm). The *Zea mays* antimicrobial activity was prominent against *Shigella* (25 mm) and *Staphylococcus aureus* (19 mm). The synthesized AgNPs were characterized using UV-Vis spectroscopy, Fourier-transform infra-red (FTIR) spectroscopy, and Scanning electron microscope (SEM). This study therefore will help in choosing the plant synthesis with better activity against microbes.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Numerical investigation of the performance of parabolic trough solar collector utilizing nanofluids as working fluids

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NANO2021/P013

Keywords
Parabolic trough solar collector (PTSC)
Nanofluids
Non-uniform heat flux
Numerical analysis

Abstract

Parabolic trough solar collectors have been utilized to harvest solar energy for heating and power generation for ages. While several attempts have been made to improve the design and performance of solar collectors, little attention has been focused on the enhancement of the thermal conduction efficiency of the heat collection fluids. By adding nanofluids, a mixture of nanoparticles and base fluids, the thermal conductivity of the working fluids can be improved, and invariably the performance of the collectors can be enhanced. This paper presents a computational fluid dynamics (CFD) simulation of a parabolic trough solar collector in which pure water, CuO/water and TiO_2/water nanofluids were used as working fluids. The nanofluids were set at 5 vol. (%) while turbulent flow condition with non-uniform heat flux was applied at the outer surface of the receiver. The receiver heat profiles, at varying lengths and diameters, were obtained using a general-purpose ray-tracing software-SolTrace. The results indicated the Nusselt number increased by 33% and 22% when the fluid flow rate and Reynold number were increased by 48% and 42%, respectively. The simulation results agreed with the existing experimental data within ±5% error. In addition, the performance of the solar collector, when CuO/water nanofluid was used, was 22.7% and 9.3% higher than pure water and TiO_2/water nanofluids, respectively. Therefore, it is recommended that CuO/water nanofluids be utilized for parabolic trough solar collectors, given the high energy demand occasioned by population explosion and COVID-19 pandemic.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Formulation and evaluation of a multi-drug loaded liposome for the management of non-small lung cancer (NSLC)

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NANO2021/P014

Keywords
Non-small lung cancer
Osimertinib
Cetuximab
Liposomes
Drug delivery
Cytotoxicity

Abstract

This investigation was dedicated to the production and assessment of batches of multi-drugs loaded liposomes for the management of NSLC. Osimertinib (OS), a third-generation epidermal growth factor inhibitor (EGFR-TKI) as well as Cetuximab (CX) were selected for the study. Lipid film hydration technique (LFHT) was employed in the production of the liposomes. These liposomes batches were thereafter characterized by determining the morphology, dimensions, zeta potentials and polydispersity index. The encapsulation, the release and the *in-vitro* cytotoxicity of each of the batches were equally evaluated. The produced liposome batches were all spherical and in nano size ranges with mean particle sizes ranging between 46.6 ±1.09 and 50.3±1.09 nm. The values of the zeta potential (−35.5±2.21 to −36.2±2.19) suggest stable and well dispersed liposomal formulations. The encapsulation capacity, *in-vitro* drug release and cytotoxicity differ significantly ($p \leq 0.05$) among batches. These differences may be due to the use of different proportions of drug delivery polymers and the synergetic effect of the actives. Formulations X_1, X_2 and X_3 that were multi-drugs loaded liposomes displaced cytotoxicity of 92.8, 93.2 and 93.4 %; while X_4 and X_5 (single drug-loaded liposomes) had lower lethal power of about 80.9 and 81.1 % respectively. There is however the need to optimize and scale up these multi-drugs loaded liposomal formulations for the benefit of patients with NSCLC.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Preliminary design for development of nanocomposite 3-D printing filament from nanokaolin/polyethylene waste

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NANO2021/P015

Abstract

Keywords
3-D printing filament
Nanocomposite
Nanokaolin
Polyethylene waste
Taguchi method

This paper is a preliminary design for the development of nanocomposite 3-D printing filament. The design is the basis of an optimization approach for improving mechanical properties in nanocomposite 3-D printing filament developed from nanoclay/polyethylene waste. This work adopts extrusion process method to develop the nanocomposite filament. Factors considered for the design are pre-cure temperature (40, 50, and 70 ^{o}C), cure temperature (120, 130, and 140 ^{o}C), nanokaolin content (0.5, 1.0, and 1.5wt %) and recycled high-density polyethylene (rHDPE) ratio (0.2, 0.6, and 1.0wt %) for three levels. Combination of these factors aids responses investigation of extrusion effects on nanocomposite filament developed from nanokaolin/rHDPE and their mechanical properties using Design of Experiment (DOE) by Taguchi Method. Process responses signify modification of materials structure forming nanocomposite filament with improved mechanical properties (tensile modulus, tensile strength and strain at break), impact strength, fracture toughness, melt flow index (MFI) and water absorption physical properties. Preliminary design leads to Analysis of Mean (ANOM) and Analysis of Variance (ANOVA) establishing most significant effects on the property following percentages contribution of dominant factors. Additionally, for others, property enhancements will be determined from the design through their dominant factors. Taguchi method points out dominant parameters and gives optimum parameter settings for each property. This work recommends trials and validation processes.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Nano-silver, gold and alloy fabricated using *Pleurotus ostreatus* (MK751847) extract and its antioxidant potential

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NANO2021/P016

Keywords
Pleurotus ostreatus
AgNPs
AuNPs
Ag-AuNPs
Antioxidant activities
Myconanofabrication

Abstract

Myconanofabrication has been considered to be a structured and satisfactory method for the synthesis of various types of nanoparticles with vast potential and remarkable application in diverse fields. In this study, *Pleurotus ostreatus* (PO) extracts were used to synthesize silver (PO-AgNPs), gold (PO-AuNPs) and alloy bimetallic nanoparticles (PO-Ag-AuNPs) and their antioxidant potentials were evaluated. UV–vis spectroscopy peaks at 430, 530 and 538 nm and FTIR at 3425, 3259, and 3441 cm^{-1} for PO-AgNPs, PO-AuNPs and PO-Ag–AuNPs respectively. The nitric oxide scavenging activity, 2,2- diphenyl-1-picrylhydrazyl, total phenolic and total flavonoid contents of the extracts and the synthesized nanoparticles increased in a dose-dependent manner as compared to the standard. PO-Ag-AuNPs and PO-AuNPs have the highest nitric scavenging power of 72.9% and 72.2% respectively, followed by PO-AgNPs (48.6%) and the least value of 36% obtained in PO at 100 µg/ml. PO-AuNPs showed the highest value of 75.4% for DPPH followed by PO-AgNPs (68.05%) and PO-Ag-AuNPs (67.41%). PO-Ag-AuNPs showed the highest value of TPC (162.7 µg GAE/g), followed by PO-AgNPs (147.33 µg GAE/g), PO-AuNPs (135.79 µg GAE/g), while PO gave 121.67 µg GAE/g as least value at concentration 100 µg/ml. The highest TFC of 101.8 µg/g QE was obtained by PO-AgNPs with the least value of 89.8 µg/g QE obtained in PO. The results obtained confirmed *P. ostreatus* as a potential biomaterial for nanoparticle synthesis which can be exploited for its antioxidant activity.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Performance evaluation of nanocomposite substrate for microstrip patch antenna at 5G network frequency band

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NANO2021/P017

Keywords
MWCNTs
Microstrip patch antenna
MWCNT-Al_2O_3-ceramic Composite
5G network
Bandwidth enhancement

Abstract

Addition of nanoparticles to form composite substrates is a drastic improvement in properties that include mechanical strength, toughness, frequency-dependent relation, electric or thermal conductivity of functional materials. Taking into consideration the extraordinary characteristics, specific properties and potentials of nanostructure carbon materials like carbon nanotubes (CNTs) in terms of their extraordinary heat conductivity, mechanical strength, electromagnetic compatibility, frequency-dependent permittivity and permeability which are useful in the design of broadband absorbing or functional materials at microwave band, they can be deployed as microstrip patch antenna in 5G network. In this paper, Multiwalled Carbon Nanotubes (MWCNTs) have been synthesized, purified, characterized and used to develop MWCNTs-Al_2O_3-ceramic composite substrates for Rectangular Microstrip Patch Antenna (RMPA) at 5G network frequency range of 15-55GHz. The developed composite samples properties namely real and imaginary relative permittivity and permeability, microwave absorptiveness, magnetic loss tangent, dielectric loss tangent and bulk conductivity which are required patch antenna substrate properties for High-Frequency Structure Simulator (HFSS) were obtained using transmission/reflection device and further used to characterize and evaluate the performance of a typical rectangular patch antenna at 5G network frequency range of 15-55GHz, and the results obtained were compared with that of existing Al_2O_3-ceramics. The results of the developed composite substrates showed better performance in terms of bandwidth enhancement than ordinary Al_2O_3-ceramic at the frequency band considered. Hence, MWCNT-Al_2O_3-ceramic composite substrate is a promising material for dielectric substrate applications in electronic and communication devices.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Nanoformulation of silver, gold and alloy using cell-free bioflocculant from domestic wastewater bacterial consortium and their antioxidant and anti-microbial potential

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NANO2021/P018

Keywords
Bio-flocculant,
AgNPs
AuNPs
Ag-AuNPs
Antioxidant activities
Antibacterial activity

Abstract

Nanobiotechnology has received prodigious attention due to its outstanding applications in various fields. This research aimed at isolating bio-flocculant–producing bacteria and used the cell-free bio-flocculant (BF) to synthesize AgNPs, AuNPs, Ag-AuNPs and their antibacterial and antioxidants activities were evaluated. The UV-vis spectroscopy showed surface plasmon resonance at 570, 516 and 550 nm and FTIR significant peaks at 3183, 3752 and 3786 cm^{-1} for BF-AgNPs, BF-AuNPs and BF-Ag-AuNPs respectively, indicating protein as both capping and stabilizing agents for the synthesized nanoparticles. Antibacterial efficacy, nitric oxide scavenging activity, total phenolic (TPC) and total flavonoid contents (TFC) of the synthesized nanoparticles increased in a dose-dependent manner as compared to the standard. BF-AgNPs gave highest antagonistic effects against tested bacteria (2-68%), followed by BF-AuNPs (4-61%) and BF-Ag-AuNPs (1-39%). The highest nitric scavenging power of 66.5% was observed in BF-Ag-AuNPs, followed by BF-AgNPs (61.3%) and the least value of 33.3% was observed in BF-AuNPs at 100 µg/ml. BF-AuNPs showed the highest total phenolic content of 195.20 µg GAE/g which was very close to the value obtained in BF-Ag-AuNPs (192.35 µg GAE/g), while BF-AgNPs gave the least value of 162.54 µg GAE/g at concentration 100 µg/ml. A significantly higher total flavonoid content of 95.73 µg/g QE was displayed by BF-AgNPs, while BF-AuNPs and BF-Ag-AuNPs showed the least value of 47.77 µg/g QE. The results obtained confirmed cell-free bio-flocculant as a prospective biomaterial to synthesize nanoparticles that can be exploited for its antibacterial and antioxidant activity.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Nanotechnology: Applications in treatment of industrial wastewaters: A review

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NANO2021/P019

Keywords
Wastewater treatment
Pollution
Adsorption
Nano-adsorbent

Abstract

Water pollution and freshwater contaminations are some of the global problems that directly affect lives of organisms which directly rely on water for their livelihood (man, organisms, plants). To alleviate these challenges, various treatment methods such as membrane filtration, ion exchange, coagulation as well as adsorption have been adopted to reduce wastewater generated and improve qualities of effluent discharged from industries to meet specified minimum permissible limits. Among all, adsorption is considered to be more efficient in terms of cost, ease of handling and re-use for treatment. Furthermore, adsorption technology exhibits excellent removal efficiency using adsorbents prepared from raw or waste materials or nanoparticles synthesized from wastes. Nano-materials exhibit outstanding properties such as small particle size, catalytic potential, large surface area and a great number of active sites, hence allowing high removal efficiency. The nano-material in this contest referred to as "new generation nano-adsorbent" is capable of removing pollutants even at low concentrations. Numerous pathways of synthesizing nanoparticles fall under two approaches namely: bottom-up and top-down approaches. Different materials have been adopted for bulk and nano-based adsorbent with their efficiency varying for different waste water sources, nature of the adsorbents, adsorbent dosage and experimental conditions. This investigation will review advancement of waste water treatment using waste and nano-based materials as an adsorbent from 2015 till 2021.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Microbial-nano-remediation of wastewater: Approaches, challenges and prospects

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NANO2021/P020

Keywords
Bioremediation
Nanotechnology
Wastewater
Microbial-nano remediation

Abstract

Bioremediation provides a good treatment strategy for wastewater from various sources. However, it may not be completely effective especially at high wastewater concentrations and types containing effluents and chemicals considered toxic to most microorganisms. Global population increase, urbanization and industrialization have directly or indirectly led to increased generation of waste and toxic effluents materials. Therefore, the use of existing technology may not be effective and efficient in cleaning up the environment. With the discovery of nanoparticles and their many applications from polymer chemistry to drug delivery, the demand for innovative techniques of microbial nanoparticle synthesis for applications in environmental engineering and sciences increased dramatically. Nanomaterials exhibit unique physical and chemical properties and may be integrated into bioremediation to improve microbial activity and effectiveness in wastewater and effluents remediation. Microbial-nano-remediation will not only produce reduced effluent's toxic effects on microorganisms but it is also expected to provide numerous advantages over the existing bioremediation methods; such as reduced overall time and cost of wastewater and effluents treatment as well as aesthetic effects on the environment. In this review, we highlight the recent advances in microbial synthesis of nanomaterials, the use of microbes such as bacteria, protozoa and archaea in microbial synthesis of nanomaterials as well as prospects of bio-engineering approaches of microbial-nano-remediation in wastewater and effluents treatment.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Copper/polymer composite as a hole transport layer of organic solar cell

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NANO2021/P021

Keywords
Organic solar cells
Copper nanoparticles
Chromolaena odorata
Power conversion efficiency
Copper/polymer composite

Abstract

Nanotechnology has in recent times enhanced the efficiency and reduced the cost of solar cells for the development of large-scale electrical energy. We experimentally synthesized environmentally friendly and non-toxic copper nanoparticles (CUNPs) from Saim weed (*Chromolaena odorata*) of which its extract was used to develop a charge transport anode layer that improves the performance of poly (3-hexyithiophene) and phenyl-C61-butyric acid methyl ester P3HT:PCBM based organic solar cells. The electrical properties of the copper/polymer nanocomposite depict an average short circuit current density of 1.675 mA/cm^2, open-circuit voltage of 26.30 V, with a fill factor of 50.7 which are attributed to a power conversion efficiency of 12.08 %, conductivity of 7.41 S/m, and sheet resistance of 0.248 Ω. The optical properties indicate photoconductive materials with an intensive absorption in the ultraviolet band of about 200-400 nm. The modified active layer gives efficient characteristics, favorable for the development of a high-performance solar cell.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Bio-fabrication and characterization of selenium nanoparticles of *Lactobacillus fermentum* and its antagonistic effect on food-borne pathogens and formulation of nano-food

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NANO2021/P022

Keywords
Lactobacillus fermentum
Selenium nanoparticles
Nano-food
Antimicrobial activity

Abstract

This study reports the biosynthesis, characterization and antagonistic potential of selenium nanoparticles (SeNPs) from *Lactobacillus fermentum* (LF) against food borne pathogens and production of formulated Nano-food from the selenium-enriched culture. The LFSeNPs were characterized using UV-visible spectrophotometer, FTIR, SEM, TEM, XRD, EDX and DLS. The surface plasmon resonance peak was at 300 nm and the presence of proteins and polysaccharides on the surface of the biosynthesized LFSeNPs implies their possible role as a capping agent. TEM and SEM images obtained showed the spherical shape of LFSeNPs. The nano-crystalline nature of the LPSeNPs was confirmed by the XRD. Selenium ion has the highest intensity at 1.37 KeV. DLS showed that the LFSeNPs have an average particle size of 96.64 nm with 0.284 PDI. The LFSeNPs and the cell-free culture supernatant of selenium-enriched *L. fermentum* (CFCS-LFSeNPs) solution exhibited greater antibacterial activity than those from the non-selenium enriched *L. fermentum*. The growth of the food-borne pathogens was inhibited by LF-SeNPs and CFCS-LFSeNPs compared to the control. SEM of the pathogen treated with the CFCS-LFSeNPs triggered grave damage to the cell structures of the pathogens. Nano-food produced using formulated blends fermented by LFSeNPs had the highest titratable acidity and least pH compared to other blends. The mineral levels (calcium, zinc, potassium and selenium) of the Nano-food samples were significantly higher than the control samples.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Biosynthesis and characterization of selenium nanoparticles from plant growth-promoting rhizobacterial and their antifungal potential

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NANO2021/P023

Keywords
Selenium nanoparticles
Rhizobacteria
Antifungal activity
Phosphate solubilization

Abstract

Biosynthesis, characterization and antifungal potential of selenium nanoparticles from plant growth-promoting rhizosphere bacteria isolated from monkey pod tree (*Samanaea saman*) were investigated. Plant growth-promoting rhizobacteria (PGPR) from monkey pod tree rhizosphere were screened for plant growth-promoting, selenium nanoparticles biosynthesis and antifungal potentials against phytopathogens. Eight out of the thirty isolates were able to solubilize tricalcium phosphate on Pikovskaya medium (PVK) with phosphate solubilizing indexes ranging from 2.0 to 3.8. Isolate RS3F had the highest Phosphate Solubilising Index (PSI) at 3.8. Nine isolates showed a significant amount of IAA production, in which Isolate RS5B had the highest IAA production (1.14 µg/l). Isolate RS3E was the only nitrogen fixer and with the highest phosphate solubilization in a liquid medium. Plant growth-promoting Isolates RS3F and RS3E were used for green synthesis of selenium nanoparticles and the nanoparticles were characterized and their antifungal activities against some phytopathogens were evaluated. Colour changes to red indicate a reduction of sodium selenite to selenium nanoparticles. The plasmon resonance peak was at 268 nm and SeNPs were spherical. RS3ESeNP and RS3FSeNP had the highest antagonistic activity (45.0 and 40.0 mm; 23.0 and 35.0 mm) against *Aspergillus niger* and *Aspergillus flavus* respectively. *Fusarium oxysporum* was not susceptible to the RS3ESeNP and RS3FSeNP. In conclusion, metabolites from PGPR rhizobacteria can bio-reduced selenite for selenium nanoparticles biosynthesis. The SeNPs have antifungal activity against *Aspergillus niger* and *Aspergillus flavus.*

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Potentials of nanoparticle optimized biodiesel production using oleaginous microorganisms

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NANO2021/P024

Keywords
Biodiesel
Oleaginous microorganisms
Nanoparticles
Sustainable energy sources

Abstract

Currently, the world economy is heavily dependent on non-renewable fossil fuels, which represent over 75% of energy needs. However, fossil fuels are depleting because of enormous consumption. Also, the consumption of fossil fuels is contributing to the global greenhouse effect. Shortages of resources and high crude oil prices have led to the search for new alternatives, renewable and sustainable energy sources such as biodiesel. Biodiesel refers to renewable diesel fuel made from oil crops, animal fats, and food waste oil that can substitute petroleum diesel. It is environmentally friendly among other advantages. Among the generations of biodiesel feed stocks, microbial-based biodiesel from oleaginous fungi has shown great potentials, especially when nanoparticles-based materials are incorporated. All these with readily available agro-wastes have the potentials to produce renewable, sustainable, cheap and environmentally friendly diesel.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Impact of nanoclay on the water barrier property of *Momordica augustisepala* reinforced polyester composite: modelling and sensitivity study

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NANO2021/P025

Keywords
Nanoclay
Natural fibre
Reinforced composite
Polyester
Water resistance property
Momordica augustisepala

Abstract

Application of nanoclay to enhance the barrier properties of natural fibre reinforced composite is prevalent. However, increased technical understandings of the mechanism need more realization. This study investigated the effect of nanoclay (2, 4, 6 and 8 wt.%) on the water transmission ratio (WTR) of *Momordica augustisepala* micro fibre (MAMF) (5, 10, 15 and 20 wt.%) reinforced polyester polymer. Genetic algorithm (GA) was utilized for predictive modeling. Sensitivity analysis through Monte Carlo simulation (MCS) was conducted to have an in-depth knowledge of the percentage contribution of factors investigated for purpose of identifying where future composite design improvements are needed. Results showed that increment in MAMF increased the composite's WTR (g/m^2.day) while increment in nanoclay decreased the composite's WTR (g/m^2.day). The GA model had a coefficient of determination of 0.9784%. The WTR (g/m^2.day) was +57.5% incrementally sensitive to MAMF inclusion and -42.5% decrementally sensitive to nanoclay inclusion. Nanoclay within the study's experimental limit improved the water transmission resistance of polyester composite and GA method successfully predicted the composite developmental processes. Furthermore, emphasis should be placed on minimizing the MAMF inclusion fraction and maximizing the nanoclay inclusion fraction when designing polyester natural fibre reinforced composite for optimum WTR (g/m^2.day) resistance. These results are useful when developing water barrier-resistant natural fibre reinforced polyester polymer composite.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Effects of nanoparticle on heat characteristics and fluid flow in a moving isothermal cylindrical pipe

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NANO2021/P026

Keywords
Finite-difference scheme
Isothermal processes
Viscous dissipation
Temperature-dependent

Abstract

The significance and the broad application of heat transfer are found in extrusion, melt spinning, glass-fiber production processes, food processing, and mechanical forming processes. Isothermal processes have found application in the system with temperature regulators comprising very structured machines, and even living cells. The impact of nanoparticles coupled with viscous dissipation on heat characteristics of nanofluids over a moving cylindrical isothermal pipe has been investigated. A steady two-dimensional laminar boundary layer flow of incompressible, Newtonian fluid past a cylindrical pipe with uniform surface velocity and temperature has been considered. The partial differential equations governing the flow have been changed into the non-dimensional form and worked out using a finite difference scheme numerical approach executed in the C++ programming language. The numerical results obtained are presented using profiles. It has been observed that increasing the changeable viscosity parameter increases velocity while it decreases fluid temperature. The fluid temperature is enhanced as the viscous dissipation factor is increased. It is expected that the current analysis will enhance the understanding of heat behaviour of boundary layer problems using nanofluid as heat transfer working fluid under the influence of nanoparticles as applied in different engineering isothermal processes such as boiling and condensation.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Investigation of electrical conductivity of polymer composite using artificial neural network (ANN)

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NANO2021/P027

Abstract

Keywords
Polymer composite
ANN
Electrical conductivity
SEM
FTIR

Polymeric materials are of interest in scientific and technological research because they can be created to suit specific requirements for a variety of industrial applications. In this paper, the epoxy resin ($C_{21}H_{24}O_4$) matrix was mixed with nano-size particles of (Bi_2O_3) generated by the sol-gel process to make composites with 10, 15, 20, 25, and 30 wt percent of (Bi_2O_3) particles for electrical conductivity investigation. The composite samples were characterized using a scanning electron microscope (SEM) and Fourier transform infrared spectroscopy (FTIR). Furthermore, the experimental data were trained based on the Levenberg–Marquardt algorithm while tansig and Pureline transfer functions were used in the hidden and output layers respectively. The generated weights and bias values of the best-performed network were extracted for the development of the ANN-based electrical conductivity model. The results revealed that as the filler content in epoxy resin increases, so does the electrical conductivity. The output patterns of the sample as worked out by ANN are in good agreement with the experimental and literature results.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Mycosynthesis of silver, gold and silver-gold nanoparticles using *Ganoderma lucidum* extract and its antioxidant potentials

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NANO2021/P028

Keywords
Mycosynthesis
Ganoderma lucidum
AgNPs
AuNPs
Ag-AuNPs
Antioxidant activities

Abstract

Nanofabrication of nanoparticles using fungi has received lots of attention due to some unusual advantages when used as bio-factories for nanoparticles production. They produce metal nanoparticles with intracellular or extracellular enzymes acting as reducing agents. In this study, *Ganoderma lucidum* (GL) extract was used to synthesize silver nanoparticles (GL-AgNPs), gold nanoparticles (GL-AuNPs) and silver-gold bimetallic nanoparticles (GL-Ag-AuNPs) and their antioxidant potentials were evaluated. The UV–vis spectroscopy showed 424, 550 and 516 nm for GL-AgNPs, GL-AuNPs and GL-Ag–AuNPs respectively. DPPH-scavenging activities were 41.49-57.23%, 36.09-73.93% and 58.98-73.49% for GL-AgNPs, GL-AuNPs and GL-Ag-AuNPs respectively. The antioxidant activities were dose-dependent at the tested concentrations of 20-100 µg/ml with good antioxidant activities compared to standard BHA (51.46-83.57%) and ascorbic acid (53.56-88.10%). GL-Ag-AuNPs and GL-AuNPs displayed the highest nitric scavenging power of 73%, and the least value of 49% was obtained in GL-AgNPs at 100 µg/ml. GL-AuNPs showed the highest total phenolic content of 495.20 µg GAE/g, followed by GL-Ag-AuNPs (395.20 µg GAE/g) while the least value of 292.35 µg GAE/g was obtained in GL-AgNPs at concentration 100 µg/ml. A significantly higher total flavonoid content of 295.73 µg/g QE was displayed by GL-AgNPs, and GL-Ag-AuNPs gave 247.77 µg/g QE while the least value of 104.34 µg/g QE was shown by GL-AuNPs. The results obtained affirmed the efficacy of *Ganoderma lucidum* as a prospective biological material to synthesize nanoparticles that can be exploited for its antioxidant activity.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Phytochemicals, phytofabrication and biological evaluation of *Abrus precatorious* leaves and stem methanol extracts and their silver nanoparticles

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NANO2021/P029

Keywords
AgNPs
Phytosynthesis
Antibacterial activity
Anti-tubercular
Cytotoxicity
Antioxidant activity
Abrus precatorious

Abstract

Medicinal plants have proved to be rich sources of different metabolites that are therapeutically important. Nanoparticles have unique properties that have been employed as therapeutic agents in the treatment of various infections. Phytochemical, phytofabrication of silver nanoparticles (SNPs) using *Abrus precatorious* (MAP) leaves and stem methanol extracts (MAP_L and MAP_S) and their biological evaluation were investigated. The phytofabricated leaf and stem extracts silver nanoparticles (MAP_LSNPs and MAP_SSNPs) were characterized using standard methods. Antibacterial, anti-tubercular, antioxidant and cytotoxicity effects of the extracts and their SNPs were investigated. Alkaloids, flavonoids, tannins, phenols, saponins, cardiac glycoside, terpenoids were present in the extracts. MAP_L, MAP_S, MAP_LSNPs and MAP_SSNPs had the highest antagonistic activities of 24.0, 14.0, 20.0 and 24.0 mm against *Salmonella typhi, Escherichia coli* 25922, *Pseudomonas aeruginosa* 15422 and *Salmonella typhi* respectively. MAP_L and MAP_S had 30% and 63% DPPH scavenging activity and TAC, TPC and FRAP activities in a dose-dependent manner. MAP_L and MAP_S exhibited 100% anti-tubercular activities against rifampicin-resistant *M. tuberculosis* (RR-TB) 2390, 916 and 2570 and *M. tuberculosis* (RR-TB) 2390 and 916. MAP_L and MAP_S exhibited 100% anti-tubercular activities against multi-drug resistant *M. tuberculosis* (MDR-TB) 1934, 1237and 866 and *M. tuberculosis* (MDR-TB) 1934, 237 and 3152 at 20 mg/ml, respectively. MAP_L had 100% inhibitory activities against multi-drug resistant *M. tuberculosis* (MDR-TB) 1934, 1237 and 866. MAP_S had 100% inhibitory activities against MDR-TB 1934, 237 and 3152 at 20 mg/ml. MAP_L had 100% cytotoxicity effects against Hela cancer cell line. In conclusion, the plants' extracts had phytochemicals with high biotechnological values.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Sequestration of Mn (II) and Pb (II) ions from mine site wastewater using silver oxide pillared alumino-silicate

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NANO2021/P030

Keywords
Silver oxide nanoparticles
Green synthesis
Parkia biglobosa
Mining wastewater
Silver oxide pillared
Alumino-silicate
Adsorption
Mn^{2+}, Pb^{2+}
Isotherm

Abstract

Mining activity is a major source of heavy metal pollution in water resources, globally. This necessitates the removal of some heavy metal from mine site wastewater using nanomaterial such as silver oxide pillared alumino-silicate. This study synthesized silver oxide (Ag_2O) nanoparticles by green method using aqueous leaves extract of *Parkia biglobosa*. To develop pillared Ag_2O into kaolinite clay lamellar as an adsorbent by wet impregnation method and calcination at 450˚C for 2 h. The chemical composition, morphology, surface area and phase structure of the prepared nanocomposite were determined to evaluate its characteristics. The functionality of the adsorbent was tested for batch adsorptive capacity of Mn (II) and Pb (II) ions. The results of the adsorptive experiments were analyzed for their kinetics, isotherm and thermodynamics consistency. The characterization revealed that the adsorbent contains hydroxyl that is capable of binding heavy metal ions. It also showed a porous structure with a good surface area and crystallite size of 7.68 nm. The $Ag_2O/Al_2O_3/SiO_2$ nanocomposite had a removal efficiency of 78.30% Mn (II) and 68.79% Pb (II), respectively. The kinetics followed a Pseudo second order kinetics model with a highest R^2 value of 0.98 and 0.99 for Mn (II) and Pb (II) respectively. The isotherms fit well into the Langmuir model with R^2 values of 0.974 and 0.929 for Mn (II) and Pb (II). The thermodynamics revealed an endothermic reaction, feasible with less randomness. Therefore, the pillaring effect of Ag_2O on the alumino-silicate was responsible for the enhanced adsorptive capability of the ions and antimicrobial activity by the nanocomposite.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Synthesis of silver nanoparticles and antimicrobial activities of methanolic extract of *Azadirachta indica* leaf against selected pathogenic organisms

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NANO2021/P031

Keywords
Azadirachta indica
Methanolic extract
Biosynthesis
Silver nanoparticles
MIC
MBC

Abstract

Azadirachta indica is a plant commonly known as neem. It is native to the Indian subcontinent and most countries in Africa, including Nigeria. The aim of this study was the synthesis of silver nanoparticles and evaluation of antimicrobial activities of crude methanolic extract of leaves of *Azadirachta indica* against pathogenic clinical isolates of *Staphylococcus aureus, Escherichia coli* and *Candida albicans*. The characterization of synthesized AgNPs was carried out using the UV-visible spectrophotometer. Antimicrobial activities, MBC and MFC were conducted using the disc diffusion method while MIC was determined using the broth dilution method. The antimicrobial activity of the synthesized *Azadirachta indica* AgNPs was carried out using the standard agar well diffusion method. Qualitative phytochemicals analysis revealed the presence of tannins, phenols, alkaloids, phytosteroids, and terpenoids while flavonoids, steroids and saponin were absent. Antibacterial activities of the extracts using the ditch method at concentrations of 100, 50, 25, 12.5, and 6.25 mg/ml recorded no zone of inhibition for *Staphylococcus aureus* and *Escherichia coli*. The synthesized silver nanoparticles did not inhibit *Staphylococcus aureus* while it recorded zones of 5 and 14 mm against *Escherichia coli* and *Candida albicans,* respectively. Based on the results obtained from this study, it could be inferred that methanolic *A. indica* leaf extract contain phytochemicals of pharmacological significance which can be exploited as antifungal agent.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Improving the performance of polymer solar cells using silver nanoparticles-based photoactive film layer device

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NANO2021/P032

Abstract

Polymer solar cells blended with silver nanoparticles (AgNPs) are under intensive research considerations as an alternative to conventional silicon-based inorganic photovoltaic solar cells due to their easier method of processing, low cost and high flexibility. However, organic solar cell research and device development still have a long way to go to be able to compete with conventional inorganic solar cells. This paper presents green synthesized silver nanoparticles-based active film layer to improve polymer solar cells performance. The silver nanoparticles were characterized with SEM, TEM, XRD, FTIR, UV-visible. The optical and electrical properties of the active film layer embedded with the silver nanoparticles and the assembled solar cells based on the photoactive layer embedded with the silver nanoparticles were analyzed. UV-Visible spectroscopy showed intensive absorption within the visible range of wavelength for the prepared nanoparticles. SEM images revealed that the nanoparticles are spherical and granular. FTIR spectrum showed the strong and broad absorption peak at 1598 cm^{-1} and 3427 cm^{-1} revealed O-H and C-C stretching vibration. TEM images revealed that the distribution of the particles is uniform. XRD pattern revealed the face-centered cubic (FCC) structure of the nanoparticles. Heat treatment on the P3HT: PCBM/AgNPs based active film layer favoured solar radiation absorption. Electrochemical performance evaluation of the solar cell gives average current and capacitance values of 220 µA and 700 µF while the electrical characteristics give an open-circuit voltage (V_{OC}) and short-circuit photocurrent density (J_{SC}) of 0.66 V and 9.99 A with a conversion efficiency of 3.83 %. The green synthesized silver nanoparticles showed good enhancement in the development of photoactive layer of polymer solar cells performance.

Keywords
Solar cells
Green synthesis
Silver nanoparticles
Electrical characteristics

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Synthesis and antimicrobial activities of silver nanoparticles from cold aqueous extract of *Aloe vera* leaf against selected pathogenic organisms

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NANO2021/P033

Keywords
Aloe vera
Phytochemicals
Antimicrobial activity
Biosynthesis
Silver nanoparticles

Abstract

The study aimed at investigating the phytochemical compounds, anti-bacterial and anti-fungal activity of cold aqueous extract of *Aloe vera* together with its synthesized silver nanoparticles. The phytochemical compounds; phenols, tannins, alkaloids, flavonoids, phytosteroids, steroid, saponins and terpenoids were screened by standard qualitative methods. Phenols, tannins, phytosteroid, saponins, and alkaloids were present but steroid, flavonoid and terpenoids were absent. Antimicrobial assay (antibacterial, antifungal, MBC and MFC) was carried out using the disc diffusion method while MIC was determined using the broth dilution method. Test organisms were MDR *Escherichia coli*, *Staphylococcus aureus* and *Candida albicans*. Silver nanoparticles (AgNPs) were successfully synthesized using *Aloe vera* leaf extract and the formation and stability of the reduced silver nanoparticles in the colloidal solution were monitored using UV-vis spectroscopy. The synthesized silver nanoparticles in agar well diffusion test inhibited *Escherichia coli* (16 mm) and *Candida albicans* (12 mm) but had no effect on *Staphylococcus aureus*. Antimicrobial effect of cold extract showed *Staphylococcus aureus* was inhibited at 100, 50 and 25 mg/ml, while the other two organisms were resistant. The synthesized AgNPs showed excellent antibacterial property compared to the $AgNO_3$ solution. With further analysis, it could be concluded that *Aloe vera* extract can be used effectively in the production of antimicrobial AgNPs for commercial applications.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Synthesis of silver nanoparticles and antimicrobial activities of aqueous extract of *Azadirachta indica* against *Escherichia coli, Staphylococcus aureus* and *Candida albicans*

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NANO2021/P034

Keywords
Azadirachta indica
Aqueous extract
Silver nanoparticles
E. coli
S. aureus
C. albicans

Abstract

Due to the growing threat to the emergence of antibiotics resistant pathogens, a novel source of efficacious therapy needs to be developed. Medicinal plants with known abilities of therapeutic potential have recently been annexed to combat microbial-related ailments. The qualitative phytochemical components of aqueous extracts of *A. indica* leaf indicated the presence of tannins, phenols, flavonoids, steroids, and terpenoids, while alkaloids, phytosteroid and saponins were absent. Antimicrobial assay (antibacterial, antifungal, MBC and MFC) of aqueous extract against multidrug-resistant *Escherichia coli, Staphylococcus aureus* and *Candida albicans* at concentrations of 100, 50, 25, 12.5 and 6.25 mg/ml using disc diffusion method were carried out and MIC using broth dilution method were assessed. Assessment of the minimum inhibitory concentration (MIC) presented with no reaction for *Escherichia coli* and *Staphylococcus aureus,* while *Candida albicans* was inhibited at 25.0 mg/ml. The minimum bactericidal concentration (MBC) of the extracts revealed no activity on *Escherichia coli* and *Staphylococcus aureus,* while the minimum fungicidal concentration of *Candida albicans* was 25.0 mg/ml. Silver nanoparticles (AgNPs) were successfully synthesized using *A. indica* leaf extract. Synthesized nanoparticles were characterized using UV-vis spectroscopy. Synthesized AgNPs had antibacterial activities of 8 mm and 7 mm for *Escherichia coli* and *Staphylococcus aureus* respectively. The result from this study revealed the role of AgNPs in increasing the antimicrobial properties of *Azadirachta indica* leaf extracts. This is recorded in the inhibitory activities of the synthesized AgNPs against pathogens.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Corrosion inhibition performance of gloss paint incorporated with silver nanoparticles on carbon steel and aluminium substrates in 2.0 M H_2SO_4 solution

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NANO2021/P035

Keywords
AgNPs
Mild steel
Gravimetric
Potentiodynamic
Polarization
Corrosion control

Abstract

Corrosion control of metals in aggressive environments has attracted a lot of attention due to the huge economic losses associated with corrosion. This study examined the inhibition effects of silver nanoparticles (AgNPs) incorporated in gloss paint on corrosion of carbon steel and aluminium in 2.0 M H_2SO_4 solution. The AgNPs were biosynthesized via green chemistry and characterized using Fourier Transform Infrared, UV-Vis spectrometer, and Transmission Electron Microscope. Samples of carbon steel and aluminium were uniformly coated with a mixture of gloss paint containing AgNPs solution at five different concentrations of 0, 5, 10, 15, and 20 µg/ml. The corrosion efficiency of the paint-AgNPs was conducted via gravimetric, gasometric, and potentiodynamic polarization analyses. Results of the gravimetric analysis revealed an increased weight loss with increased period of exposure and decreased concentration of AgNPs in the paint. The corrosion rates for the mild steel and aluminum samples were 0.051 and 0.005 mmpy with inhibition efficiencies of 42% and 69%, respectively, when immersed in 20 µg/ml AgNPs-incorporated coating and exposed for 120 h. Potentiodynamic polarization analysis revealed that the presence of AgNPs in the paint (as inhibitor) retarded the anodic dissolution by the formation of protective films on the mild steel and aluminium sample surfaces. The evolution of hydrogen gas from 20 µg/ml AgNPs-incorporated coating was significantly reduced by 81% and 14% for mild steel and aluminium, respectively when compared with the control samples at 200 min of exposure. These results revealed that incorporation of AgNPs into the gloss paint matrix to minimize the degradation due to corrosion of the mild steel and aluminium samples.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Development of carbon nanotube based charge transport layer for organic solar cells

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NANO2021/P036

Keywords

Organic photovoltaic
Carbon nanotube
Poly (3,4-ethylenedioxythiophene)
Poly(styrene sulfonate)
Solar efficiency

Abstract

Solar cells based on organic films are particularly attractive because of their ease in processing, mechanical flexibility, and potential for low-cost fabrication. Poly(3,4-ethylene dioxythiophene): poly(styrene sulfonate) (PEDOT: PSS), has been most commonly used in organic photovoltaic (OP) but recombination of photogenerated charge carriers at the interface is a major mechanism for the power loss however, micromorphology, and electrical conductive gradient of the PEDOT: PSS has a great effect on charge transport process. Therefore, this research focuses on the modification of the charge transport layer for OP using green synthesized carbon nanotube (CNT) for improved efficiency. CNT was prepared from graphite powder using extract of *Callitropsis nootkatensis* leaf. It was then analyzed using scanning electron microscope (SEM), field emission scanning electron microscopy (FESEM), Fourier transforms infrared (FTIR), X-ray diffraction (XRD), and UV-Vis spectroscopy respectively. Deposition and optimization of CNT/PEDOT: PSS charge transport layer devices were done using the spin coating technique. Four point-probe was used to measure the photocurrent of fabricated devices. SEM image of the obtained sample maintains its tubular structure properly dispersed at 500 nm and 10 nm, FESEM shows agglomeration of nanotube which is conserved in hot-pressed compacts, XRD shows the diffraction pattern which exhibits tetragonal structure and FTIR revealed the chemical bond and its functional group. The maximum absorbance of CNT/PEDOT: PSS was obtained at an optimal annealing temperature of 400 ^{o}C for 1 h, also electrical properties give a power output of 12.58 W and sheet resistance of 274 Ω/cm^{2}. This research showed that incorporating synthesized CNT into the charge transport layer could improve the overall photovoltaic performance of OSC.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Synthesis characterization and application of graphene progress and challenges: A review

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NANO2021/P037

Keywords
Graphene
Synthesis
Application
Battery

Abstract

Graphene, an allotrope of carbon is the strongest and thinnest material that consists of a single layer of carbon atoms with uniquely tuneable properties. Graphene-based materials (GBM) exhibit great potential in several applications such as sensor, photovoltaic, battery, and optoelectronics due to their unique 2D structure and outstanding intrinsic physical properties owing to their extraordinary electronic, optical, magnetic, thermal, and mechanical properties as well as large specific surface area In this review, several methods have been reported for the synthesis of graphene; chemical vapor deposition (CVD), chemical or plasma exfoliation of graphite from natural graphite, and micromechanical exfoliation of graphite, but those methods haven't proven to be commercially viable. However, several types of graphene containing powder form materials such as graphene oxide, graphene nano-platelets graphene nanoribbons, and graphene quantum dots as well as graphene enabled products such as graphene ink or graphene masterbatches. Therefore, one of the key challenges of graphene is on how to prepare large scale and high-quality graphene-based material cost-effectively, easy to re-stack which causes the decline of its physical properties and processability. This review also aimed at the progress and challenges of graphene synthesis.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Synergistic antibacterial and free radical scavenging potentials of phytosynthesized titanium dioxide nanoparticles from aqueous leaf extract of *Tetrapleura tetraptera*

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NANO2021/P038

Keywords
Antibiotics
Free-radical-scavenging
Mitochondria
Lipid peroxidation
Titanium oxide
Nanoparticles
Multidrug resistance
Tetrapleura tetraptera

Abstract

This study reports phyto-synthesis of titanium dioxide nanoparticles from aqueous leaf extract of *Tetrapleura tetraptera*. The UV-vis spectrum displayed maximum absorbance at the wavelength of 238 nm. The FTIR absorption spectrum showed peaks at 3376, 3468 and 3849 cm^{-1}, the EDX micrograph shows the formation of titanium dioxide nanoparticles, the TEM micrograph produced agglomerated and roughly spherical particles within the size range of 47.67-121.61 nm and the SAED analysis showed that the particles were crystalline as depicted by the ring patterns of diffraction. The synergistic potential of the nanoparticles was evaluated with four commercial antibiotics: Lincomycin (500 mg), Ampliclox (500 mg), Ciprofloxacin (500 mg) and Flagyl (400 mg) at concentrations of 20, 40, 60 µg/ml against five multidrug-resistant clinical isolates; *Staphylococcus aureus, Klebsiella oxytoca, Pseudomonas aeruginosa, Proteus vulgaris* and *Escherichia coli*. The results showed that the clinical isolates were more sensitive to the synergic activities of antibiotics and the synthesized nanoparticles at 20, 40 and 60 µg/ml than the antibiotic alone. The 2,2-Diphenyl-1-Picryl-Hydrazyl (DPPH) scavenging activities of the nanoparticles showed that the higher concentrations of 60 µl/ml (81.92%) and 40 µl/ml (79.41%) displayed more scavenging potentials than the lower concentration of 20 µl/ml (63.12%) and 10µl/ml (62.76%). Furthermore, the free-radical-scavenging and rat liver mitochondria lipid peroxidative inhibitory activities of the nanoparticles were observed within the concentration of 10, 20, 40, 60 µl/ml by 64.43, 84.29, 84.39 and 99.80% respectively. Conclusively, the nanoparticles can be used to augment both narrow and broad-spectrum antibiotics and the free radical scavenging properties of the nanoparticles established their potentials in combating oxidants/free radicals in or outside the living system.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Phytochemical screening, synthesis of silver nanoparticles of root extract of *Landolphia owariensis* and evaluation of their anti-trypanosomal activity

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NANO2021/P039

Keywords
Landolphia owariensis
Green synthesis
Silver nanoparticles
Anti- trypanosomal activity

Abstract

African trypanosomiasis is a disease of man and domesticated animals and if not treated it can be very fatal. Nanotechnology is a growing area in the field of science. More recently green synthesis of silver nanoparticles (SNPs) is gaining recognition and is widely used in the field of medicine due to their unique chemical and physical properties. This paper reports the phytochemical, synthesis of silver nanoparticles (AgNPs) using aqueous root extract of *Landolphia owariensis* and investigating their anti-trypanosomal potentials. The phytochemical examination of this plant extract showed that the plant contains some secondary metabolites such as alkaloids, tannins and saponins among others which act as both reducing and capping agents. Stable and spherical shape-controlled AgNPs were formed within 15-30 min of slow heating at 70 ^{o}C. The synthesized silver nanoparticles were characterized with UV-visible spectroscopy, Scanning Electron Microscopy (SEM), X-ray Diffractometer (XRD) and Fourier Transform Infrared Spectroscopy (FTIR). The UV-visible spectrum of colloidal solutions had absorbance peaks at 471.6-504.4 nm. They were found to be spherical with an average size in the range of 10-90 nm. Also, synthesized nanoparticles were tested for anti-parasitic activity on *Trypanosoma brucei brucei in vitro* which showed good activity with MIC value of 0.25 mg/ml.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Impact and fatigue properties of recycled aluminium cans reinforced with graphene nanoparticles and rice husk ash: optimization of process parameters

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NANO2021/P040

Keywords
Reinforcement
Optimization
Frequency
Aluminium cans
Particle size
Weight fraction
Graphene

Abstract

Most automotive and aerospace engine parts operate under dynamic, mechanical and thermal conditions. These parts are mostly loaded to cyclic mechanical load with a frequency of over 100 Hz, such that fatigue, impact and other means of damages are primarily important to be considered for better use. Optimization of the process parameters to achieve the desired impact and fatigue strength is inevitable in the stir casting of aluminium composites. In this study, response surface methodology was applied to optimize the stir casting process in other to evaluate the effect of process variables like particle size and weight fraction of reinforcements on impact and fatigue properties of aluminium composite. The composites of Aluminum-Graphene nanoparticle (G)-Rice Husk Ash (RHA) were produced by stir casting from recycled aluminium cans using 0.4 wt.% graphene nanoparticles and rice husk ash particulate (150, 300, 600 µm at 0.8, 1.2 and 1.6 wt.%). The blend of composites was mixed following the design of experiment in a fuel-fired crucible furnace melted to 750 ± 2 ^{o}C. The particulates were introduced into the molten bath and stirred for homogeneity at a speed of 140 rpm for 2 min. The molten bath was poured into a pre-heated permanent die cavity steel mould and allowed to cool to room temperature before knockout. The cast produced were machined by ASTM standard into an appropriate coupon for impact and fatigue tests. Data obtained were subjected to ANOVA at 5% level of significance and linear regression equations. Composite of Al/1.6 wt.%, 150 µm RHA/0.4 wt.% G produced an optimal result of 2.46 x10^{6} cycles fatigue life. The optimal impact energy of 12.21 J was obtained at Al/0.8 wt.%, 600 µm RHA/0.4 wt.% G. The regression equations generated are capable of predicting the measured properties to the acceptable level of accuracies with the least error (±5). The results obtained have shown that the wt. % and particle size of RHA with 0.4 wt. % of G has a significant effect on the fatigue and impact strength of the composites.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Application of nanotechnology in food packaging and safety: Perception, role and regulation

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NANO2021/P041

Keywords
Nano-particles
Intelligent packaging
Food preservation
Nanosensor

Abstract

Recent development in nanotechnology has proven its usefulness in all fields including the food. With the growing population of about 8 billion people around the world, production of food is inadequate where a large proportion of those living in developing countries face daily food shortages due to lack of access to foods, poverty, environmental impact, political instability among others. However, consumers are increasingly demanding minimally processed healthy foods with more natural flavour and colour, high quality and long shelf-life. The food industry is driven towards meeting consumers' demand for fresher and healthier food. Food packaging is an integral part of food preservation and concerted efforts are geared towards its constant development. The conventional food packaging materials faced certain challenges which make the emergence of nanotechnology a welcome development in food packaging through improving its quality or creating innovation into the packaging. Nanotechnology has several areas of applications in Food Science and Technology which include food microbiology, food processing, food packaging, food safety (detection of food-borne pathogens), shelf life extension of food products and functional food development. Nanotechnology-enabled food packaging includes improved packaging embedded with nanoparticles mixed with polymer chains to improve the gas barrier properties, as well as temperature, and humidity resistance of the packaging. Intelligent/smart packaging is designed for sensing biochemical or microbial changes in food. Some smart packaging containing nanosensors has been developed as a tracking device for food safety. Packaging is revolutionized due to the integration of nanocomposites, nanosensors, and biodegradable nanocomposites for improved leakage proof, gases free, and pathogen-less food packaging. Although few reports have established the potential of nanotechnology in food packaging, there is a need to undertake further toxicological and migration studies to ensure safe development of nanotechnologies in the food packaging industry. This paper reviews limitation associated with conventional food packaging materials, the potential application of nanotechnology in food packaging and safety-related issues.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Phyto-synthesized titanium dioxide nanoparticles from *Lecaniodiscus cupanioides* stem aqueous extract: the biomedical and mycelial inhibitory potentials against toxigenic molds of stored grains

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NANO2021/P042

Keywords
Antifungal
Anticoagulant
Biomedical
Nanoparticles
Thrombolytic
Titanium oxide nanoparticles
Lecaniodiscus cupanoides

Abstract

Titanium dioxide nanoparticles were phytosynthesized from *Lecaniodiscus cupanoides* stem aqueous extract and characterized using UV-vis spectroscopy, FTIR, EDX, TEM and SAED. Ultra-violet visible spectroscopy of the TiO_2 nanoparticles displayed maximum absorbance at the wavelength of 302 nm. FTIR of TiO_2 nanoparticles showed distinct strong peak at 3739, 3391, 3236, 2904, 2379, 1878, 1597, 1379 and 1221 cm^{-1}. The EDX patterns revealed the presence of titanium in the colloidal suspension and the TEM micrographs showed the biofabrication of titanium dioxide as agglomerated and rhomboid particles in the size range of 40.88-93.89 nm. The SAED showed that the particles were crystalline as depicted by the ring patterns of diffraction. The antioxidant activities of the nanoparticles against 2, 2-Diphenyl-1-Picryl-Hydrazyl (DPPH) showed that the lower concentrations of 10 µl/ml (90.96%) and 20 µl/ml (90.86%) showed more scavenging potentials than the higher concentration of 40 µl/ml (86.66%) and 60 µl/ml (81.11%). Rat liver mitochondria lipid peroxidation inhibitory activities of the nanoparticles were observed within the concentration of 10 µl/ml (79.87%), 20 µl/ml (84.58%), 40 µl/ml (85.38%) and 60µl/ml (85.57%). The synthesized TiO_2 NPs showed anticoagulant activities of 11.3, 13.7, 15.5, and 17.3% at 30, 45, 60 and 75 µg/ml, respectively. It produced thrombolytic activities of 31.1, 22.1, 7.1 and 5.9% at 30, 45, 60 and 75 µg/ml respectively. The nanoparticles gave inhibitions of 69.6, 72.9, 65.2 and 58.1% against *Aspergillus niger, Fusarium solani, Aspergillus flavus* and *Aspergillus fumigatus* respectively. Conclusively, the nanoparticles could be used as an eco-friendly antifungal agent. Furthermore, the free radical scavenging, anticoagulant and thrombolytic properties of the nanoparticles could be exploited more in the area of drug development.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Phytotoxicity and bioaccumulation of nanomaterials in plant-soil mediated systems

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NANO2021/P043

Keywords
Plant system
Nanoparticles
Phytotoxicity
Bioaccumulation
Nanofertilizers
Plant health

Abstract

Nanotechnology is quickly advancing and gaining popularity in agriculture due to its numerous benefits. However, because of the unique features of nanomaterials, their toxicity has prompted serious concerns about the environment, plant health, and human health. Nanofertilizers are particularly crucial to understand as crop plants do not only provide food security but might also serve as a potential channel for nanoparticle transport and bioaccumulation into the food chain. Increased nanoparticle concentration resulted in phytotoxic effects such as reduction in root and shoot length and biomass production, genetic material damage, and so on. The composition, shape, and size of nanomaterials, as well as the plant anatomy, all influence their inhibitory effects on plant growth. However, there isn't enough information on its effect on the anatomy of the plant and whether nanoparticles will be bioaccumulated in plants and then end up in higher-level organisms. This review highlights and discusses recent investigation reports on possible nanomaterial uptake by various plants, as well as their implications on physiological and anatomical characteristics in plant systems.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Performance optimization of Perovskite photovoltaic solar cells by sandwiching magnesium manganese oxide in the Perovskite cell

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NANO2021/P044

Keywords
Photovoltaic devices
Perovskite cells
Numerical simulation
Lead-free cells
Cu_2O
TiO_2
$Mg_2Mn_3O_8$

Abstract

The performance of photovoltaic devices based on organic-inorganic halide perovskite materials has skyrocketed, and they are rapidly approaching commercialization. Lead-free perovskites have recently gained much attention as a significant research topic compared to toxic lead-based materials. Numerical simulation was used to optimize the device performance of a methylammonium tin iodide ($MASnI_3$) based perovskite solar cell. The effect of many critical parameters on device performance, such as non-toxic hole transport layers (HTLs), doping density, the thickness of different layers, and defect density were thoroughly investigated using numerical simulation. With copper (I) oxide (Cu_2O) as the hole transport layer, and TiO_2 as the electron transport layer (ETL), and $Mg_2Mn_3O_8$ with a bandgap of 1.45eV (close to the bandgap of the based material) sandwiched between the module of FTO/TiO_2/$MASnI_3$/Cu_2O/Ag, the optimized device architecture achieved the highest power conversion efficiency of more than 27.43%. This suggests that by fine-tuning device parameters, high-performance and stable lead-free perovskite solar cells could be achieved experimentally in the future.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Synthesis and characterization of silver doped zinc oxide nanoparticles for application as photoanode in dye-sensitized solar cell

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NANO2021/P045

Keywords
Dye sensitized solar cell
Co-precipitation
Zinc oxide;
Silver
Photo-anode

Abstract

Dye Synthesized Solar Cell (DSSC) is rapidly gaining more attention as a unique non-conventional energy system. Zinc oxide (ZnO) nanoparticles are considered as one of the promising photo-anode materials for DSSC. ZnO nanoparticles possess exceptional physicochemical, optical and structural properties. However, the activities of ZnO are limited to irradiation wavelength in the ultraviolet region due to its wide bandgap. Therefore, it is pertinent to narrow the bandgap for its effective application as photo-anode in DSSC. Here, we report the silver doped ZnO (Ag/ZnO) using the co-precipitation method and its characteristics towards application as photo-anode in DSSC. Undoped and Ag/ZnO nanoparticles were prepared by co-precipitation technique and characterized. The XRD result for the un-doped and Ag/ZnO nanoparticles indicated a hexagonal wurtzite structure. Ag/ZnO at doping concentration of 0, 0.25, 0.50, 0.95 and 1% has band-gaps of 3.20, 3.21, 3.19, 3.08, and 3.13 eV respectively, as obtained from the DRS studies. The SEM micrograph revealed the spherical shape of the nanoparticles with crystallite size ranging from 25.66 to 36.97 nm. The EDX results revealed the atomic concentration of un-doped, 0.5 and 1% Ag/ZnO to be 0, 0.5, and 0.91% respectively. Raman Spectroscopy confirmed the ZnO doping process and phonon shifted due to silver doping and the presence of a series to periodically repeating peaks in the spectrum indicated a high-quality crystal structure of the obtained nanoparticles. AgNPs doped ZnO showed enhanced optical properties and a narrow energy band gap which consequently improved the photo-anode in DSSC.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Utilization of gum arabic capped magnetite nanoparticles in the removal of some divalent metal ions from wastewater

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NANO2021/P046

Abstract

Keywords
Magnetite nanoparticles
Gum arabic
Divalent metal ions
Adsorption

Gum Arabic capped magnetite nanoparticles (MNP_5) were synthesized from Fe^{2+} -and Fe^{3+} by the co-precipitation method and functionalized by coating the particles for stability in aqueous suspension. The nanoparticles synthesized were characterized using Transmission Electron Microscopy (TEM), Fourier transform infrared spectroscopy (FTIR) and powder x-ray diffraction (XRD). The nanoparticles produced were utilized as an adsorbent in the removal of some divalent metal ions (Mn^{2+}, Cu^{2+}, Zn^{2+}, Cr^{2+}, and Cd^{2+}) from rubber and cassava processing effluents. The effects of contact time and adsorbent mass dosage on the efficiency of adsorption were examined. The results of the FTIR spectrum of the co-precipitated magnetite nanoparticles confirmed the presence of magnetite with a sharp peak at 583 cm^{-1}. The XRD showed that the nanoparticles were crystalline. The adsorption data obtained from both effluents were subjected to various sorption isotherms and kinetic models. The pseudo-second-order reaction model had the best fit for the adsorption process. This study showed that magnetite nanoparticles have great potential in the treatment of wastewater laden with the studied heavy metal ions.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Purifying capabilities of titanium oxide (TiO_2) nanoparticle in wastewater treatment

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NANO2021/B047

Keywords
Wastewater
Nanoparticles
Titanium oxide
Treatment

Abstract

The United Nations projected that by 2025; there will be a need to obtain potable water from wastewater, due to the ever-increasing generation of wastewater. Therefore, there is a continual need to treat wastewater before it is discharged to the environment. Nanoparticles have been applied in many sectors including medical and industrial sectors among others. This study was carried out to investigate the purifying capabilities of Titanium oxide in the treatment of domestic and industrial wastewater, sourced from Oyo township. Titanium oxide (TiO_2) was tested against wastewater (1g/100ml) for a duration of 3 and 6 h. Bacteriological analysis and physicochemical parameters of the wastewater were determined before and after the addition of nanoparticles to ascertain the purifying capabilities of the nanoparticles, using standard methods. Results showed that there was 82.0% reduction in bacterial enumeration, 78% reduction in total coliform count, 26.2% reduction in BOD_5 levels, 9.15% reduction rate in electrical conductivity values, 2.3% reduction in pH rates, 90.0% reduction of total suspended solids, 83.3% of total dissolved solids, 99.4% of total solids and 32.1%, 24.1%, 70.2% and 70.2% for lead, cadmium, nickel and chromium respectively. Titanium oxide showed impressive positive effects as the values of tested water quality indices. It was also observed that longer exposure of wastewater to nanoparticles guarantees greater effectiveness. The study recommended that private and governmental wastewater treatment facilities in Nigeria, employ the use of nanoparticles in treating waste water.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Synthesis, characterization and application of a composite adsorbent in remediation of bitumen-polluted water

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NANO2021/P048

Keywords
Bitumen-polluted water
Copper anoparticles
Nanocomposite
Echinochloa pyramidalis

Abstract

This study reports the remediation of bitumen-polluted water (BPW) using a composite adsorbent prepared from synthesized copper nanoparticles (CuNPs) and activated carbon of *Helix pomatia* (HP). The leaf extract of *Echinochloa pyramidalis* (antelope grass) was used to synthesize CuNPs. The synthesized CuNPs was characterized using UV-visible spectroscopy, transmission electron microscopy (TEM), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX) and Fourier transform infrared (FTIR). The synthesized CuNPs was impregnated on activated carbon of *Helix pomatia* to produce a composite adsorbent. The prepared composite adsorbent was applied to remediate BPW collected from Agbabu River, in Ondo State, Nigeria using the column adsorption technique. The UV-visible spectrum of CuNPs shows maximum absorbance at 620 nm, while FTIR spectrum showed peaks at 969, 1517 and 2070cm^{-1} which indicate the C-H bend in alkene, C-O stretching in carboxylic acid and C-C band in alkyne respectively. Cu was prominent (82.45%) in the EDX spectrum and SEM analysis depicted spherical particles of about 124 nm. The nanocomposite remediated the bitumen-polluted water with pH, COD, turbidity, conductivity, TPH, oil and grease and BOD of 7.2, 11.05 mg/l, 3.12 NTU, 120.5 µscm^{-1} , 0.25 mg/l, 0.10 mg/l and 8.0 mg/l, respectively. The results of this study show that the composite adsorbent improved the quality characteristics of bitumen polluted water.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Anti-diabetic plant products and their nanoparticle-based delivery

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NANO2021/B049

Keywords
Nanotechnology
Diabetes mellitus
Nanotherapy
Green synthesis

Abstract

Diabetes mellitus is a complex metabolic disorder of carbohydrate, protein and fat caused by relative insufficiency of insulin or its inaction. The prevalence of the disease is increasingly growing and very alarming with 463 million people known to be living with the disease in the year 2019. The number of people living with the disease is estimated to increase by 25% by the year 2030. The drugs presently in use to manage the disease have adverse effects and this necessitates fortifying therapeutics used in combatting this metabolic disorder. In this regard, various approaches have been explored in the management of diabetes and a lot of research attention has been drawn to nanotherapy. Nanoparticles are readily used due to their stability and effectiveness in delivering natural products. The lethal potency of non-green nanoparticles in biological systems has limited its advancement thereby projecting the importance of green nanoparticles. Green nanoparticles are eco-friendly, cost-effective, readily available, and biocompatible of which plants are major sources. This review explores plant-based nanoparticles with anti-diabetic abilities, their mechanisms in ameliorating diabetes in different experimental models. This information will give a general overview of the recent advances in Phyto-nanotherapy, the knowledge gap and the future perspectives of nanotechnology in the management of diabetes.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Antioxidant, anti-inflammatory and lipid peroxidation inhibition of photosynthesized silver, gold and silver-gold nanoparticles using *Peperomia pellucida* aqueous extract: A preliminary study

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NANO2021/B050

Keywords
Green synthesis
Peperomia pellucida
Nanoparticles
Antioxidant
Anti-inflammatory
Lipid peroxidation

Abstract

Green bio-fabricated nanoparticles have received profound attention due to their simplicity in synthesis and potential biomedical applications. The potential biomedical application of photosynthesized silver, gold and silver-gold nanoparticles using *Peperomia pellucida* aqueous plant extract was investigated. The synthesis of the nanoparticles followed standard procedure after which they were characterized using UV-visible spectrophotometer. Antioxidant activity, anti-inflammatory and lipid peroxidation were evaluated using DPPH, inhibition of protein denaturation and Fe^{2+}-induced lipid peroxidation in liver homogenate respectively. The silver nanoparticles were absorbed maximally at 424 nm, gold at 560 nm and silver-gold at 546 nm. The silver nanoparticles elicited significant anti-oxidant activity, inhibition of protein denaturation and lipid peroxidation when compared with others. This study implies that silver nanoparticles have better potential as an agent for anti-oxidant and anti-inflammation. Further study is however required to explore more potential applications for the synthesized nanoparticles.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Filtration and microbial removal studies of Cu nanoparticles-treated blended clays candle-like filter for water purification

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NANO2021/P051

Keywords
Nanoparticles
Clays
Candle filter
Filtration rate
Coliform Bacteria

Abstract

In this paper, filtration rate and microbial removal efficiency of blended clay point-of-use porous ceramic candle-like filters, treated with copper nanoparticles, have been reported. Red potter's clay and white kaolin samples were obtained, pulverized and wet-sieved to obtain the finest particle sizes. Sawdust from hardwoods only was collected and carefully sieved to 500 µm. Different ceramic candle-like filters were fabricated from the blends of red potter's clay, kaolin and sawdust. The ratio of the clay to sawdust was 55:45, 50:50 and 45:55 percent by volume while the ratio of red potter's clay to kaolin in the mixture was 1:1, 1:2 and 2:1. Atterberg's Plasticity Index (API) and the flexural strength of each clay: sawdust mixtures were determined. The fabricated filters were eventually soaked in synthesized colloidal copper nanoparticles for 24 hours. Filtration study was carried out for 1 hour after which the filtrate was processed. The result showed that the plasticity and flexural strength increased with decreasing amount of kaolin clay and sawdust in each clay–sawdust mixture. However, the filtration rate increased with increasing volume fraction of kaolin clay and sawdust in each clay-sawdust mixture. Microbial removal studies showed 100 % Coliform bacteria removal efficiency for all the fabricated filters utilized for filtration but not effective against total heterotrophic bacteria (THB) and Fungi except in a few filters. It can be concluded that water purification with the blended clays-sawdust-Cu nanoparticle is very efficient and the newly fabricated filters are usable by rural dwellers.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Interfacial polymerisation and optical characterisation of copper-doped ZnO- and NiO-polyaniline nanocomposites

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NANO2021/P052

Keywords
Conducting polymers
Nanoparticles
Interfacial polymerisation
Nanocomposites
Optoelectronic devices

Abstract

Cu-doped ZnO- and NiO-polyaniline nanocomposites have been synthesized by in-situ oxidative interfacial polymerization of aniline in the presence of the doped metal oxides nanoparticles. The nanoparticles and five and fifteen percent (5% and 15%) Cu-doped nickel and zinc oxides, ranging from 10 – 40%, were synthesized and were incorporated into the polyaniline (PANI) matrix. The Fourier transform infrared (FTIR) spectra revealed the characteristic peaks of PANI and the incorporation of the doped nanoparticles. The optical absorbance spectra and the accompanied optical bandgap values of PANI and the nanocomposites were obtained from the UV-Vis absorption spectra data. The spectra showed that PANI and its nanocomposites were absorbing in the visible region (between 350−500 nm) and from the visible to near-infrared (NIR) region (between 700 nm and above). The bandgaps of all the nanocomposites are still within the range of the photon energies of the visible light (3.1 eV−1.8 eV), corresponding to the wavelength of 400 nm-700 nm which determines the electroluminescence (EL) colour in LED application and sunlight absorption in solar cell application. The electrical conductivity and sheet resistance of selected samples were obtained by the four-point probe method. The observed increased electrical conductivities of the nanocomposites might be as a result of enhanced inter-chain mobility of the charge carriers and the formation of an enhanced network of charge transfer due to the presence of the nanoparticles. Conducting nanocomposites synthesized with doped compound nanoparticles are nanomaterials that could serve as active materials for optoelectronic and photovoltaic devices fabrication.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Preliminary biomedical assessment of silver, gold and gold-silver nanoparticles synthesized using *Euphorbia lateriflora* extract

Badmus, J.A[1*]., Adeyemo, R.O[1]., Egbeyode, T.A[1]., Olanrele, H[1]., Olagbaju, V.O[1]., Hassan, B.O[1]., Afolabi, A.A[1]., Yekeen, T.A[2]., Lateef, A[2]., and Adebayo, E.A[2]

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NANO2021/B053

Keywords
Euphorbia lateriflora
Natural products
Nanoparticles
Lipid peroxidation
Anti-inflammation

Abstract

Bio-fabricated nanoparticles using natural products are currently enjoying attention because of their inherent potential as agents against oxidative-related degeneration. This study reports the green synthesis of silver, gold and gold-silver nanoparticles using *Euphorbia lateriflora* aqueous plant extract. The silver nanoparticle was synthesized under normal conditions by reacting 1 mm of silver nitrate ($AgNO_3$) solution with the aqueous plant extract in the ratio of 25:1. The gold-silver nanoparticles (1 mM; 1:3) were synthesized by reacting the aqueous plant extract in the ratio 20:1. The characterization was carried out by a UV-visible spectrophotometer. DPPH scavenging activity, Fe^{2+}-induced lipid peroxidation in liver homogenate, protein denaturation and proteinase inhibitions were evaluated. The results showed that silver nanoparticles produced significant antioxidant activity and protein denaturation inhibition when compared with gold and gold-silver nanoparticles. Contrarily, gold nanoparticles presented significant inhibition of Fe^{2+}-Induced lipid peroxidation when compared with other nanoparticles. There was no significant difference in the inhibitory activity of silver, gold and gold-silver nanoparticles against proteinase. The study shows that the entire nanoparticles have potential as agents for antioxidants and anti-inflammatory. The silver nanoparticle, however, showed outstanding activities and provide a basis for further study on characterization and biomedical applications.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Effects of crude extracts and *Petiveria alliacea*-mediated silver nanoparticles on insect infestations and nutritional values of okra (*Abelmoschus esculentus* L.)

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NANO2021/B054

Keywords
Petiveria alliacea
Nanoinsecticides
Podagrica species
Abelmoschus esculentus
Proximate contents
Mineral contents

Abstract

This experiment was conducted to evaluate the efficacy of crude extract of *Petiveria alliacea* and *P. alliacea*-synthesized silver nanoparticles against field insect pests of okra and their effects on the proximate and mineral contents of the okra fruits. Silver nitrate was used as a precursor in the synthesis of AgNPs by employing cold leaf and root extracts of *P. alliacea*. Cypermethrin and untreated plots were included in the experiment for comparison. The results showed that the crude extracts and AgNPs exhibited insecticidal effects against the observed insects. None of the crude extracts of *P. alliacea* and nanoinsecticide had the potency of Cypermethrin in the control of *Podagrica* species. Nanoinsecticide mediated by *P. alliacea* root significantly improved the proximate contents of the harvested okra fruits (17%) followed by crude and leaf-nanoinsecticide (16.9%). The least proximate and mineral contents were observed from the harvested okra fruits treated with Cypermethrin and untreated plants. Therefore, the crude extracts of *P. alliacea* and their nanoformulations can be used in the control of field insect pests of okra without negative effects on the nutritional contents.

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Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Evaluation of toxicological effects of chicken feather-mediated silver nanoparticles using *Clarias gariepinus*

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NANO2021/B055

Keywords
Feather-mediated AgNPs
Clarias gariepinus
Toxicity
Histology

Abstract

This study investigated the potential toxicity of chicken feather-mediated silver nanoparticles (CF-AgNPs) on *Clarias gariepinus*. *C. gariepinus* juvenile (325) were procured from a fish farm and acclimatized. Behavioural responses and lethal concentrations of CF-AgNPs on exposed fish were evaluated using 800, 850, 950, 1000 and 1050 µg/ml in three replicates. Chronic toxicity of the CF-AgNPs was evaluated using 40L of 5, 10, 50 and 100 µg/ml with 15 fish exposed per concentration, renewed at every 48-hour for 42 days. Haematological, histopathological, biochemical (total protein, lipid peroxidation, glutathione, glutathione peroxidation, and superoxide dismutase activities) parameters, as well as selected organs (liver, gills, kidney and muscle), were evaluated on five *C. gariepinus* per concentration. Data were analyzed using one-way analysis of variance and Duncan multiple range test ($P \leq 0.05$). CF-AgNPs had Plasmon resonance at 416 nm. FTIR showed that biomolecule present served as capping and stabilizing agents while TEM revealed a size range of 7-27.45 nm. Behavioural changes of *C. gariepinus* observed were erratic swimming, air gasping and loss of reflex which increased as concentration increases. The 96 h LC_{50} of 858.576 µg/ml was recorded. Weight gain and reduction in the PCV, RBC and Hb were observed for exposed fish compared to the control. Lesion observed in liver, gills, kidney and muscle were severe in 100 µg/ml of treated fish. CF-AgNPs caused noticeable fluctuations in the biochemical activities of the selected organs of *C. gariepinus* compared to control except in gills. The results showed that CF-AgNPs caused behavioural changes and had acute and chronic toxic effects on the exposed *C. gariepinus*.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Field evaluation of crude extracts and nanoparticles synthesized by *Petiveria alliacea* against insect pests of leafy vegetable (*Amaranthus caudatus*) and their effects on nutritional contents of *Amaranthus* leaves

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NANO2021/B056

Keywords
Petiveria alliacea
Nanoinsecticides
Pyrgomorpha vigirandi
Phyllotreta spp
Amaranthus caudatus
Proximate contents
Mineral contents

Abstract

This experiment was conducted to compare the efficacy of crude *Petiveria alliacea* extracts and silver nanoparticles synthesized using *P. alliacea* against field insect pests of *Amaranthus caudatus* and their effects on the proximate and mineral contents of the harvested *Amaranthus* leaf. Silver nitrate was used in the biosynthesis of *P. alliacea* leaf and root extracts-mediated silver nanoparticles. Two synthetic insecticides (Dirchlovour and Cypermethrin) and untreated plots were included in the experiment. The result shows that crude extracts of *P. alliacea* and their nanoformulations exhibited insecticidal action against the two observed insects (*Pyrgomorpha vigirandi* and *Phyllotreta* spp) and the insecticidal efficacy was compared with Dirchlovour. Both nanoinsecticide and crude extracts of *P. alliacea* significantly improved proximate and mineral contents of the harvested *Amaranthus* leaves when compared with the two synthetic insecticides and untreated *Amaranthus* plants. Therefore, the use of nanoinsecticide and crude extracts of *P. alliacea* in the management of leafy vegetables can be incorporated into the management practice of *A. caudatus,* especially in the organic farming system.

Nano Plus: Sci. Technol. Nanomat. 3 (2021) 1-85
https://doi.org/10.48187/stnanomat.2021.3.001

Nano Plus: Science and Technology of Nanomaterials
Journal home page: https://www.stnanojournal.org/
ISSN: 2782-8166 (print) 2782-8174 (electronic)

Preliminary effects of silver nanoparticles bio-fabricated using aqueous extract of *Citrus sinensis* peel on acetic acid-induced ulcerative colitis in male Wistar rats

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NANO2021/B057

Keywords
Silver nanoparticle,
Citrus sinensis peel
Ulcerative colitis
Inflammatory bowel
Disease
Macroscopic score

Abstract

Ulcerative colitis is a chronic and relapsing systemic inflammatory bowel disease (IBD) with multifactorial causes. This study was aimed to investigate the healing potential of aqueous peel extract of *Citrus sinensis* bio-fabricated silver nanoparticles (CsPEx-AgNPs) in acetic acid-induced ulcerative colitis in male Wistar rats. Forty-two male Wistar rats weighing 200±20 g were randomly assigned into six groups; Group 1 (Control group), Group 2(Colitis group), Group 3(Colitis + CsPEx (*Citrus sinensis* peel extract, 250 µg/kg), Group 4 (Colitis + $AgNO_3$, 250 µg/kg), Group 5(Colitis + CsPEx-AgNPs, 25 µg/Kg) and Group 6(Colitis + CsPEx-AgNPs, 250 µg/kg). Colitis was induced in groups 2-6 with a single intra-rectal administration of 6% acetic acid (1ml/100g body weight). Rats were monitored for ulcerative colitis index after 24 h of induction, followed by oral administration of regimens in groups 3-6 for 7 days. On the eighth day post colitis induction, change in the weight of the animals, diarrhea score and colonic weight, thickness, and macroscopic score (index of tissue damage) were studied. There was no significant difference ($P>0.05$) in animals' weight change, diarrhea score, and colon weight across the groups. Significant increases ($P<0.001$) in thickness and macroscopic scores of animals in Groups 2, 3, and 4 when compared with Group 1 indicate sustained colitis. The silver nanoparticles at both concentrations ameliorated the induced colitis as shown by a significant reduction of colon thickness and microscopic scores when compared with the Colitis group. The results of this study revealed that CsPEx-AgNPs significantly healed the induced-ulcerative colitis compared with the other treatments.