

Kwame Nkrumah University of Science and Technology, Kumasi **KEEP** bulletin

A College of Engineering Newsletter.

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WELCOME ADDRESS

elcome to the seventh edition of the KEEP Bulletin.

This edition highlights the KNUST Engineering Education Project (KEEP) Postgraduate building milestone. The KEEP postgraduate building is currently 100% complete and operational. The contractors have formally handed it over, and this milestone falls into DLI 4 (Quality of Education).

KEEP seeks to deliver highquality postgraduate courses, conduct, and disseminate applied research focused on addressing development challenges related to industrialisation, digital development (ICT), energy systems, renewable energy, manufacturing, and the exploration and development of the oil and gas industry. The Government of Ghana funds the project as part of the World Bank's Africa Centres of Excellence for Development Impact (ACE Impact) Project hosted by the College of Engineering, KNUST.

I am also delighted to announce the launch of the KNUST College of Engineering Endowment Fund. The Fund aims at enhancing the quality of engineering education in Ghana. It will provide reliable and stable funding to improve the quality of postgraduate engineering education and research. It will also support entrepreneurship and innovation to create new businesses from engineering research and development. (Find details here <u>https://kceef.knust.</u> edu.gh/) I want to use this medium to appreciate Alumni and Institutions contributing to the Endowment Fund. These include Ing Christian Nti, CEO of Ghana Highway Authority, Prof. Elijah Kannatey-Asibu, Volta River Authority, ASIB Construction, Associated Consultants Limited, College of Engineering, KNUST, Ghana Institution of

Engineering, Ghana Grid Company, Ghana Highway Authority, Electricity Company of Ghana, Ghana National Gas Company, National Petroleum Authority, Ghana Highway Authority, Civil Engineering Class of 1996, Electrical Engineering Class of 2002, Civil Engineering Class of 1994, RPS Engineering, Ing. William Amuna, Ing. Harold Esseku, BrainBirds Academy, Mercury Heights, and Ing. Kwabena Bempong,

Contributions are welcome and should be directed to the following bank details:

Account Name: KNUST COLLEGE OF ENGINEERING ENDOWMENT FUND

Account Numbers: 904 000 824 8502 (Cedis Account) OR 904 000 952 7588 (US Dollar) Bank Name: STANBIC BANK Swift Code: SBICGHAC Bank Address: P. O. Box CT 2344 Cantonments, Accra Branch: KNUST



Prof. Jerry John Kponyo) (Project Lead, KEEP)

Donations to the Fund can also be made via this link: <u>https://kceef.</u> knust.edu.gh/

KEEP sincerely appreciates all alumni who have filled out the Alumni Google Form. If you are yet to do so, please follow the link (https://forms.gle/xnPsNCJXDC-28s7kU8) to complete information on your basic biodata; this should not take more than 2 minutes of your time.

We welcome contributions and suggestions from stakeholders and readers to help improve future editions. Please send all such requests and inquiries to keep@ knust.edu.gh

Cheers!

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Prof. Kwabena Biritwum Nyarko, Immediate Past KEEP Project Lead, appointed 4th Provost of the College of Engineering



Prof. Kwabena Biritwum Nyarko is an alumnus of KNUST, graduating with a Bachelor of Science in Civil Engineering. He holds an MSc in Sanitary Engineering from the UNESCO-IHE Delft Institute for Water Education in the Netherlands and a PhD from the UNESCO- IHE Delft Institute for Water Education and the Institute of Social Studies in The Hague, Netherlands.

His areas of expertise are engineering economics, costing and pricing of water, sanitation, hygiene service delivery, and water supply for urban communities. His research interest covers hydraulic and water quality modelling of water distribution systems, sanitation technologies, and sustainable water and sanitation service delivery. He is a member of the Ghana Institution of Engineers (GHIE) and the immediate past Vice Dean of the Faculty of Civil and Geo-Engineering. He is also the immediate past Project Lead for the KNUST Engineering Education Project (KEEP). Currently, he serves as the Principal Investigator for the Rural Evidence and Learning for Water (REAL-Water) programme.

As the newly appointed Provost of the College of Engineering, KNUST, his vision is to make the College the preferred choice for quality engineering education and impactful research. He seeks to provide strategic leadership by mobilising all significant stakeholders - Faculty, Administrators, students, alumni, and Partners - to achieve this vision for the College.

His tenure of office will focus on eight (8) key themes:

- Enhancing students' experiences by delivering quality programmes with improved soft skills to help solve real-world problems.
- Making research impactful by increasing the number and quality of socially relevant research.
- Strengthening industry and community engagements to bridge the gap between industry and academia.
- Providing quality human resources by attracting, retaining, and continuously building staff capacity.
- Increasing the financial resource mobilisation capacity of the College through the CoE Endowment Fund, endowed chairs, and research grants.
- Increasing international engagement to enhance competitiveness and visibility.
- Developing state-of-the-art infrastructure through the provision of modern education and research infrastructure and continuing all ongoing projects (GETFUND and ACE buildings)
- Improving governance and introducing a digitalised administrative system.

To make this vision a reality, he appeals for the cooperation and support of all stakeholders (Faculty, Administrators, Project Staff, Students, Alumni, and Partners).

Production Team

Editor-in-chief: Prof. Kwabena B. Nyarko Managing Editor: Kwadwo Nyantakyi Marfo Content Editor: Irene Otuba Nunoo Production Editor: Francis K. N. Nunoo

ACE-Impact Projects Expert Advocates for Entrepreneurship and Innovation



The Vice-Chancellor, Prof. (Mrs.) Rita Akosua Dickson (4th from left), the Pro Vice-Chancellor, Prof. Ellis Owusu-Dabo (6th from right), and other KNUST management team with Dr. Chux Daniels (3rd from left), Mr. Jonas Adjei (2nd from left) and the KEEP team.

Dr. Chux Daniels, the Expert for the Colleges of Engineering (under the Africa Centres of Excellence Impact Project), has emphasised that innovation is the future of engineering and encouraged the KEEP team to keep working hard to maintain its status as one of the best ACE Centres in achieving the Disbursement Linked Indicators (DLI) required.

He stressed that innovation should be part of science and technology as the focus of the University. In addition, he said that engaging the industry in teaching and learning activities will aid innovation and commercialisation and bridge the gap between academia and industry.

Dr. Chux Daniels, the Expert for the Colleges of Engineering under the Africa Centres of Excellence Impact Project, and Mr. Jonas Adjei, the Finance Officer at the Association of African Universities (AAU), visited the KNUST College of Engineering (CoE) from November 21 to 22 2022, to witness the current implementation status of KEEP. They had discussions and engaged with students, staff, Management, and the Advisory Board Chairpersons of KEEP.

The experts paid a courtesy call on the Vice-Chancellor of KNUST, Prof. Mrs. Rita Akosua Dickson.

In her interaction with the experts, Prof. Dickson established the need for partnerships and for KNUST to play an instrumental role as one of the subregion's leading science and technology universities.

She stated that entrepreneurship and innovation are at the heart of KNUST and that the University fulfils this passion through its Innovation Hub, which facilitates entrepreneurship and innovation.

The Provost of the College of Engineering, KNUST, Prof. Kwabena Biritwum Nyarko, thanked the University Management for their support in making the KNUST Engineering Education Project (KEEP) one of the leading Centres among the 53 African Centres of Excellence.

Dr. Chux Daniels thanked the Vice-Chancellor for her warm reception and congratulated her on being appointed the first female Vice-Chancellor of the university. He also seized the opportunity to applaud the KNUST Management team of the College for the excellent work done and their crucial role in mentoring the Gambian Technical Training Institute (GTTI) to upgrade into a full-fledged university, the University of Applied Science, Technology, and Engineering (USET). He iterated that the College's mentorship partnership is a significant impact and achievement.



The Administrative Manager of the Innovation Centre, Adams Kasuadana Sulemana, making a presentation to Dr. Chux Daniels and KEEP project team members on Innovation Centre's activities

The experts further met with the KEEP team for updates on the activities of KEEP, the West Africa Sustainable Engineering Network for Development (WASEND), the College of Engineering Innovation Centre, and the Responsible Artificial Intelligence Lab (RAIL). The team also visited the fully furnished RAIL lab in the KEEP building, the Innovation Centre, and the Dipper Lab.

Prof. Biritwum further remarked in his updates that KEEP had invested money in innovation through an Innovation Challenge and that Prof. Kwaku Adjei was leading the efforts on this challenge, and a course on innovations is also to be considered. He mentioned that just as the University of Sussex is known for its robust innovation system, the College of Engineering, KNUST, also aims to leave a footprint in KNUST regarding innovation.



A tour at the Dipper Lab, CoE, KNUST

Prof. Kponyo, the Team Lead for KEEP, mentioned that as a Centre of Excellence, the College needs to set itself apart as a place of excellence and the preferred destination for engineering education.



Dr. Chux Daniels (in suit) touring the College of Engineering Innovation Centre

Prof. Kponyo also announced on behalf of the Provost that there are plans to expand the space for the CoE Innovation Centre into an Innovation lane where students can have the requisite equipment and maker space to think and innovate.

Present at the meeting were Prof. Kwabena Biritwum Nyarko, Provost, College of Engineering, Mr. Edward Mansal, Director of USET, Prof. Jerry John Kponyo, Deputy Project Lead, Prof. Kwaku Amaning Adjei, Dean of the Faculty of Civil and Geo-Engineering and the Quality Assurance and Innovations Coordinator, KEEP, Dr. Kwadwo Mensah-Darkwa, Head of Materials Engineering Department, Dr. Eric Tutu Tchao, Digital Development Technologies Research Theme Lead, KEEP, Dr. Daniel Opoku, Marketing/Outreach Officer, KEEP, Dr. Eunice Akyereko Adjei, Monitoring and Evaluation Officer, KEEP, Mr. Kwadwo Nyantakyi Marfo, Project Manager, KEEP, Mr. Abraham Yenu Lambon, Finance Officer, KEEP, Miss Gifty Antoinette Hukpati, Communication Officer, KEEP, Mrs. Afia Kesewaa Akosah Agyenim Boateng, Alumni Relations Officer, CoE and Mr. Asante Eric, Assistant IT Officer.



Team members of KEEP with Dr. Chux Daniels and team.

KEEP Hang Out with **Dr. Chux Daniels, The Innovations Expert**



Dr. Chux Daniels

KEEP: We're glad to engage with you. Could you kindly tell us about yourself?

Dr. Chux Daniels: I am Dr. Chux Daniels, a lecturer at the University of Sussex in the UK, based at the Science Policy Research Unit (SPRU). SPRU is one of the global leaders in innovation studies and was funded by Kirk Freeman.

I started with Agriculture and entered IT and engineering at the Master's level. I studied Computer and Information Technology and Computer Engineering at the

University of Brussels, VOB free university, and then I had an MBA. After graduating, I had my Ph.D in Science and Technology studies at the University of Sussex, where I have worked since. I do a lot beyond academia. I do much work on Policy Space Innovation Policy. I also work for the World Bank; an example is what I do now on African Centers of Excellence and IDRCs in Canada (International Development Research in Cooperation with the Canadians). I have worked for CEDAR, UN the list goes on. I have done technology assessments for Rwanda as well.

KEEP: What is your specific role in the African Centres of Excellence (ACE) Impact Project?

Dr. Chux Daniels: I am an expert on the ACE Impact for the College of Engineering: KNUST. The ACE Impact project has about 53 institutions. I am the World Bank expert for the KNUST Engineering Education Project (KEEP), focusing on engineering education and excellence. I am also the Expert for the Gambia, where they are setting up a University of Applied Science, Engineering, and Technology (USET). What excites me about this university is the combination of engineering and innovation directly from scratch. Engineers can address challenges or problems as entrepreneurs and innovators when they graduate. As a result, they can create and also find work.

KEEP: What are your expectations for these two impact projects?

Dr. Chux Daniels: KEEP has achieved most of the Disbursement Linked Indicators (DLIs). USET is now emerging to become a complete Centre because it is a new, developing university. KEEP is one of the best-performing ACEs, and upon visiting the new KEEP building, there is more room for work to be done. KEEP is also supporting the USET in Gambia in becoming a full-fledged University.

KEEP: What can be done to help improve Engineering Education in Ghana?

Dr. Chux Daniels: We have to focus on excellence. Excellence is a mindset that will help us attract international lecturers who would

like to work with us and improve engineering education.

KEEP: How can we develop research into commercial products to solve engineering problems?

Dr. Chux Daniels: There is valuable research, but it takes considerable strength to identify those research with commercialisation potential. We need to have a system to filter the research which is commercialised. We can use the College of Engineering as a safe space to demonstrate how this can be done.

KEEP: I want you to speak to the young engineers. What virtues should they possess to become great engineers?

Dr. Chux Daniels: I enjoy engineering because it is impactful and practical. For example, suppose a transportation system fails. What are we going to do about it? Every engineer needs to possess the desire and passion for solving problems. There are electricity problems nationwide that will require perseverance to solve. Engineering success requires collaboration, and focus is essential.

KEEP: Any final words?

Dr. Chux Daniels: My final word is to encourage the good work I have seen in KEEP these past two days. It is awe-inspiring. I can feel much hunger with the team. They are not satisfied with their work even when it is fantastic. The engineers need more motivation and funding because these ideas are good.

KEEP: Thanks for your time.



KNUST College of Engineering Launches its **Endowment Fund**



The KNUST College of Engineering (CoE) Endowment Fund was launched on October 14, 2022, at the Alisa Hotel, Accra.

The Fund aims to empower the College of Engineering to become an internationally acknowledged Centre of Excellence in engineering education, producing high-calibre graduates with knowledge and expertise to support Ghana and Africa's industrial and socio-economic development.

The objectives are to improve the quality of postgraduate programmes, expand access to postgraduate programmes, provide scholarships to attract brilliant students, and improve infrastructure to support teaching and learning.

The target is to raise fifty million Ghana Cedis (GH 50,000,000.00) within five years.



Hon. Dr. Yaw Osei Adutwum, Minister of Education, Republic of Ghana.

The Minister of Education, Hon. Dr. Yaw Osei Adutwum, speaking at the launch, stated that the government is very pleased with the College of Engineering and will continue to assist the College. He urged the College to continue to work in producing critical minds for the development of Ghana and the world.



Ing. Emmanuel Antwi Darkwa, CEO, VRA (standing).

The Chief Executive Officer of the Volta River Authority (VRA), Ing. Emmanuel Antwi Darkwa, expressed his enthusiasm about the Fund, saying, "The establishment of the KNUST College of Engineering Endowment Fund is timely as it would support the provision of additional resources to enable the College to deliver on its mandate." He thus encouraged all persons who have benefitted directly or indirectly from the College to contribute generously to the Fund.

On behalf of the VRA, the CEO committed to donating annually to the Fund.

The Pro Vice-Chancellor, Prof. Ellis Owusu-Dabo, celebrated the College for achieving great strides and developing the idea to establish a fund. He further called on all to ensure the Endowment Fund grows to support the College, train students, and beef up its facilities. "We need the skills sharpened, not just by acquiring a degree but skills and competencies," he stated.

He promised Management's accountability and transparency to ensure that the purpose of the Fund is met.



Prof. Ellis Owusu Dabo, Pro Vice-Chancellor, KNUST.



Prof. Mark Adom-Asamoah, then Provost of the College of Engineering

In his address, the then Provost of the College of Engineering, Prof. Mark Adom-Asamoah, stated that since its establishment, the College has grown and expanded. He said the College currently runs 18 undergraduate and over 30 postgraduate programmes under three faculties: the Faculties of Electrical and Computer Engineering, Civil and Geo-Engineering, and Mechanical and Chemical Engineering.

He added that the College had made notable strides in infrastructure and innovations that have trained a skilled workforce contributing their quota to the nation's development and the world.

He mentioned that the College also hosts three World Bank Africa Centres of Excellence (ACES), namely: the KNUST Engineering Education Project (KEEP), Regional Water and Environmental Sanitation Centre, Kumasi (RWESCK), and the Transport Research and Educational Centre, Kumasi (TRECK).

"These Centres, through the provision of scholarships, have led to an increase in the number of postgraduate students as a result of the funding from the World Bank through the Government of Ghana and to ensure that the gains achieved are not eroded, the establishment of an endowment fund is imperative," he concluded.



Prof. Kwabena Biritwum Nyarko, Immediate Past Project Lead of KEEP.

Prof. Kwabena Biritwum Nyarko, the then Project Lead for KEEP, seized the opportunity to appreciate alumni and institutions who have contributed to the Endowment Fund. These include Ing Christian Nti, CEO of Ghana Highway Authority, Prof. Elijah Kannatey-Asibu, Volta River Authority, ASIB Construction Ltd, Associated Consultants Limited, College of Engineering, KNUST, Ghana Institution of Engineering, Ghana Grid Company, Ghana Highway Authority, Electricity Company of Ghana, Ghana National Gas Company, National Petroleum Authority, Ghana Highway Authority, Civil Engineering Class of 1996, Electrical Engineering Class of 2002, RPS Engineering, Civil Engineering Class of 1994, Ing. William Amuna, Ing. Harold Esseku, BrainBirds Academy, Mercury Heights, Mr. Leslie Addico and Ing. Kwabena Bempong.



Dignitaries present at the launch.

KEEP KNUST Collaborates with **University of Rwanda**



Faculty visit to the University of Rwanda

The Kwame Nkrumah University of Science and Technology (KNUST) has signed an MoU with the University of Rwanda to undertake activities in collaborative digital development and energy.

The KNUST Engineering Education Project (KEEP), an Africa Centre of Excellence at KNUST, and the African Centre of Excellence in Internet of Things (ACEIOT), together with the African Centre of Excellence in Energy for Sustainable Development (ACEESD) at the University of Rwanda will be the primary implementers of the activities captured within the MoU.

These collaborative activities include:

- Joint research activities, which involve exploring opportunities for joint research projects.
- Mobility among faculty members and students where academic exchange programmes will be organised for students and faculty members. Faculty members will use the exchange programme to teach, aid research, and offer professional training.
- Collaborative workshops, seminars, and academic meetings.

 Developing tailor-made short courses for professional development.



Faculty tour at the ACE IOT lab

The MoU will generate new knowledge and insights to address challenges faced by Ghana, Rwanda, and the subregion in providing high-quality engineering education. This will be achieved by offering state-ofthe-art postgraduate and doctoral programmes and undertaking collaborative projects that provide opportunities for long-term interactions with industry and academia.



A screenshot of participants from KEEP, KNUST and the University of Rwanda at a Zoom meeting.

SEMINAR CORNER

Precision and Reliability of GNSS Services: Space Weather a Major Limiting Factor



Prof. Wayne Scales addressing participants at the seminar.

rof Wayne Scales, A J. Byron Maupin Professor at the Virginia Technical University, has said that understanding weather space is critical to the precision and reliability of positioning, navigation, and timing services from the Global Navigation Satellite Systems (GNSS). He further mentioned that geomagnetic storms, substorms, solar flares, and ionospheric irregularities could result in GNSS deterioration. This emphasises the importance of studying Space Systems Engineering activities, including space exploration, Astrophysics and Space Systems.

Prof Scales was speaking at a seminar hosted at the College of Engineering, KNUST on Space Science, Engineering and Global Navigation Satellite Systems on July 8, 2022, as part of the College of Engineering Seminar Series at the College of Engineering, Simulation Lab. In his lecture, he explained the nature and appearance of outer space, space weather, and their interaction with communication systems such as the Global Positioning System (GPS).



A cross-section of participants at the seminar

Prof. Wayne Scales is also the founding Director of the Center for Space Science and Engineering Research (Space@VT), which runs a number of interdisciplinary programmes and curricula for undergraduate and postgraduate students. He has been actively developing the Quantum Information Science and Engineering (QISE) programme at the College of Engineering, Virginia Tech. He serves as the Associate Vice Provost for Research and Diversity, with responsibilities that challenge him to support special research initiatives and research partnerships with Historically Black Colleges and Universities (HBCUS).

He concluded with a presentation on Quantum Information Science and Engineering in the Experiential Learning Hardware Laboratory. He reiterated the importance of Space Systems Engineering and the programme's fundamentals, including space exploration, Astrophysics, and Space Systems.

Further on, Prof. Wayne Scales and his Virginia Tech team discussed with team members from KNUST Engineering departments how best the two institutions could collaborate in joint research, joint research supervision, and teaching and learning activities. The team from KNUST comprised Prof. Mark Adom-Asamoah, then Provost of the College of Engineering,

KNUST, Prof. Kwabena Biritwum Nyarko, then Project Lead for the KNUST Engineering Education Project (KEEP), and faculty members from the Engineering Departments within the College.

The discussions yielded an agreement to constitute joint technical teams, one in KNUST and the other in Virginia Tech, to supervise the collaborative activities. Also, the team from Virginia Tech agreed to share materials on their curriculum with KNUST to study which aspects could be adopted in KNUST.

The team promised to revisit KNUST before the year ends.



Prof. Mark Adom Asamoah, then Provost of College of Engineering, KNUST (seated in the middle) with the KNUST and Virginia Tech team.



A group photograph of participants of the seminar.

Group photograph of the team from Benin paying a courtesy call on the Provost, College of Engineering, KNUST.

Faculty Members from Universite D'Abomey–Calavi, Benin, pay a Working visit to KNUST

seven-member delegation of faculty from the College of Engineering, Université D'Abomey – Calavi, Benin (CoE, EIE) has paid a one-week working visit to the College of Engineering, KNUST, from August 27 to September 2 2022, to study the best academic and administrative practices at KNUST.

The team comprised the Director of Ecole Polytechnique D'Abomey – Calavi / CoE-EIE Coordinator, Prof. Alitonou Guy Alain, the CoE-EIE Deputy Coordinator, Prof. Fifatin François-Xavier, the Training Manager, Dr. Houanou K. Agapi, the Corporate Relations Officer, Prof. Oumorou Aliou A. Madjidou, the Research Officer, Prof. Tchobo Fidèle Paul, the Monitoring and Evaluation Manager, Dr. Chetangny Patrice Koffi and the Bilingual Administrative Assistant, Mrs. Kpoglo Clotilde.

They first paid a courtesy call on the then Provost of the College of Engineering, Prof. Mark Adom Asamoah, who welcomed them to Ghana and KNUST. As part of his welcome address, he noted that KNUST had been ranked by Times Higher Education World University Impact Ranking as the premier university in Africa and the 14th globally in delivering quality education.

Both parties gave brief presentations on the history and activities of their respective universities and Colleges of Engineering. Both Colleges of Engineering agreed to collaborate in research areas through the West Africa Sustainable Engineering Network for Development (WASEND) and to revive the Memorandum of Understanding (MoU) signed by both universities some years back.

To ascertain and adequately understand how KNUST functions and the role it plays in teaching and learning activities, the Benin team toured the KNUST main library, the Quality Assurance and Planning Office (QAPO), the Photocopy Unit, the International Programmes Office (IPO) and the College of Engineering Innovation Centre.



Group photograph after the meeting at the International Programmes Office (IPO).

They also toured the various laboratories in the College of Engineering, KNUST, during which they interacted with Prof. Emmanuel Frimpong, Head of the Department for Electrical and Electronics Engineering, who took the team through the structure of academic programmes in the department.

The Benin team further met with the KNUST Engineering Education Project (KEEP) management, led by Prof. Kwabena Biritwum Nyarko, where both African Centres of Excellence (ACE) gave presentations on their project and what has been achieved so far. Both teams agreed to collaborate more, especially in research supervision and publications.

The team also toured the facilities and laboratories of the Transport Research and Education Centre, Kumasi (TRECK), and the Regional Water and Environmental Sanitation Centre, Kumasi (RWESCK). They also visited the newly completed College of Engineering Postgraduate Building (KEEP building), which houses state-of-the-art workshops and laboratories for teaching and learning.

given them. They additionally reiterated the need to renew the

MoU between the universities for further research and collaborative activities.

The Provost, in turn, informed the Benin team that an institutional students' visit could be organised to make the CoE laboratories accessible to students from the Université D'Abomey. He emphasised that the MoU will go through the required legal processes for it to be signed by the Vice-Chancellor of KNUST so it can be rolled out. He thanked the team for the visit and called for a deeper relationship between KNUST and Université D'Abomey, Calavi-Benin.



Mandela Toku (in the mask), the Lab Manager at RWESCK, explained a point to the delegation.



Kwadwo Nyantakyi Marfo, the Project Manager of KEEP explaining a point to the delegation on the Digital Development Technologies Thematic Lab in the KEEP building

KEEP Hang Out with **Daniel Chika Onyinanya**, A KEEP Scholar



Daniel Chika Onyinanya

KEEP: Kindly tell us about yourself.

Daniel: My name is Daniel Chika Onyinanya. I come from Enugu State, Nigeria. I had my first degree in B.Eng Mechanical Engineering at the University of Nigeria, Nsukka, Nigeria. My interest is in Engineering, Innovation, and Science. My hobbies are football, reading, and politics.

KEEP: What brought you to Ghana?

Daniel: While I had my national service in Nigeria, I searched for scholarship opportunities to further my education outside Nigeria because I wanted a different experience in another

country. I was drawn to the Kwame Nkrumah University of Science and Technology (KNUST) in Ghana because of my interest in science and technology. I applied for my postgraduate education at the College of Engineering, where I studied MSc in Renewable Engineering Technologies. I was admitted in the last quarter of 2019 and graduated in November 2021 as part of the first cohort of the KNUST Engineering Education Project (KEEP) scholarship scheme. I am proud to be part of the pioneers of KEEP.

KEEP: Kindly tell us about your research work.

Daniel: My research topic was "Technical and Economic Potential Assessment of Rooftop Solar Photovoltaic System for Electricity Generation." I used the College of Engineering, KNUST, as my case study, assessing how rooftop solar panels could be harnessed for electricity generation. I focused on the number of solar panels needed for installation and their equivalent energy generation potential. The primary purpose of my research was to determine the technical and economic potential of utilising rooftop solar photovoltaics for electricity generation at the College of Engineering. Dr. Ato Quansah and Dr. Richard Opoku supervised my work. The outcome of the research showed that about 1460 kW of solar PV capacity is installable on the suitable rooftop area (8874.42 m²) in the College of Engineering, having an electricity generation potential of 1930.7 MWh. It was also discovered from the economic analysis that the project is a financially viable one, with a Net Present Value (NPV) of \$1,382,916.26, an Internal Rate of Return (IRR) of 16%, and a Simple Payback Period (SPP) of 5.8 years. All these findings indicate that grid power can be substituted with solar panels in the College of Engineering. Even though the cost of solar panels may be high presently, it has long-term benefits.

KEEP: What was your motivation for this research?

Daniel: In line with the plan of the government of Ghana to achieve 10% renewable energy integration by 2030 and that of the corporate strategic plan (CSP) of KNUST intended for a period spanning across 2016-2025, to stimulate the use of unconventional and clean energy sources (solar, and waste

conversion), my supervisors and I decided to work on a reliable and a cleaner energy supply for the College of Engineering. The project's vision is to start with the College and then extend it to the University. This is to make sure there is energy sufficiency and efficiency.

KEEP: What Is the Significance of your research?

Daniel: There are many benefits when it comes to solar energy. One advantage is that solar PV technology is getting cheaper with upcoming innovations and technologies. Secondly, there is a global call for cleaner energy with the shift from fossil fuel which causes a lot of pollution, greenhouse warming, and global warming, to solar energy sources. This will bring about a cleaner source of energy and a carbon credit in the long term. A carbon credit is a measure to reward countries working on taking away the emission of carbon dioxide (CO2) from the atmosphere. This can benefit Ghana financially when we fully transition from fossil fuel to green energy. Again, solar is energy from the sun, replenishing itself; it never depletes and is renewable, unlike fossil fuels with a finite life span. Renewable energy, in general, is very beneficial.

KEEP: Do you think there are enough resources for postgraduate engineering education in Ghana?

Daniel: There are opportunities for postgraduate engineering education. An example is the KNUST Engineering Education Project (KEEP) which supports brilliant but needy students with scholarship opportunities and equips postgraduate students with numerous opportunities and facilities to aid quality postgraduate education in Ghana.

KEEP: What are the next steps for you, if I may ask?

Daniel: I am currently working with the Nigerian National Petroleum Company Limited (NNPCL) and intend to further my studies with a PhD in Mechanical Engineering, specialising in gas technology or renewable energy. This will significantly benefit my home country as I contribute my knowledge and skills to the development of Nigeria.

KEEP: Any final words?

Daniel: I would like to say a massive thank you to the KEEP project, which made my postgraduate education possible. KEEP provides the best postgraduate engineering education in Ghana. I thank the **KEEP** management team for their excellent work and service. I also want to thank my supervisors, Dr. David Ato Quansah and Dr. Richard Opoku, who have been of great help to the success of my education and have impacted my life in diverse ways. A special mention to Mr. Kwadwo Nyankatyi Marfo, Project Manager, KEEP. He has been very supportive from the beginning of my postgraduate education till now. I also want to appreciate my Ghanaian and Nigerian friends who supported -God's able Aidam, Akwasi Poku, Valentine Chibueze, Ifeanyi Kizito, Anthony Ohanyere, and everyone who made my stay in KNUST a memorable one; I am very grateful.

KEEP: Thank you for your time and for sharing your experience.

Daniel: Thank you too.



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PERFORMANCE EVALUATION OF WASTE TYRE-ACTIVATED CARBON AS A HYBRID SUPERCAPACITOR ELECTRODE

By Dr. Kwadwo Mensah-Darkwa



Dr. Kwadwo Mensah-Darkwa, Department of Materials Engineering.

Introduction

aste tyres and other polymeric materials are a major global environmental problem, with Europe producing 3.3 million tons of automotive waste tyres and a stockpile of over 5.7 million tons. Most of these waste tyres find their way to Africa, especially Ghana. Research is underway to reduce this waste problem by developing advanced materials. Pyrolysis is one of the most practical, costeffective, and environmentally friendly methods of recycling polymeric waste and waste tyres into value-added materials. The process can decompose organic material through heating in the absence of oxygen at 400 °C to produce carbon-based materials like carbon black and other derivatives, which can be used to make activated carbon. Activated carbon has various uses, including as a material for energy storage in supercapacitors. Supercapacitors are electrochemical storage devices that accumulate and release energy through reversible ion adsorption and desorption at the electrode material and electrolyte interface. They can be made from activated carbon, metal oxides, or conducting polymers and offer benefits like high power density, long lifespan, and safety. Carbon-based supercapacitors, in particular, can offer high charge and discharge rates and excellent power density but have low energy density due to the low capacitance value of the electrode material.

However, adding materials like metal oxides and conducting polymers can produce positive outcomes by reducing diffusion length and increasing the conductivity of carbon-based electrode materials. Recent studies have demonstrated that using conductive polymers in supercapacitors creates remarkable cyclic stability and capacitive activity. Combining these materials (carbon-based and pseudo-material) can produce high energy density and specific capacitance for supercapacitor energy storage applications.

Background

Over the past few decades, there has been a substantial increase in waste, with plastic waste being the most predominant. To minimise this waste problem and its related environmental and health issues, disposable polymeric materials, especially car tyres, have been employed for novel materials development in several fields, contributing to sustainable development goals 3, 7, 9, 12, and 13. Due to their non-degradable nature, scrap tyres are usually burnt in the open setting. The open burning of scrap tyres tends to pollute the environment by producing toxic fumes from the complex bonds and the cross-linked structure that constitute the polymer used in manufacturing the tyres. The present-day review article suggests new waste management procedures for polymeric materials

and an advanced method for converting them into high-value supercapacitor electrode materials with substantial yields via costeffective expertise and practical strategies. Alchemy Alternative Energy is a company at Prampram in the Greater Accra region. Alchemy Alternative Energy deals in the catalytic conversion of waste or scrap tyres into lowgrade petroleum products known as residual fuel oil (RFO), pyrolytic gasses, and waste tyre-derived carbon (carbon black). Alchemy Alternative Energy's core mandate is providing cheap fuel (residual fuel oil) for industrial applications. The pyrolytic gas, derived from extracting RFO from the waste tyre, can be used for household purposes and as automobile fuel.

However, the company utilises fuel gas as a secondary fuel source for powering their machines. The waste tyre derived carbon (carbon black) has numerous applications across several fields like membranes for water filtration, supercapacitors for energy storage, printer inks, gas purification, gold purification, metal extraction, sewage treatment, filters in compressed air, filters in gas masks, paints, coatings, and many other applications. However, in Ghana, there is yet to be a market for it. Hence the waste tyre-derived carbon is being disposed of as waste. From the literature, carbonaceous materials are used as super-capacitive electrode materials for energy storage due to their chemical, physical and electrochemical properties. Therefore, there was a need to characterise the waste tyre-derived carbon's chemical, physical and electrochemical properties and thus improve its energy density and specific capacitance by incorporating it with iron oxide.

Hence the primary reason for this research is to study the prospect

of using waste tyre-derived carbon (Carbon black) produced at Alchemy Alternative Energy company doped with iron oxide for supercapacitor energy storage applications.

Research objectives

The research objectives were

- To characterise the physical and chemical properties of carbonaceous material derived from the raw waste tyre produced at Alchemy Alternative Energy company.
- 2. To fabricate electrodes using iron oxide-modified activated carbon material derived from the waste tyres.
- To characterise the electrode to assess the performance of the hybrid electrode material.

Research Outcomes

Sample acquisition from Alchemy Alternative Energy Company

The Raw Waste Tyre Derived Carbon (RWTDC) used in this study was collected from Alchemy Alternative Energy Company located at Prampram, Accra, Ghana. It was collected from the combustion chamber 24 hours after production. The sample was collected into an air-tight container due to its hygroscopic nature.

Materials preparation and electrode fabrication

The RWTDC material was washed with distilled water and activated at 900 °C for 3 hours using KOH. An iron-incorporated waste tyrederived carbon was produced by mixing the activated waste tyrederived carbon and the iron oxide in a ratio of 5:1. The electrodes were fabricated by mixing the electrode materials (raw waste tyre carbon, the activated waste tyre carbon, and the iron-incorporated waste tyre carbon) with polyvinyl alcohol (PVA) solution which is the binding agent in a weight ratio of 0.94:0.06, respectively to form a slurry followed by coating on a carbon form.

Physiochemical analysis

X-Ray fluorescence analysis, X-Ray diffraction analysis, and Fouriertransform infrared spectroscopic analysis were used for elemental composition determination, diffraction pattern, and functional group observation in the electrode materials.

Electrochemical evaluation

The fabricated electrodes used has a total mass of 5 mg and were coated unto a 1.12 g carbon foam with an area of (1×7) cm². A three-electrode setup was used; the design included a graphite rod as a counter electrode (CE), silver/silver chloride (Ag/AgCl) as a reference electrode (RE), and the prepared samples as the working electrode (WE). Electrochemical measurements were examined on a CORRTEST instrument (Wuhan, China) at room temperature using a 6M KOH aqueous electrolyte solution. The cyclic voltammetry analysis was performed using a constant voltage and scanned at a rate ranging from 5, 10, 20, 50, 70, and 100 mV/s at a voltage window of 1 to 0 V. The galvanostatic charge and discharge cycles were performed using a constant current and scanned at a current density ranging from (1-5 A/g) at a voltage window of --1 to 0 V. The electrochemical impedance spectroscopy analysis was

also performed using an initial frequency of 100,000 Hz to a final frequency of 0.01 Hz.

The galvanostatic charge and discharge cycles were used in the cyclic stability test, and the test was performed for 1000 cycles at a current density of 2 A/g.

Results of the chemical analysis

The x-ray diffraction pattern and the x-ray fluorescence analysis for the Fe₂O₃ incorporated sample (IIAWTDC) showed several peak intensities of Fe₂O₂ and an increase in the fundamental composition values of iron (Fe) of the hybrid electrode material signifying effective incorporation of the Fe₂O₂ into the activated waste tyre derived carbon. Also, the functional groups present in the materials were determined using an FTIR spectroscopy analyser. It showed C-O stretch, C=C stretching, two bends, SO, in sulfones bonds, O-H stretch, and asymmetrical stretching in O=C=O in electrode materials.

Results of the electrochemical analysis

Incorporating the Fe₂O₃ into the AWTDC electrode material resulted in a synergy effect of the electric double-layer capacitor and the pseudocapacitor, thus achieving a hybrid electrode material (IIAWTDC) with better electrochemical properties. Therefore, the specific capacitance, energy, and power density values for the cyclic voltammetry curves

and the galvanostatic charge and discharge cycles for all the samples were also measured. The results depict a significant increase in the electrode materials upon activation and doping of the electrode materials. Thus, the iron incorporation activated waste tyre-derived carbon (IIAWTDC) electrode material recorded the highest performance in all the electrochemical analyses with a capacitance value of 1400 F/g at a current density of 1 A/g. The cyclic stability test for all the electrode materials was performed to investigate the stable nature of the electrode materials. Capacitance retention of 98.63% was obtained for the hybrid electrode material (IIAWTDC) after 1000 cycles at a current density of 2 A/g.

Conclusion

The results suggest that the iron oxide doped waste tire-activated carbon electrodes can be utilised as hybrid supercapacitor electrodes in energy storage applications.

Recommendations

Future research should be carried out:

- To explore the fabrication and testing of a supercapacitor cell (coin cell, pouch cell, or cylindrical supercapacitor cell)
- On the optimisation of properties of a functional supercapacitor cell.



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