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Department	School of Engineering and the Built Environment
Supervisors	Dr Mark Dorris, Dr Dongyang Sun
Funding Status	Funded PhD Project (Worldwide)
Application Deadline	14/04/2022
Project Title	Seaweed nanocellulose-based conductive biopolymer composites for flexible and sustainable wireless communication systems

PROJECT DESCRIPTION

Flexible Hybrid Printed Electronics (FHPE) involve imprinting of electrically functional components onto a substrate to create functional, flexible electronic devices such as biosensors, environmental sensors, actuators, and radio frequency identification (RFID) smart tags. This project will focus initially on RFID tags and the design and construction of flexible antennae based on nanocellulose fibres (CNF) which have been made electrically conductive.

The project will build on in-house expertise on ion-conductive films and in seaweed-based nanocellulose applications. Nanocellulose from seaweed has desirable properties for these applications and is derived from a fully sustainable patented process with zero waste. With the continued rise of FHPE applications, economic, social and environmental sustainability will be a key concern in manufacturing and this project will directly address these concerns with ethically sourced biodegradable materials.

Antennae will be made by casting copper activated CNF into moulds and by inkjet/3D printing to assess the suitability of these methods for different applications. RFID tags incorporating chips and sensors will be designed, manufactured and tested. This work will be based in the Nanomaterials labs in the School of Engineering and the Built Environment and combines expertise from Mechanical Engineering and Design and Electrical and Electronic Engineering subject groups.

Sensors are low power devices and it can be a challenge to keep charged depending on the local environment of their use. With the advent of 5G, small antennae may be able to harvest energy directly from 5G signals to maintain charge in the device and this will be assessed as part of the project. RFID tags will incorporate chips and sensors leading to more interdisciplinary projects in this area. There is also great potential for the design and manufacture of wireless technology products themselves such as wearable tech for ID, security and access.

Academic qualifications

A first degree (at least a 2.1) ideally in Electrical/Electronic Engineering with a good fundamental knowledge of Materials Science.

English language requirement

IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. [Full details of the University's policy](#) are available online.

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<p>Essential attributes:</p> <ul style="list-style-type: none"> • Experience of fundamental electronics • Competent in chemistry • Knowledge of wireless communications • Good written and oral communication skills • Strong motivation, with evidence of independent research skills relevant to the project • Good time management <p>Desirable attributes: Knowledge or interest in sustainable materials and nanomaterials</p>	
<p>Indicative Bibliography</p>	<p>Klemm, D., Cranston, E., Fischer, D., Gama, M., Kedzior, S., Kralisch, D., Kramer, F., Kondo, T., Lindström, T., Nietzsche, S., Petzold-Welcke, K. and Rauchfuß, F., 2018. <i>Nanocellulose as a natural source for ground-breaking applications in materials science: Today's state</i>. <i>Materials Today</i>, 21(7), pp.720-748.</p> <p>Agate, S., Joyce, M., Lucia, L. and Pal, L., 2018. Cellulose and nanocellulose-based flexible-hybrid printed electronics and conductive composites – A review. <i>Carbohydrate Polymers</i>, 198, pp.249-260.</p> <p>Du, X., Zhang, Z., Liu, W. and Deng, Y., 2017. Nanocellulose-based conductive materials and their emerging applications in energy devices - A review. <i>Nano Energy</i>, 35, pp.299-320.</p>
<p>Funding notes</p>	<p>This project may be funded by a scholarship of the School of Engineering and Built and Environment. Please see School-funded PhD scholarships - RESEARCH AND INNOVATION (napier.ac.uk) for information on the scholarships and how to apply for them.”</p>
<p>Enquiries</p>	<p>For informal enquiries about this PhD project, please contact Dr Mark Dorris, m.dorris@napier.ac.uk</p>
<p>Web page</p>	<p>https://www.napier.ac.uk/research-and-innovation/research-degrees/application-process</p>

<p>School RDPL signature</p>	
<p>Date</p>	18/01/2022
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