UNIVERSITY OF LEICESTER

EPSRC-ENG5-YE

Surface functionalised nanodiamonds for antimicrobial resistance application

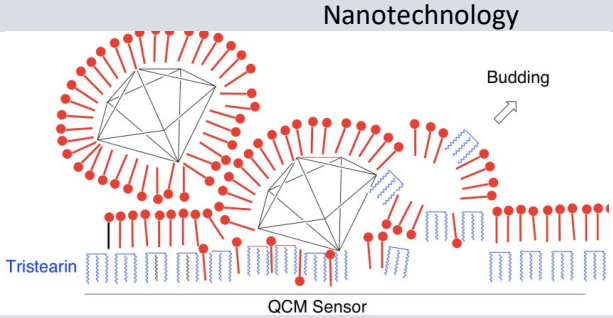
Highlights

Tackling the global challenge on antimicrobial resistance

Utilising novel form of nanomaterials - nanodiamonds

Increasing employability by developing interdisciplinary research skills

Level	PhD
First Supervisor	Prof Haitao Ye
Second Supervisor	Prof Marco Oggioni
Application Closing Date	21st January 2019
Subject Areas	Biochemistry Biomedical Engineering Materials Engineering Microbiology Nanotechnology



Surface functionalised diamond can facilitate the penetration of lipid, which could be used to deal with the penetration of bacteria's cell walls to play a key role in antimicrobial resistance

Overview

Antimicrobial resistance (AMR) has been identified as one of the main challenges facing the 21st century, and presents a spectrum of complex and multifaceted questions, ranging in scope from fundamental scientific research at the horizons of disciplines through to the behaviour of individuals and society.

The need for novel antibiotics comes from the high incidence of bacterial infection and the growing resistance of bacteria to conventional antibiotics; new methods for reducing bacterial activity and associated infections are badly needed. Nanotechnology, the use of materials with dimensions on the atomic or molecular scale, has become increasingly utilized for medical application and is of great interest as an approach to killing or reducing the activity of numerous microorganisms. Several classes of antimicrobial nanomaterials (such as Ag, Cu, ZnO, Fe3O4, Al2O3, TiO2, SiO2) and nanosized carriers for antibiotic delivery have shown some effectiveness for treating infectious diseases, including those caused by antibiotic-resistant organisms, in vitro and in animal models. In order to be practical in clinical application, these nanomaterials need to fulfil several requirements: broad availability, easy and stable surface functionalization, dispersibility in aqueous solution, non-toxicity and environmental friendliness.

Among the many promising nanomaterials, nanodiamond particles (NDs) are receiving increased attention as they comply with all of these prerequisites. NDs demonstrated an innate compatibility with biological environments and low toxicity in comparison with other nanoscale structures. The readily modifiable surface, which is easily functionalised, has enabled NDs to be conjugated to specific molecules, opening a plethora of biomedical applications that include orthopaedic engineering, synthesis of contact lenses , single cell magnetometry, toxicity studies in worms and rodents, cancer stem cell targeting, targeted breast cancer therapy and pharmaceutical delivery. Moreover, NDs can be made hydrophilic or hydrophobic, are available in large quantities, and are proven safe and biocompatible. ND possesses several other advantages over other nanoparticles and objects (like carbon nanotubes or polymer NP), such as not swelling in any solvents, being completely inert, having inherent

fluorescence, and long-term thermal (up to 450oC) and mechanical stability. Therefore this project is timely, aiming to develop a nanodiamond-based platform for antimicrobial applications.

Methodology, Critical Skills and Training and Development

- To develop the antimicrobial activities of unmodified and a range of novel surface-modified nanodiamonds (NDs) against the reference strains of Staphylococcus aureus and Escherichia coli, including drug-resistant strains. Validation will be performed on panels of clinical isolates;
- To examine the potential of NDs in potentiating or restoring the activity of traditional antibiotics against resistant isolates;
- To study the synergistic effect of NDs-antibiotics conjugates against antimicrobial resistant bacteria. The unique properties of ND in combination with traditional antibiotics will generate new paradigms in antimicrobials;
- To explore by phenotypic and genomic tools if ND exposure drives selection of ND-resistant bacteria in order to predict long term efficacy and sustainability.

The proposed research programme is very timely and will require a multidisciplinary approach between nanotechnology, materials science, chemistry and microbiology.

The multidisciplinary collaboration will allow us to build a stronger team by providing complementary research skills and knowledge to each existing strength.

Further Reading

1) H. J. Kim , Diamond Nanogel-Embedded Contact Lenses Mediate Lysozyme-Dependent Therapeutic Release, ACS Nano 8 (2014) 2998.
2) X. Wang et al, Epirubicin-Adsorbed Nanodiamonds Kill Chemoresistant Hepatic Cancer Stem Cells, ACS Nano 8 (2014) 12151.
3) G. Balasubramanian et al, Nanoscale imaging magnetometry with diamond spins under ambient conditions, Nature 455 (2008) 648.

Additional Entry Requirements

- Degree in biomaterials, biochemistry or related subject
- Experience of nanomaterials characterisation eg SEM, Raman, FTIR or QCM

Funding

This research project is one of a number of projects in the College. It is in competition for funding with one or more of these projects. Usually the project which receives the best applicant will be awarded the funding.

Home/EU Applicants

This project is eligible for a fully funded EPSRC studentship which includes :

- A full UK/EU fee waiver for 3.5 years

- An annual tax free stipend of £14,777 (2018/19)
- Research Training Support Grant (RTSG)

Studentships are available to UK/EU applicants who meet the EPSRC Residency Criteria; if you have been ordinarily resident in the UK for three years you will normally be entitled to apply for a full studentship.

If you are an EU student and do not meet the residency criteria, please contact csepgr@le.ac.uk for more information on the funding options available.

International Applicants

- Unfortunately, there is no funding for international students on this project.

Application Instructions

The online application and supporting documents are due by **Monday 21st January 2019**.

Any applications submitted after the deadline will not be accepted for the studentship scheme.

References should arrive no later than **Monday 28th January 2019**.

Applicants are advised to apply well in advance of the deadline, so that we can let you know if anything is missing from your application.

Required Materials

1. Online application form
2. Two academic references
3. Transcripts
4. Degree certificate/s (if awarded)
5. Curriculum Vitae
6. EPSRC Studentship Form
7. English language qualification

Applications which are not complete by the deadline will not be considered for the studentship scheme. It is the responsibility of the applicant to ensure the application form and documents are received by the relevant deadlines.

All applications must be submitted online, along with the supporting documents as per the instructions on the website.

Please ensure that all email addresses, for yourself and your referees, are correct on the application form.

For more information, please visit our website at :
https://www2.le.ac.uk/colleges/scieng/research/postgraduate-opportunities/epsrc-2019/instructions