**PhD project title:** Discovery of New Nanomaterials - Design, Synthesis and Application using Calixarenes.

**Project funder:** The Open University, Milton Keynes.

**Key words:** Nanomaterials, calixarenes, sensors, sensitising agents, photovoltaics.

**Supervisors in the School of Life, Health and Chemical Sciences (LHCS), The Open University:**
- Dr Nick Power – Lecturer in Organic Chemistry

**Project extended supervisory team:**
- Dr Jon Golding – Senior Lecturer in Health Sciences
- Dr Nick Chatterton – Lecturer in Chemistry
- Dr Suela Kellici – Associated Professor in Materials, London South Bank University

**Synthesis of versatile calixarene derivatives for applications in the discovery and design of nanomaterials.**

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a) An electron micrograph of spherical MXenes formed by the exfoliation of etched MAX phase (multi-layered parent material) using a calixarene derivative\(^1\).  
b) An example of a calixarene derivative, p-sulfonic acid calix[4]arene\(^2,3\).

**The Project**

This project will involve chemical synthesis of materials, including organic synthesis of calixarenes, and designing and developing methodologies for their application in the systematic nano-engineering of materials in the reduced dimensions.

Characterization techniques include:

- Nuclear magnetic resonance spectroscopy
- Fourier transform Infra-Red spectroscopy
- Raman spectroscopy
- Scanning electron microscopy
- Transmission electron microscopy
- X-ray diffraction
- Dynamic light scattering measurements
- Differential scanning calorimetry
- X-ray photoelectron spectroscopy

Materials based on nano-sized particles or those tailored to have nano-architectures in well-defined size and shapes, have received much attention from both the scientific community and industry due to their promise of exceptional properties at the reduced dimensions. Whether the nanoparticles are derived from metals, graphene, or a hybrid/composites of organic or inorganic materials, they offer a potential or means to exploit enhanced properties such as optical, mechanical, magnetic, chemical or electronic with a prospect to be readily utilized in a wide variety of technological and/or biomedical applications, properties which are often not attainable by macro materials.

Current methods for producing nanomaterials have many challenging elements, these include control over parameters such as solubility, functionalization, uniformity, reproducibility, mono-dispersibility of the
nanoparticles, and the nucleation and growth of those that are crystalline. Typically, a variety of agents maybe employed to enhance biocompatibility, provide functionality, and prevent agglomeration, control particle growth, stabilize dispersion, and in the case of metals, limit their surface oxidation. Many of the layered materials experience strong van der Waals inter-action thus making it very challenging to separate and stabilize them. Therefore, in this context, calixarenes are being put forward as controlling/modifying agents to enhance stability, moderate size distribution and shape, morphology, control surface activity and performance in the targeted applications of nanoparticles. Calix[n]arenes are robust macrocyclic molecules consisting of n phenolic units linked to each other by methylene bridges, where n = 4 to 8, the molecules can have a defined but flexible architecture for further molecular framework construction and derivatization.

The materials generated will undergo thorough investigations to evaluate not only their chemico-physical properties but also possible applications for example as sensors, sensitising agents, photovoltaics, single molecule magnets and beyond. These will be explored through established collaborations both within and outside The Open University.

A range of expertise and equipment will be available at The Open University laboratories (http://www.open.ac.uk/science/life-health-chemical-sciences/research). The student will be required to work in the Milton Keynes campus labs.

Funding information:
This three-year research studentship is funded by the Faculty of Science, Technology, Engineering and Mathematics (STEM) at The Open University and provides a stipend of £15,009 per year (2020 rate) and all academic fees (at UK/EU level) are covered. The project is supervised by Dr Nick Power at the Open University, supported by Drs Nick Chatterton and Jon Golding, and Dr Suela Kellici at London South Bank University. You would be required to live in the UK and within commuting distance of The Open University in Milton Keynes.

Requirements:
Applicants will be expected to have a degree (classification 2:1, or higher) in chemistry, materials sciences, pharmaceutical science, engineering, or a relevant subject. Good numeracy, ICT, communication and organisation skills are highly desirable.

Contacts:
Informal enquiries relating to the project should be directed to Dr Nicholas Power (nicholas.power@open.ac.uk).

How to Apply:
Please send an email with your CV, a completed application form and a personal statement (outlining your suitability for the studentship, what you hope to achieve from the PhD and your research experience to date) to STEM-LHCS-admin@open.ac.uk

Closing date: by the end of Friday 15th March 2020.

Interviews will be arranged promptly after the closing date, and can be conducted via Skype if appropriate.

LHCS holds Athena Swan Bronze status
Equal Opportunity is University Policy

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