UNNC-CNITECH, CAS Doctoral Training Partnership

Available PhD topics

PhD topic 1	**Design and preparation of bionic smart materials and their application in soft robots**
CNITECH Supervisor	Prof. Yuchuan Cheng
UNNC Supervisor(s)	Dr. Yong Ren
Short introduction & description of PhD	In recent years, soft robots have attracted widespread attention from academia and industry due to their elastic, deformable, and safe characteristics. Compared with rigid devices, soft devices have a higher degree of bending and greater freedom, so they can move in narrow spaces and complex environments. Given its good human-robot interaction and environmental adaptability, soft robotics have huge advantages in wearable and implantable devices, medical care, complex terrain exploration, etc. Smart soft materials owning elegant properties of simple operation, programmability, fast response, and tunable stiffness have wide applications in soft actuators, robots This project will focus on two major dimensions on (i) Preparation and performance research of smart composite materials and (ii) design and 3D printing of biomimetic soft robots.
Contact points	Informal inquiries may be addressed to Dr. Yong Ren (yong.ren@nottingham.edu.cn) and Prof. Yuchuan Cheng (yccheng@nimte.ac.cn).
PhD topic 2	**Design of Materials for CO_2 capture and utilisation**
CNITECH Supervisor	Prof. Liang Chen
UNNC Supervisor(s)	Dr Yong Ren
Short introduction & description of PhD	The electrocatalytic CO_2 reduction reaction (CO_2RR) powered by renewable-energy has potential to remit climatic hazards by capturing and dissociating CO_2 from atmosphere, along with producing value-added chemicals. However, the CO_2 molecule is highly stable so that the CO_2RR process is largely stymied by the impractically high overpotential. However, it remains a grand demand to develop highly efficient CO_2RR electrocatalysts for satisfying the industrial requirements, in terms of cost, activity, selectivity and stability. This will be studied in the project.
Contact points	Informal inquiries may be addressed to Prof. Liang Chen (chenliang@nimte.ac.cn) and Dr Yong Ren (yong.ren@nottingham.edu.cn).
PhD topic 3	**Detection and purification of targeted Extracellular vesicles via surface plasmon resonance**

CNITECH Supervisor	Prof. Jianping Zheng
UNNC Supervisor(s)	Dr. Jing Wang
Short introduction & description of PhD	Extracellular vesicles (EVs), actively shed from a variety of neoplastic and host cells, are abundant in blood and carry molecular markers from parental cells. Thus EVs have gained increasing interest as the biomarkers of various diseases. Among a number of different analytical methods that have been developed, Surface Plasmon Resonance (SPR) stands out as one of the ideal sensing and analytical techniques given its ultra-high sensitivity and robustness. In this potential PhD project, we intend to design an SPR biosensing system for the capture of targeted EVs and for the molecularly profiling of EV's proteins and RNAs; and we intend to functionalize the nanoparticle surface for extracting targeted EVs.
Contact points	Informal inquiries may be addressed to Prof. Jianping Zheng (Zhengjianping@nimte.ac.cn) and Dr. Jing Wang (Jing.Wang@nottingham.edu.cn).
PhD topic 4	**Development of Highly Efficient Organic Photovoltaic Cells**
CNITECH Supervisor	Prof. Ziyi Ge
UNNC Supervisor(s)	Dr. Bencan Tang
Short introduction & description of PhD	Highly efficient organic photovoltaic cells are the research focus on the photovoltaic field.The photosensitive active layer materials which absorb sunlight and convert the energy to electric energy play a decisive role in the performance of the devices. This project aims to develop high performance polymer donor materials, such as 6,7-dihydronaphtho[2,3-c][1,2,5]thiadiazole-5,8-dione-based polymers. The molecular backbone has a high degree of coplanarity, which is beneficial to charge transport, and thus it can improve the carrier mobility of the devices. By adjusting the side chain groups and so on, the donor polymers possess medium or wide optical band gap, which are easy to match with the nonfullerene organic small-molecule acceptors to prepare the high-efficiency devices. Meanwhile, we will study the influence of the different side chain and main chain structures on the active layer morphology and photovoltaic properties of the devices and explore the relationship between molecular structures and properties in order tosummarize the molecular design basis of highly efficient polymer donors. The research will adopt the designed and synthesized non-conjugated organic small-molecule electrolytes to optimize the interface between the active layer and the metal cathode, and then develop the organic solar cells with high efficiency.
Contact points	Informal inquiries may be addressed to Prof. Ziyi Ge (geziyi@nimte.ac.cn) and Dr. Bencan Tang (bencan.tang@nottingham.edu.cn).
PhD topic 5	**Development of Ionogel-Based Sensors for Underwater and Marine Sensing with Advanced Signal Processing Algorithms**
CNITECH Supervisor	Prof. Tao Chen
UNNC Supervisor(s)	Dr. Jing Wang
Short introduction & description of PhD	The marine environment is a complex and diverse ecosystem, and conventional wearable flexible sensors face numerous challenges such as corrosion, biofouling, and

	limited sensitivity in underwater environments. Ion-conducting gels (including hydrogels and ionogels), however, have great advantages with tuneable mechanical properties, excellent stretchability and biocompatibility, and show promise to overcome these challenges and provide an ideal sensing platform for underwater and marine sensing applications. The research project is composed of three major tasks: 1. Presenting three ionogels suitable for marine sensing with high sensing performance and excellent salt-resistant abilities. 2. Integrating the three ionogels and transmitting the received signals to processors on land. 3. Analyzing the signals for determining different underwater scenarios. The first task of the research project will focus on the optimization of ionogel compositions and formulations. A comprehensive literature review will be conducted for a better understanding of the physicochemical properties of ionogels and their behaviour in underwater environments. Different ionogel formulations will be synthesized and characterized for their ionic conductivity, mechanical properties, and responses to changes in environmental factors such as temperature, pH, pressure, and salinity. The ionogel formulation will be optimized to achieve better operation performances for underwater and marine sensing applications. The second task of the research project requires the integration of the signals from three distinct ionogel-based sensors, and different wireless transmission techniques should be considered. In this task, commercially used modules are acceptable. The third section of the project is about signal processing. Advanced signal processing algorithms will be developed to analyze the received signals from the ionogel-based sensors for detecting and identifying different scenarios. Proper electronic circuits and algorithms should be designed for the decoupling of signals from the three distinct sensors. The research project will be interdisciplinary, involving chemistry, materials science, and signal processing, and will contribute to the development of new sensor technologies for underwater and marine sensing applications. Further improvements will be demonstrated as human-adhesive interfaces for health monitoring and danger warning.
Contact points	Informal inquiries may be addressed to Prof. Tao Chen (tao.chen@nimte.ac.cn) and Dr. Jing Wang (Jing.Wang@nottingham.edu.cn).
PhD topic 6	**Effect of nutrient concentration on microbially influenced corrosion in coastal waters**
CNITECH Supervisor	宋振纶 (Zhenlun Song)
UNNC Supervisor	Enrico Marsili
Short introduction & description of PhD	Biofilms are microstructured microbial communities, in which microbial cells are encased in a self-produced extracellular polymeric substance, comprising proteins, polysaccharides and extracellular DNA. In the environment, the species composition of biofilms depends on the surrounding water, temperature, pH, and the concentration of organic nutrients, among other factors. Biofilms formed at submersed steel surface can accelerate or occasionally slow down corrosion rate. The “protective” effect of biofilms can be observed in the initial stage of biofilm formation and seems to depends on the

	carbon source concentration in the water. However, for long exposure time, the protective effect of biofilm morphs into acceleration of corrosion rate, likely due to the complex three-dimensional structure of biofilms, which create differential aeration zones on the steel surface, where localised corrosion increases. However, the unified corrosion mechanism of steel in presence of mature microbial biofilms has not been yet elucidated. In this project, the PhD candidate will investigate the local dynamic of biofilm formation on steel and microbially influenced corrosion of steel, combining local electrochemical measures with scanning electrochemical microscope and surface analysis via scanning electron microscopy. Biofilms on steel samples will be grown in dedicated bioreactors to increase reproducibility. The Microbial Ecology of biofilms will be also investigated to determine those species that have a prevalent protective effect on the steel surface. Different steel samples ranging from common carbon steel to superduplex, corrosion-resistant steels will be tested, both in the laboratory and in Ningbo coastal waters. This NIMTE/CBI-UNNC joint PhD project is suitable for a M.Sc. in Chemical Engineering or Material Science with an interest in Microbiology and Biofilm Science.
Contact points	Informal inquiries may be addressed to Associate Prof Enrico Marsili (enrico.marsili@nottingham.edu.cn) and Prof Zhenlun Song (songzhenlun@nimte.ac.cn).
PhD topic 7	**Multi-colour emissive luminescent nano/micromaterials: synthesis and biological relevant applications including labelling, detection, and imaging**
CNITECH Supervisor	Prof. Jianping ZHENG
UNNC Supervisor(s)	Dr. Yong REN
Short introduction & description of the PhD project	Highly sensitive and selective detection technologies are important research tools for life science. Among them, fluorescence technology has attracted widespread attention due to the merits of non-invasive, visual, and sensitive detection. However, the autofluorescence and scattered light from biological matrix can bring serious spectral interferences, and thereby result in low sensitivity or the ratio of signal to noise (S/N). Developing of novel luminescent materials with high quantum yield and the S/N ratio is an efficient strategy to overcome the above-mentioned limitations, but a challenging task. Time-resolution luminescence detection has been demonstrated to be extremely sensitive method in bio-medical applications. Persistent luminescence nanoparticles (PLNPs) can maintain emissive and keep detectable after removing of the excitation, are ideal time-resolution luminescent label candidates. This project will focus on two aspects i.e. synthesis and surface modification of PLNPs with strong and multi-colour emission, and their biological applications of labelling, detection, imaging, etc.
Contact points	Informal inquiries may be addressed to Prof. Jianping ZHENG (zhengjianping@nimte.ac.cn) and Dr Yong REN (Yong.Ren@nottingham.edu.cn).
PhD topic 8	**Sp^2 Carbon Conjugated Two-Dimensional Covalent Organic Frameworks for Water Treatment**

CNITECH Supervisor	Prof. Tao Zhang
UNNC Supervisor(s)	Prof. Jun He
Short introduction & description of PhD	Purification of water sources is one of the greatest challenges facing the world today, since huge areas of the planet are suffering from poor water quality because of the increasing contaminations from organic compounds as well as microorganisms. Two-dimensional covalent organic frameworks (2D COFs) especially that are connected by sp^2 carbon conjugated linkages have emerged as promising candidates for water treatment in recent years. Their excellent structural regularity, robust framework, and inherent permanent porosity provide an innovative platform for constructing novel organic materials with excellent adsorption, separation and catalytic properties, which are thus promising for different water purification processes. In this potential PhD project, we intend to extensively investigate the practical optimization of material synthesis process, efficacy assessment of pollutant removal/degradation, and its theoretical working mechanism, etc.
Contact points	Informal inquiries may be addressed to Prof. Tao Zhang (tzhang@nimte.ac.cn) and Prof. Jun He (Jun.He@nottingham.edu.cn).
PhD topic 9	**The Investigation of Surface Plasmon Resonance Based on Optical Fiber and Its Application in Biosensing**
CNITECH Supervisor	Prof. Aiguo Wu
UNNC Supervisor(s)	Dr. Jing Wang Dr. Yong Ren
Short introduction & description of the PhD project	Surface Plasmon Resonance (SPR) has been demonstrated to be the sensing mechanism which outstands in high sensitivity comparing to other sensing mechanisms. SPR delivers a sensitivity up to 10^{-6} RIU which enables the detection of low molecular weight analytes, e.g. viruses, and the detection of analytes with extremely low concentration, e.g. cancer biomarkers. However the relatively narrow dynamic range and its lack of multiplexing capability are still the main challenges for researchers nowadays. SPR can be excited in three configurations, i.e. Kretschmann, grating and waveguide. Besides the high sensitivity delivered by SPR, optical fiber, as a type of waveguide, possesses unique advantages in exciting SPR, including: 1. high stability, as the optical path is completely enclosed within the optical fiber so that the signal is immune to environmental disturbances; 2. easiness in miniaturization, as the diameter of SM optical fiber is ~125 µm, which is significantly less than the other 2 SPR configurations. 3. multiplexing flexibility. Combining the microfluidic technique, multiple sections along the optical fiber within the flow cell can be designed to excite SPR, and the multiple sensing units can be designed to enlarge the dynamic range as well as the multiplexing sensing of different analytes simultaneously.

	This project will focus on investigation of the excitation mechanism of SPRs based on optical fiber configuration and its application in healthcare at later stage.
Contact points	Informal inquiries may be addressed to Dr. Jing Wang (Jing.Wang@nottingham.edu.cn) and Prof. Aiguo Wu (Aiguo@nimte.ac.cn).
PhD topic 10	**The optimization and research of multi-component quantum dot material devices based on CuInS2/CuInSe2, focusing on the ligand and structure of photodiode devices and the optimization of the electron transport side.**
CNITECH Supervisor	Dr Lei Qian
UNNC Supervisor(s)	Dr Jing Wang
Short introduction & description of the PhD project	Colloidal quantum dots ($CuInS_2$ QDs) do not contain toxic heavy metals and have large absorption coefficients in a wide spectral range, and is becoming a new type of quantum dot material that has attracted plenty of attention in recent years. The broad photoluminescence tunability from visible to near-infrared light makes this material a potential for high-quality detectors. At present, there are still several major problems in the application of this material in the field of detection. First, the device structure of $CuInS_2$ used in sensing still needs to be optimized, and it is necessary to find a suitable ligand to form an excellent PN junction; second, the current experiments of this quantum dot material data show that its stability is not good, its lifespan is relatively short, and it cannot meet the requirements of industrialization, which still needs to be improved. We try to optimize the performance of the detector by modifying the ligands of the quantum dots and by optimizing the structure of the electron transport side device. The ultimate goal is to make a complete device structure that can be used for optical detection. In the following research, we will introduce the concept of self-assembly, construct a long-range ordered quantum dot structure, and explore methods to control self-assembly, in order to pursue better performance and mechanism of quantum dots.
Contact points	Informal inquiries may be addressed to Dr Lei Qian (Qianlei@nimte.ac.cn) and Dr Jing Wang (Jing.Wang@nottingham.edu.cn).

- Formal applications should follow the instructions in 'How to apply' section.
- Student recruitment includes, but is not limited to the above PhD topics. If your interested UNNC and/or CNITECH doctoral supervisor(s) do not have a topic available, please contact them first and agree on a suitable collaborative topic before submitting an application.