UNNC - SARI, CAS Doctoral Training Partnership

Research areas

1. Energy Storage and Conversion
2. Energy and Environment

Available PhD topics

Formal applications should follow the instructions in the 'How to apply' section.

PhD topic 1	**CO2 capture and conversion**
SARI Supervisor	Prof. Wei WEI
UNNC Supervisor(s)	Prof. Xiaolei Fan
Short introduction & description of PhD project	CO2 capture and conversion are important technology for CO2 reduction, this project will mainly focus on the development of porous and functional materials for CO2 adsorption and activation, so the CO2 from industrial flue gas can be directly converted to useful products.
Contact points	Informal inquiries may be addressed to Prof Wei Wei (weiwei@sari.ac.cn) and Prof Xiaolei Fan (Xiaolei.Fan@nottingham.edu.cn).
PhD topic 2	**Electrocatalytic reduction of CO2 in aqueous solutions under ambient conditions**
SARI Supervisor	Prof. Wei Chen
UNNC Supervisor(s)	Dr Mengxia Xu
Short introduction & description of PhD project	Electrochemical CO_2 conversion to valuable chemicals is of significance as a research hotspot since it not only can convert CO_2 under mild conditions, but also store renewable electricity as high energy density chemicals, exhibiting great potentials for renewable energy consumption. In this project, a new strategy on CO_2 electroreduction to multicarbon oxygenates in aqueous solutions is proposed here using the copper-based hybrid hollow fiber electrode. The electrode micro/nanostructured active sites and gas-solid-liquid three phase interfaces will be designed and constructed, and as-fabricated the hierarchical hybrid hollow fiber will also be configured to favor key intermediate formations and subsequent coupling reactions.
Contact points	Informal inquiries may be addressed to Dr Mengxia Xu (Mengxia.Xu@nottingham.edu.cn) and Prof Wei Chen (chenw@sari.ac.cn).
PhD topic 3	**Electrofermentation: a novel technology to improve 1,3-propanediol biosynthesis**
SARI Supervisor	Prof Jian Hao
UNNC Supervisor(s)	Dr Enrico Marsili
Short introduction & description of PhD project	1,3-Propanediol (1,3-PDO) is an important chemical with applications in the cosmetics, pharmaceutical, and especially polymer industries. 1,3-PDO can be produced by feeding glycerol to anaerobic bacteria, including *Lactobacillus* sp., without the need for

	expensive co-factors. However, the productivity is low, thus improvements of the microbial strain or the process are needed to increase the productivity, thus lowering the unit cost. The major limitations in anaerobic 1,3-PDO production are the slow growth and redox imbalance caused by the low potential of the terminal electron acceptor. Our recent work has shown that both limitations can be addressed through electrofermentation (EF). In EF, *Lactobacilli* biofilms are grown on conductive surface, like graphite or stainless steel, which are poised at mild oxidative potential (e.g., 0.4 V vs. Ag/AgCl), in presence of a biocompatible redox mediator that facilitate extracellular electron transfer between biofilm and the conductive surface. At this potential, the conductive surface serves as an effective electron acceptor, increasing the NAD+ pool, thus the growth rate and metabolic activity of *Lactobacilli*. Similar considerations apply to *Klebsiella* sp., as both microorganisms are weak electricigens, i.e., their metabolism can be driven by an applied electrochemical potential. In this project, the student will work with both supervisor to set-up and optimize a laboratory-scale EF system for production of 1,3-PDO. In the first part of the project (month 1-18), the candidate will work with Prof Hao (SARI) to choose a suitable strain for the process such as *Lactobacilli* sp. or *Klebsiella* sp. and determine the optimal process conditions in absence of electrochemical stimulation. The 1,3-PDO secreted will be characterised for purity and a preliminary process simulation study will be carried out. In the second part of the project (month 19-36), the student will work with Assoc Prof Marsili (UNNC) to set-up and optimize the EF based on the results of his/her work at SARI. It is expected to carry out local bioelectrochemical investigation of the *Lactobacilli* sp. or *Klebsiella* sp. biofilm to determine local reactivity and 1,3-PDO production, thus supporting the EF optimization study. If the lab-scale bioprocess is successful, an industrial partner for feasibility study and scale-up of the process to pilot scale will be identified in the Shanghai or Ningbo area. Both supervisors will fund the research expenses for this project. The PhD candidate will have access to high-end equipment and receive excellent training, which will help in securing a position in the Bioprocess industry at the end of the PhD or to engage in the academic career. Both supervisors are expert Biochemical Engineers with 40+ year combined experience in Bioprocess, Biofilm science, and Bioelectrochemistry. They have supervised to completion 8 PhD students. University of Nottingham Ningbo is the first Sino-foreign University in China, and comprise both international and Chinese scholars with strong research experience. China Beacons Institute is a newly opened research centre focused on ecological transition and sustainable technology. Shanghai Advanced Research Institute of Chinese Academy of Sciences (SARI) is a young research institute jointly established by Chinese Academy of Sciences (CAS) and Shanghai Municipal government in 2012. SARI focuses on innovative research and core technology R&D in the fields of accelerator science, photon science, energy science and information science.
Contact points	Informal inquiries may be addressed to Assoc Prof Enrico Marsili (enrico.marsili@nottingham.edu.cn) and Dr/Prof Jian Hao (haoj@sari.ac.cn).
PhD topic 4	**Functional Covalent organic frameworks in energy storage and conversion systems**
SARI Supervisor	Prof. Gaofeng Zeng
UNNC Supervisor(s)	Prof. Jun He
Short introduction & description of PhD project	Covalent organic frameworks (COFs), as a class of an emerging class of crystalline porous polymers, are constructed with designable building blocks linked by covalent bonds. COFs have high surface areas, good thermal and chemical stability and controllable porosities. COFs have shown various applications in different fields, including gas sorption and separation, catalysis, energy storage, and ions conduction. Importantly, the one dimensional and open channels providers fast transport pathway for electrolytes, which make COFs shown various applications in electrochemical systems. With using catalytic building units or immobilizing the active sites within the pores, COFs have been widely used in electrocatalysis, such as oxygen reduction

	reaction (ORR), oxygen evolution reaction (OER), hydrogen evolution reaction (HER), carbon dioxide reduction (CO2RR) and nitrogen reduction reaction (NRR). And with introducing electroactive sites in frameworks or porous channels, COFs have been used in lithium-ion batteries, lithium-sulfur batteries, supercapacitors.
Contact points	Informal inquiries may be addressed to Prof. Gaofeng Zeng (zenggf@sari.ac.cn) and Prof. Jun He (jun.he@nottingham.edu.cn).
PhD topic 5	**The preparation of bifunctional catalysts and their application on the hydroisomerization of long-chain n-alkanes**
SARI Supervisor	Prof. Jiusheng Li
UNNC Supervisor(s)	Prof. Xiaolei Fan
Short introduction & description of PhD project	As a large amount of fossil energy is still being plied, how to utilize it efficiently, cleanly and with high value-added has become an urgent issue to be addressed. Among them, the Fischer–Tropsch (F–T) process is a technical strategy for indirect coal liquefaction in modern coal chemical industry, but the downstream utilization of F–T wax (*n*-alkane content up to 95%) has been an intractable problem. Alkane hydroisomerization reaction can produce lubricants with enhanced low temperature fluidity and has attracted the attention of researchers. Especially, the design of bifunctional catalysts for long-chain *n*-alkanes hydroisomerization is the research priority. This project will focus on the following aspects, (1) construction of mesoporous structure in zeolites to enhance the diffusion property; (2) preparation of single-atom or nanoclusters of metal to provide the (de)hydrogeneration property; (3) new strategy to ensure the metal-acid balance of the bifunctional catalysts.
Contact points	Informal inquiries may be addressed to Prof. Jiusheng Li (lijs@sari.ac.cn) and Prof. Xiaolei Fan (Xiaolei.Fan@nottingham.edu.cn).
PhD topic 6	**The preparation of highly active catalysts for propane dehydrogenation with CO2**
SARI Supervisor	Prof. Xinqing CHEN
UNNC Supervisor(s)	Prof. Xiaolei FAN Dr. Xiaoxia Ou
Short introduction & description of PhD project	Propylene is one of the most important basic chemicals in the world, and the propane dehydrogenation to propylene becomes one of the most promising and attractive techniques for the production of propylene. The oxidative dehydrogenation of propane using CO_2 as a soft oxidant is a promising route, where CO_2 can remove carbon via the reverse Boudouard reaction. Moreover, converting CO_2 into a value-added chemical is an approach for the carbon neutral. In this project, (i)develop the key technology of CO_2-coupled propane dehydrogenation to propylene, which activates the C=O bond in CO_2, simultaneously activate the propane C-H bond and inhibit the C-C cleavage through the designed bifunctional catalyst system; (ii) To explore the mechanism of CO_2 as a weak oxidant for high selectivity of propylene production, and reveal the synergy of catalyst support, metal-support interaction, (iii) to develop a stable, anti-sintering, and high activity catalyst for CO_2 coupled propane dehydrogenation to propylene.
Contact points	Informal inquiries may be addressed to Prof Xiaolei FAN (Xiaolei.Fan@nottingham.edu.cn), Prof Xinqing CHEN (chenxq@sari.ac.cn) and Dr. Xiaoxia Ou (Xiaoxia.Ou@nottingham.edu.cn).