UNNC – Yongjiang Laboratory Doctoral Training Partnership

It's essential that you have contacted the UNNC and/or YLAB supervisors before applying.

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

Research areas

- New Material
- Advanced Manufacturing

Available PhD topics

PhD topic	**3D Scene Understanding and Machine Learning**
YLAB Supervisor	Dr. Zetao Chen, Dr. Lijun Li.
UNNC Supervisor(s)	Dr Ruibin Bai
Short introduction & description of the PhD project	Join our cutting-edge research team! We are excited to announce an opportunity for a motivated and talented student to join our dynamic research team as a PhD candidate. This project is at the forefront of computational understanding of 3D environments and aims to bridge the gap between virtual and real-world interactions. Project Overview: The world we live in is inherently three-dimensional, and comprehending these 3D spaces is fundamental to enhancing how we interact with our surroundings virtually. In this groundbreaking PhD project, you will be diving deep into the realm of machine learning, with a focus on developing novel algorithms and techniques for spatial and semantic understanding of real-world scenes. Your Role: • Investigate and develop advanced machine learning models for 3D Computer Vision and Machine Learning, specifically in the area of '3D scene understanding'; • Work with a variety of visual data, including images and depth/3D observations; • Writing a dissertation and publications; • Collaborate with a team of experts in a supportive and innovative research environment. What We're Looking For: • A master's degree in Computer Science or Mathematics, ideally with a focus on Computer Vision, Machine Learning, or related fields;

	• In-depth knowledge in one or preferably more of the following areas is considered an advantage: Deep Learning, 3D Computer Vision, or Computer Graphics; • Experience with deep learning frameworks (e.g., TensorFlow, PyTorch) • Proficiency in C++ coding skills in a plus;
Contact points	Informal inquiries may be addressed to zetao-chen@ylab.ac.cn.
PhD topic	**Additive manufacturing of fullerite from fullerene**
YLAB Supervisor	Prof. Biwei Deng, Prof. Ning Lin
UNNC Supervisor(s)	Prof. Christos Spitas, Dr. Yi Nie
Short introduction & description of the PhD project	By ionising and accelerating fullerene molecules in vacuum to a precisely controlled narrow energy window, or by manipulating fullerene molecules with tightly focusd femtosecond laser, and directing them at a suitable substrate (e.g. graphene), we propose to cause controlled fusion of the fullerenes and the substrate, and subsequently of fullerenes to fullerenes in subsequent layers. We shall thereby develop an additive manufacturing process, capable of producing net shape fullerite to any scale, depending on application times, obtaining structures of unprecedented strength-to-weight ratio as well as several other beneficial multiphysical properties. The research will make use of both computational (MD, DFT) and physical models (new experimental apparatus) to prove the concept and produce a first demonstration of the process, the material, and their capabilities.
Contact points	Informal inquiries may be addressed to Dr. Yi Nie (yi-nie@nottingham.edu.cn).
PhD topic	**Advanced Power Electronics Control for Ultra-resilient Power-electronics based micro-grids**
YLAB Supervisor	Huijun Gao
UNNC Supervisor(s)	Giampaolo Buticchi
Short introduction & description of the PhD project	The 14th Five-year Plan of China has listed the 'carbon peaking' and 'carbon neutrality' as main goals. As for the grid side, the concept of Microgrid (MG) was proposed to enable a greener and smarter grid by integrating distributed energy resources (DERs), therefore boosting the utilization rate of energies and the system-level efficiency. With consideration of higher penetration of renewable energy, apparently advanced control strategies are preferred to achieve fast dynamics, energy management and monitoring within the MG. This project will focus on: 1) issues of renewable energy when connected to the grid. 2) Advanced controls for system-level coordination of DERs in the MG.
Contact points	Informal inquiries may be addressed to Giampaolo Buticchi (Giampaolo.Buticchi@nottingham.edu.cn)
PhD topic	**Algorithm-driven automated photocatalysis in flow**
YLAB Supervisor	Dr. Zhenghui Wen
UNNC Supervisor(s)	Prof. Tao Wu
Short introduction & description of the PhD project	Photocatalysis exploits light for driving reactivity under mild conditions, contributing to advancements in synthetic methods for pharmaceuticals, agrochemicals, and materials. Nonetheless, challenges persist in optimizing, replicating, and scaling these techniques. These challenges stem from practical considerations like uneven light absorption and experimental variability, alongside chemical complexities such as poorly understood reaction mechanisms and

	intricate interactions among various variables. These phases in advancing photocatalytic processes are crucial yet time-consuming components of contemporary chemical manufacturing, requiring expertise and precision due to their intricate and sensitive nature. In response to the need for efficient optimization of complex photocatalytic reaction conditions, we will aim to develop an algorithm-driven robotic platform with this project, facilitating the self-optimization, intensification, and scale-up of photocatalytic transformations.
Contact points	Informal inquiries may be addressed to Prof. Tao Wu (tao.wu@nottingham.edu.cn) and Dr. Zhenghui Wen (Zhenghui-wen@ylab.ac.cn).
PhD topic	**Designing novel electrode materials and electrolyte for high-performance rechargeable Li/Na ion batteries**
YLAB Supervisor	Prof Ning Lin
UNNC Supervisor(s)	Prof. Muhammad Sajjad
Short introduction & description of the PhD project	Developing the new type of electrode materials and new battery systems is crucial for high-performance secondary Li/Na/K ion batteries with high energy/power density and long-term cycling life. However, the preparation and application of new materials, especially for new battery systems, require a systematic evaluation from material to cell. Therefore, this project will focus on four major dimensions on (i) designing and fabrication of new anode materials (e.g. silicon, hard carbon, metal, etc), (ii) the exploration of new batteries systems (e.g. solid-state battery, etc.), (iii) the understanding of the electrochemical energy storage mechanism (e.g. phase transition process, interface reaction, DFT/MD calculation, etc.), and (iv) multi-scale failure analysis of the cylindrical/ pouch battery.
Contact points	Informal inquiries may be addressed to Prof Ning Lin (ning-lin@ylab.ac.cn) and Muhammad Sajjad (muhammad.sajjad@nottingham.edu.cn).
PhD topic	**Development of high-performance nanoconfined catalysts for activation and conversion of CO_2 to green methanol**
YLAB Supervisor	Dr Fei Chang
UNNC Supervisor(s)	Dr Nicholas Musyoka Dr Xiaoxia Ou
Short introduction & description of the PhD project	The production of methanol and its derivatives represents a pathway for the use and storage of hydrogen produced by Renewable Energy (RE) sources such as solar photovoltaics (PV) and wind energy. Also, bearing in mind that captured CO_2 can be used as a reactant to produce methanol, the adoption of wide-scale power-to-methanol technologies can play an important role in large-scale CO_2 recycling which would serve as a promising means for combating the rising CO_2 emissions. The catalytic conversion pathway of direct CO_2 hydrogenation can be achieved via various routes, which include thermo-catalytic reaction, photo-catalysis, electro-catalysis, and bio-catalysis. Among them, the thermo-catalysis route has the most promising prospects for a faster transition to commercialisation since this process has been demonstrated at huge pilot plants. However, for the process to favourably compete with the conventional syngas route, there is a need for continued development of efficient and stable CO_2 transformation catalysts. Therefore, the proposed project aims at the development of nanoconfined catalysts for the selective hydrogenation of CO_2 to methanol. Nanoconfinement is often known to lead to exciting and anomalous phenomena due to the enhanced surface-to-volume ratio, the reduced potential toward agglomeration, and the tunable nanointerface that leads to dramatic changes in molecular transport and reaction kinetics. The nanostructured catalyst system will be obtained through the

	confinement strategy of transition metals in super porous support materials (zeolite-templated carbon (ZTC) and MOF-derived carbons (MDC)) due to their tunable porosity and hydrophobic nature, which could help alleviate the effect of the presence of water (a co-product with methanol), which often leads to accelerated sintering of active sites. This strategy could help in reducing catalyst deactivation and subsequently reduce the consecutive steps in the production of methanol. Furthermore, the development of this nanostructured catalyst system will follow two suggested approaches, i.e. (i) use of bimetallic oxides and/or hydrides (such as Zn-Zr and/or Zn-Ce) as active sites and (ii) understanding the promotional and support effects of established CuZn catalyst.
Contact points	Informal inquiries may be addressed to Fei Chang (fei-chang@ylab.ac.cn) Nicholas Musyoka (Nicholas.Musyoka@nottingham.edu.cn) Xiaoxia Ou (Xiaoxia.Ou@nottingham.edu.cn)
PhD topic	**External field-enhanced photocatalytic CO_2 reduction toward value-added C2 products**
YLAB Supervisor	Dr. Chang Fei
UNNC Supervisor(s)	Dr. Zhang Honglei
Short introduction & description of the PhD project	Sunlight-driven conversion of CO_2 into fuels or useful chemicals is a promising methodology for solving the world crises of energy supply and the rising atmospheric CO_2 level. Present studies on CO_2 photocatalytic reduction mainly give C1 products (CH_4, CO, HCOOH etc.), yet value-added C2 products such as ethylene and ethane are sparsely reported or produced only with low selectivity. This is because the generation of ethylene is much more challenging compared to C1 products. First, CO_2 is inert and the C-O bond is difficult to be cleaved into C1 intermediate such as *CO. Second, photocatalytic materials with high binding affinity to the C1 intermediate is required, which is an indispensable prerequisite for the subsequent C-C coupling reaction. Third, the C-C coupling reaction to C_2 products is a multi-electron involved step hindered by a significantly high kinetic barrier. Therefore, to achieve efficient C_2 products synthesis, it is necessary to dedicatedly design a promising catalyst or catalytic system. Herein, this project will focus on external field-enhanced photocatalytic technique for CO_2 reduction to value-added C2 products. Novel photocatalysts will be synthesized and used in the reaction. Through combining the comprehensive in-situ, ex-situ characterizations and theoretical calculations, the C–C coupling reaction mechanism will be studied. The optimal catalysts are expected to exhibit significant improvement in the C2 production rate and a much- improved C2 electron–based selectivity, superior to the traditional photocatalysts.
Contact points	Informal inquiries may be addressed to Dr. Zhang Honglei (Honglei-Zhang@nottingham.edu.cn) and Dr. Chang Fei (fei-chang@ylab.ac.cn).
PhD topic	**Impact surface modification of graphene/ silicon etc to produce printed circuits**
YLAB Supervisor	Prof. Biwei Deng, Prof. Ning Lin
UNNC Supervisor(s)	Prof. Christos Spitas, Dr. Yi Nie
Short introduction & description of the PhD project	By accelerating various ions in vacuum to a precisely controlled narrow energy window, or by tightly focusing femtosecond laser beam as energy source, and directing them at a suitable substrate (e.g. graphene, silicone), we propose to cause controlled surface modification, in the form of addition, doping etc to create multifunctional feature patterns and gradients with electrical semiconducting properties, electromagnetic, optical and thermal properties etc. We shall thereby

	develop a surface modification process, capable of producing miniaturised multifunctional printed circuits with several revolutionary applications to nanotechnology. The research will make use of both computational (MD, DFT) and physical models (new experimental apparatus) to prove the concept and produce a first demonstration of the process, the material, and their capabilities.
Contact points	Informal inquiries may be addressed to Dr. Yi Nie (yi-nie@nottingham.edu.cn).
PhD topic	**In-situ preparation of high-strength substrate for VACNT growth for high root-strength ultra-high friction and damping elements**
YLAB Supervisor	Prof. Biwei Deng, Prof. Ning Lin
UNNC Supervisor(s)	Prof. Christos Spitas, Dr. Yi Nie
Short introduction & description of the PhD project	By controlling the density of the VACNT growth sites in a CVD/ PECVD process, we propose to create 'nano-bristles' such that, when placed in face-to-face configuration with an appropriate length-wise overlap of the individual CNTs, they will act as friction elements reaching unprecedentedly high friction coefficients with zero wear. We shall thereby produce a new type of nano-friction shear element with applications to vibration damping (application to semiconductor wafer stages in vacuum etc), clutching and braking for linear and rotary mechanical systems, which can be characterized while observed with in-situ mechanical tests at nanoscale. One of the key research thrusts will be in the strengthening of the CNT-to-substrate mechanical interface, which will be accomplished by surface modification introducing additional epitaxial growth layers, 'burying' the CNT root and thereby increasing its contact surface with the substrate layers. The research will make use of both computational (MD, DFT) and physical models (new experimental apparatus) to prove the concept and produce a first demonstration of the process, the material, and their capabilities.
Contact points	Informal inquiries may be addressed to Dr. Yi Nie (yi-nie@nottingham.edu.cn).
PhD topic	**In-situ preparation of high-strength substrate for VACNT growth for self-cleaning filters**
YLAB Supervisor	Prof. Biwei Deng, Prof. Ning Lin
UNNC Supervisor(s)	Prof. Christos Spitas, Dr. Yi Nie
Short introduction & description of the PhD project	We propose to grow in-situ VACNT nano-bristles with controlled density on finely perforated films using a CVD/ PECVD process, which will be subsequently wrapped around themselves or placed face-to-face in order to produce filters, which by a similar process of (partial) unwrapping and/ or fluid flow reversal can be made self-cleaning. By appropriate selection of the CNT diameter, length, and the VACNT and substrate perforation density the pressure drop vis a vis the mechanical strength and filtering capacity can be optimised. The research will make use of both computational (MD, DFT) and physical models (new experimental apparatus) to prove the concept and produce a first demonstration of the process, the material, and their capabilities.
Contact points	Informal inquiries may be addressed to Dr. Yi Nie (yi-nie@nottingham.edu.cn).
PhD topic	**Novel 3D mechanical metamaterials for vibration and acoustic control**
YLAB Supervisor	Dr Biwei DENG (Biwei Deng - ResearchGate)
UNNC Supervisor(s)	Assoc. Prof. Dunant Halim (Dunant Halim - University of Nottingham Ningbo China)
Short introduction & description of the PhD project	Metamaterials are newly emerged materials in the past few decades that possess outstanding physical properties beyond nature's reach. By designing the periodic structures of metamaterials, one can manipulate the propagation behaviour of various forms of waves, such as electromagnetic waves, elastic waves and acoustic waves, within or on the surfaces of the metamaterials. In view of mechanics, this

	unique tunability of metamaterials gives rise to the potential applications in versatile scenarios such as vibration suppression, sound attenuation and so on. The grand challenge in the field of mechanical metamaterials lies in both design and manufacturing. Currently the design of mechanical metamaterials in 2D space is well developed, whereas the case in 3D space is faced with greater challenges due to the increased complexity associated with the additional dimension. In this project, we seek to explore the general theory of designing novel 3D mechanical metamaterials aiming for the specific applications of vibration and acoustic control. The realization of 3D mechanical metamaterials with advanced manufacturing tools, such as 3D printing, is the other emphasis of this project.
Contact points	Informal inquiries may be addressed to Dr Dunant Halim dunant.halim@nottingham.edu.cn and Dr Biwei Deng biwei-deng@ylab.ac.cn.
PhD topic	**Oxide-based neuromorphic devices for brain-like perception chips**
YLAB Supervisor	Prof. Qing Wan
UNNC Supervisor(s)	Prof. Jim Greer Prof. Guang Zhu
Short introduction & description of the PhD project	Human brain is the most perfect universal intelligent agent in nature. Brain-like computing draws inspiration from the way the human brain processes information, solving many challenges such as memory walls and power walls with fewer devices, lower energy consumption, and higher energy efficiency. The ultimate goal of neuromorphic engineering is to mimic biological synapses and neural network architectures and develop ultra-low power intelligent computers with autonomous learning and cognitive functions. We will combine advanced micro-nano technology to achieve IGZO transistors and their 3D integration, develop oxide memristors and multi-port neuromorphic transistors. In terms of cutting-edge exploration, we will also integrate silicon PN junction and Si/IGZO heterojunction photovoltaic detectors in situ to achieve zero power artificial visual perception function, propose the concept of constructing a inverted spatiotemporal integration network for spike dynamics, explore the noise facilitation function in spike neural networks, and achieve ultra-low power human eye/brain like image recognition function.
Contact points	Informal inquiries may be addressed to Prof. Jim Greer (Jim.Greer@nottingham.edu.cn), Prof. Guang Zhu (Guang.Zhu@nottingham.edu.cn) and Prof. Qing Wan (qing-wan@ylab.ac.cn).
PhD topic	**Photosensitive functional organic-inorganic hybrid resist for additive manufacturing nanofabrication technology**
YLAB Supervisor	Dr Biwei DENG
UNNC Supervisor(s)	Asst. Prof. Honglei ZHANG
Short introduction & description of the PhD project	Additive manufacturing techniques have been widely employed in various fields due to their arbitrarily complex 3D fabrication ability, and in the manufacturing of micro/nanostructures, laser-direct-printing-based TPL(two-photon lithography) is regarded as one of the most promising methods. Among the materials adapted to TPL, single-component polymers are not comparable to organic-inorganic hybrid photoresists in terms of functionality such as electrical conductivity, mechanical strength and optical properties. Currently, the main challenges in nano-additive manufacturing are high-quality and high-throughput. The grand challenge of hybridised material systems lies in design and fabrication. In this project, we attempt to design and elucidate the effects and mechanisms of the interactions between inorganic components and organic resins to achieve stable preparation of controllable material systems and

	functional modulation for application scenarios. Another focus of this project is to achieve high-throughput fabrication using advanced fabrication tools (TPL) and highly sensitive material systems.
Contact points	Informal inquiries may be addressed to Dr Honglei ZHANG Honglei-Zhang@nottingham.edu.cn and Dr Biwei Deng biwei-deng@ylab.ac.cn.
PhD topic	**Research on advanced power electronics converters based on WBG semiconductor devices**
YLAB Supervisor	Dr. Chunyang Gu
UNNC Supervisor(s)	Dr. Jing Li
Short introduction & description of the PhD project	Third generation power electronic devices and their applications in aviation systems: The characteristics of SiC and GaN wide-band-gap (WBG) semiconductor devices and their applications in high frequency and high power density aviation power electronic power converters are investigated to improve the reliability of gate driver, and the optimal strategy for reducing conduction loss and switching loss is researched. Research on topology of multilevel converter for propulsion and grid-connected: Research on topology design method of overall efficiency and power density maximization of multilevel controller, explore the modulation mode and dv/dt mechanism of multilevel controller, and find out the influence law of multilevel controller on motor insulation life. Multiphase/multilevel modulation and control strategy research: The vector control system of three-phase permanent magnet synchronous motor is studied to reduce the voltage withstand on each power switch tube, so that it can be applied in high-power and high-voltage occasions to reduce the phase current harmonics.
Contact points	Informal inquiries may be addressed to Dr. Jing Li (Jing.Li@nottingham.edu.cn) and Dr. Chunyang Gu (Chunyang-Gu@ylab.ac.cn).
PhD topic	**Research on distributed intelligent DC power distribution system for multi-electric aircraft/ships**
YLAB Supervisor	Dr. Chunyang Gu
UNNC Supervisor(s)	Prof. Giampaolo Buticchi
Short introduction & description of the PhD project	Modelling and stability analysis of multi-electric aircraft power distribution system: Complete real-time integrated power monitoring and management system of aircraft HVDC system; It provides an effective means for real-time monitoring and management of aircraft DC power supply system. A control scheme for high-power DC-DC battery chargers/converters suitable for aviation applications is investigated, and the control system is optimized based on linearization equations. For the aircraft distributed multi-converter system, a droop control strategy based on virtual impedance is analyzed to realize the combination with the energy storage system to effectively improve the power quality of the aircraft grid system and suppress system fluctuations. Research on DC multi-port energy router used for intelligent distribution of multi-electric aircraft: The circuit model of multi-winding transformer is analyzed, the power decoupling methods and voltage control methods of multiple active bridge converter are proposed, and a variety of soft switch phase-shift modulation methods of multiple active bridge converter are investigated to realize the soft switching control of multiple active bridge converter and reduce the current stress of the devices.

Contact points	Informal inquiries may be addressed to Prof. Giampaolo Buticchi (Giampaolo.Buticchi@nottingham.edu.cn) and Dr. Chunyang Gu (Chunyang-Gu@ylab.ac.cn).
PhD topic	**Research on high performance electric propulsion/traction motor design and control**
YLAB Supervisor	Dr. Chunyang Gu
UNNC Supervisor(s)	Dr. Weiduo Zhao
Short introduction & description of the PhD project	Research on control strategy of high speed motor: Design of high performance motor for electric propulsion or traction applications. Establish the calculation model of iron loss, analyze the high frequency characteristic of iron core material and the variation rule of magnetic field in iron core. Iron consumption calculation considering the effects of harmonic and rotating magnetization. An efficient optimal control strategy for iron consumption suppression is researched. Multi-phase motor control strategy research: multi-phase motor fault-tolerant control strategy research. The variation of the output torque and phase current of the motor under fault-tolerant control is verified by finite element method. The electromagnetic torque fluctuation is calculated and compared with normal operation. The decoupled fault-tolerant control strategy of multiphase motor in fault-tolerant operation is investigated.
Contact points	Informal inquiries may be addressed to Dr. Weiduo Zhao (Weiduo.Zhao@nottingham.edu.cn) and Dr. Chunyang Gu (Chunyang-Gu@ylab.ac.cn).