Supervisory Team	Xu Sun
Short introduction & description of research project	The rapid advancement of autonomous driving technology has the potential to revolutionize transportation by improving safety, efficiency, and convenience. However, as autonomous vehicles (AVs) transition from full human control to varying levels of automation, the interaction between human drivers/passengers and AVs becomes a critical research area. One of the key challenges in this domain is the ability to detect and respond to human fatigue and emotional states, which can significantly impact driving safety, trust in AV systems, and overall user experience. This PhD project aims to explore novel HCI mechanisms to accurately detect and interpret human fatigue and emotions in the context of autonomous vehicles. The research will focus on multi-modal data collection, including physiological signals (e.g., heart rate variability, electroencephalography), behavioral cues (e.g., eye-tracking, facial expressions), and contextual factors (e.g., driving conditions, environmental stimuli). By integrating these data sources with machine learning models, the study will develop real-time adaptive systems capable of enhancing driver-passenger interaction and vehicle response mechanisms.
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Supervisory Team	Prof Jian Yang Prof. Christos Spitas
Short introduction & description of research project	The project will focus on advancing the understanding and control of nonlinear vibration systems through data-driven approaches. Nonlinear vibrations, common in engineering systems like aerospace structures, mechanical systems, and civil infrastructure, often lead to complex energy transfer mechanisms that are challenging to analyse using traditional linear methods. The study aims to develop innovative data-driven techniques to better characterize and suppress these vibrations by analysing energy transfer dynamics. The project will leverage machine learning and advanced signal processing tools to extract patterns and relationships from experimental or simulated data. These methods enable the identification of key energy transfer pathways and nonlinear interactions that govern system behaviour. By analysing these pathways, the study seeks to design more effective vibration suppression strategies, such as nonlinear vibration isolators and absorbers, to mitigate unwanted vibrations and enhance system performance. A key contribution of the research is the integration of data-driven models with physical insights, allowing for a more accurate representation of nonlinear phenomena. The paper also explores the use of dimensionality reduction techniques to simplify complex datasets, making it easier to identify dominant energy transfer modes. Additionally, the study highlights the potential of real-time data processing for adaptive control systems, which can dynamically adjust to changing vibration conditions. The findings demonstrate the effectiveness of data-driven methods in improving the analysis and suppression of nonlinear vibrations, offering significant benefits

	for engineering applications. By combining computational tools with experimental data, the research provides a robust framework for understanding and controlling complex vibration systems, ultimately leading to safer, more efficient, and reliable designs.
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Supervisory Team	Prof. Yong Ren Prof. Xiaogang Yang Prof. Yuying Yan
Short introduction & description of research project	**PhD project title: High Throughput synthesis of microcapsules with tunable gas selectivity for catalytic application using microfluidic reactors** Microcapsules are widely used in various industries, including pharmaceuticals, food, and catalysis, due to their ability to encapsulate and release substances in a controlled manner. In catalytic applications, the ability to selectively allow certain gases to permeate while blocking others is crucial for optimizing reaction efficiency and product yield. Traditional methods of microcapsule synthesis often lack the precision and scalability required for industrial applications. Microfluidic reactors offer a promising alternative, providing fine control over the synthesis process and enabling high-throughput production. The primary objective of this project is to develop a high-throughput method for synthesizing microcapsules with tunable gas selectivity, specifically designed for catalytic applications. The use of microfluidic reactors is central to achieving precise control over the microcapsule properties, enabling tailored gas permeability and selectivity. The project will focus on (1) development of a microfluidic reactor capable of producing microcapsules with uniform size and morphology; (2) selection of polymer materials for the microcapsule shell that can be tuned for gas selectivity, and incorporation of catalytic nanoparticles within the microcapsule core; (3) size distribution and morphology analysis using microscopy and dynamic light scattering (DLS), gas permeability and selectivity testing using gas chromatography and mass spectrometry; and catalytic activity assessment through controlled reaction studies; (4) optimization of the microfluidic reactor design and synthesis parameters to enhance throughput and microcapsule performance, and application of computational modeling to predict and optimize gas selectivity and catalytic efficiency.
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Supervisory Team	Xiaoling Liu, Christos Spitas, Amin Farrokh Abadi
Short introduction & description of research project	**Gradient Hierarchical Bionic Porous MXene/Biobased Composites for Broadband Acoustic Absorption, Vibration Attenuation, and Thermal Insulation** Noise pollution, vibration damage, and thermal management are critical challenges in various fields, including aerospace, intelligent buildings, electronic devices, and transportation. Conventional materials used for acoustic absorption, vibration attenuation, and thermal insulation, such as polymer foams, rubber composites, and ceramic fibers, often suffer from limited functionality, poor environmental compatibility, and insufficient mechanical stability. As modern engineering demands lightweight, multifunctional materials with enhanced performance, there is a great need to develop novel composites that simultaneously achieve broadband sound absorption, efficient vibration damping, and superior thermal insulation This research aims to develop **gradient hierarchical porous MXene/biobased composites** to simultaneously optimize broadband sound absorption, vibration attenuation, and thermal insulation. The proposed strategy involves the fabrication of an interconnected porous structure using a combination of bio-template-assisted methods and ice templating to enhance wave scattering and phonon dissipation. By employing electrostatic self-assembly or in-situ polymerization, MXene will be uniformly distributed within the biobased matrix, improving interfacial bonding and mechanical stability. The performance of the composites will be systematically characterized using impedance tube testing, dynamic mechanical analysis (DMA), and thermal conductivity measurements to evaluate their acoustic absorption, damping efficiency, and heat insulation properties. Finite element modeling (FEM) combined with Fourier-transform infrared spectroscopy (FTIR) will be employed to elucidate the interfacial interactions between MXene and the hierarchical pore network, providing insights into energy dissipation mechanisms. To validate the real-world applicability, the optimized composites will be tested in intelligent building acoustics, automotive noise reduction, and electronic device thermal management scenarios to assess their long-term durability and multifunctionality. This study represents a significant advancement in multifunctional materials by integrating broadband acoustic absorption, vibration attenuation, and thermal insulation into a single composite system. The findings will facilitate the development of lightweight, high-performance materials with broad applications in aerospace, smart manufacturing, and sustainable infrastructure
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Supervisory Team	Dr. Hao Chen Dr. Adam Rushworth Prof. Zhirong Liao
Short introduction & description of research project	This project investigates the effects of NiAl powder addition and powder structural design for enhancing the microstructure and oxidation resistance of CoNiCrAlY coatings. NiAl powders are blended with CoNiCrAlY powders, in an attempt to modify the oxidation behavior. A core-shell structure is proposed, where NiAl particles are encapsulated by CoNiCrAlY shells, aiming to regulate aluminum diffusion pathways. In addition, a multi-layer CoNiCrAlY system is also proposed to enhance the oxidation lifetime of CoNiCrAlY coatings. This project will seek using novel laser powder bed fusion process for coating fabrication and structure control.
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Supervisory Team	Professor Xiaogang Yang, Dr Guang Li, Dr Shanshan Long
Short introduction & description of research project	**Project Title: Mechanism of turbulence induced shear, micro scale shear and crystallization synergic modulation on controllable synthesis of functional micro/nano particles** This proposed project aims to in-depth reveal mechanism of turbulence induced shear, micro scale shear and crystallization synergic modulation on controllable synthesis of functional micro/nano particles. In the meantime, the project will attempt to realise the controllable synthesis of porous micro/nano drug delivery carrier material with innovative technique of advanced intelligent synthesis of medical functional micro/nano porous carrier materials and development of the synthesis system prototype. By considering the application of turbulence induced shear intensification to the synthesis process, Computational Fluid Dynamics (CFD) numerical simulation, in particular LES modelling, and experimental investigation approaches will be used to develop novel reactors that can be used for realization of such synthesis process. The proposed project will particularly focus on the aspects of hydrodynamics and crystallization kinetics involved in the synthesis process of pharmaceutical micro/nano particles. Also, the mechanism of strong coupling between hydrodynamics and chemical reaction in synthesis of functional micro/nano particles will be revealed. It is expected that the technology suitable for the complete process of synthesising pharmaceutical-functional micro/nano particles via shear turbulence intensified reactive manufacturing will be obtained. The specific research objectives as realization of the project aims include: 1. Through establishment of the whole process of preparing medical porous carrier granular product using intelligent reaction manufacturing technology, shear turbulence intensification, turbulence shear controllable synthesis, microminiaturization of the synthesis system and sustainability will be realised. 2. The effects of turbulence shear controllable synthesis hydrodynamics, coupled with the mass transfer on the synthesis process of functional

	pharmaceutical micro/nano particles for drug controllable delivery system will be fundamentally studied. 3. By fundamentally investigating the hydrodynamic characteristics on high-speed counter-swirling impinging jet and multistage Rankine vortex flow reactors and characterising the synthetic pharmaceutical micro/ nano particle carrier materials, a correlation between the hydrodynamic parameters of the reactor and the physicochemical properties of the synthetic pharmaceutical micro/ nano carrier particles will be established.
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