

Research Fellows and Research Projects (2003/2004)

MEBCS programme

Dr Chen Langxing

Expertise: Biomolecule guided nanoparticle synthesis, assembly of bimetallic and multimetallic nanoparticle, electrochemistry of metal nanoparticle

DNA Guided Synthesis of Fuel Cell Catalysts

Project Advisor : Prof Lee Jim Yang (Singapore)
Duration : August 2003 to August 2005

Project Abstract :

This research project is aimed at producing nanoscale multi-metallic particles that are active in fuel cell electrocatalysis, using biological molecules as design templates and assembly tools to guide the material synthesis and particle assembly. Molecularly designed oligonucleotides and peptides will be used to program the assembly of nanoparticles and the construction of simple nanostructures based on Watson-Cricks base-pairing of complementary sequences. The scope of work includes the preparation protocols and their optimizations, the identification of scientific issues, and the evaluation of activity and tolerance of the nanoassemblies so prepared in room temperature electrochemical oxidation of liquid methanol.

Dr Deng Rensheng

Expertise: Hydrodynamics and mixing behavior of fluidized beds, cracking and pyrolysis of heavy hydrocarbons, instabilities in granular materials, transport phenomena in other systems

Instabilities in Flow of Granular Materials

Project Advisor : Assoc Prof Wang Chi-Hwa (Singapore)
Duration : October 2001 to March 2004

Project Abstract :

The influence of periodic vibrations on the granular flow of materials is of great interest to scientists and engineers due to both theoretical and practical reasons. In this work, the equations of continuity, momentum and energy, as well as the corresponding boundary conditions, are applied to study the instability of the granular materials under vertical vibrations. Topics to be investigated include flow regimes, structures and temporal evolution, together with the kinetic mechanisms that cause the instability. The methods mainly include (1) calculating the base state; (2) finding out the instability profile after introducing small perturbations; and (3) predicting the new patterns that will form. The linear instability is studied by solving the eigenvalue problem resulting from the linearized equations, while the non-linear instability is examined by transient integration so as to figure out the long-term behavior. Additionally, a two-dimensional particle image velocimetry (PIV) system is adopted to experimentally examine and characterize pattern formation in the vertically vibrated glass beads.

Dr Palaniswamy Ravi

Expertise: Synthesis and characterization of novel stimuli responsive amphiphilic block copolymers for biomedical applications

Synthesis and Characterization of Stimuli Responsive Amphiphilic Block Copolymers for Targeted Drug Delivery

Project Advisor : Assoc Prof Tam K. C., Michael (Singapore)
Duration : August 2001 to August 2003

Project Abstract :

This project focuses on developing novel stimuli-sensitive polymers for drug and gene delivery applications. Three major classes of polymer systems will be considered; namely polyethylene-oxide/polypropylene-oxide tri-block copolymers (FDA approved), methacrylic acid (MAA) block and 2-(diethylaminoethyl methacrylate)/2-(dimethylaminoethyl methacrylate). The self-assembly of these materials produces a complex hierarchical structure that can be harnessed for potential applications described in this proposal. The atom transfer radical polymerisation (ATRP) will be adopted to synthesize a range of mono-dispersed block copolymers (e.g. PEO-b-MAA, MMA-b-MAA, MAA-b-DEA.). Other stimuli-sensitive functional groups can be used to impart pH and temperature sensitivity to the polymers. Interesting novel systems, such as the stimuli sensitive water soluble fullerene based block copolymers will be synthesized. Through the ATRP technique, we hope to synthesize mono-dispersed and well-defined block-copolymers that exhibit interesting microstructure for potential drug delivery applications.

Dr Parayil Kumaran Ajikumar

Expertise: Design, synthesis, and structure activity study of biologically active molecules such as peptides and peptido mimetic compounds, solid phase peptide synthesis, solid phase organic synthesis, Protein and peptide micro arrays and combinatorial chemistry

Design, Development and Functional Analysis of a Spatially Addressable Protein Microarray

Project Advisor : Assoc Prof Too Heng-Phon (Singapore)
Duration : March 2003 to March 2006

Project Abstract :

The advances in the modern proteomic research were highlighted by the exploration and adoption of many new techniques and strategies which provided the potential for the simultaneous study of thousands of proteins in a single experiment. Among them high-throughput array technique could provide an important tools to probe the complex analytes such as serum, whole blood and total cell extracts. Thus these emerging techniques are capable of revealing novel

protein functions and helping in a better understanding of comprehensive protein interaction networks in an organism. As like any other emerging technology, the protein micro array also showed great potential, but the difficulties of reducing "exciting theory" to "real-life practice" is an unyielding problem. The present project will address some of the existing problems and would eventually develop a novel platform for the generation and arraying of a large pool of protein into a spatially addressable format with multiplexed screening in a highly miniaturized format.

Dr Sathish Sadagopan

Expertise: Signal transduction of GDNF and NTN receptors GFR α alternatively spliced variants in mammalian cells

Importance of Alternative Splicing in Modulating the Signal Transduction of GDNF and NTN Receptors in Mammalian Cells

Project Advisor : Assoc Prof Too Heng-Phon (Singapore)
Project Advisor : Prof Harvey F. Lodish (MIT)
Duration : March 2002 to March 2004

Project Abstract :

Members of the glial cell line-derived neurotrophic factor (GDNF) family, comprising ligands of GDNF, neurturin (NTN), artemin (ART) and persephin (PSP), have been implicated to be crucial for the development, maintenance and survival of central and peripheral neurons. The GDNF ligands (GFL) can either signal through a receptor complex consisting of glycosyl-phosphatidylinositol (GPI)-anchored coreceptor (GFR α 1-4) as a ligand binding component or RET receptor tyrosine as a signaling component, or through a RET-independent pathway stimulated by GDNF. The aim of this project is to understand how the alternatively spliced isoform of the GDNF receptors GFR α , signal in neuronal cells, and hence, to delineate their signaling pathways leading to various cell functions. This will not only provide a deeper insight of the functions of GDNF ligands, GFR α 1-4 and Ret, in normal development, but also to develop therapeutic strategies for their effects on human diseases such as Parkinson's, MEN2 and Hirschsprung's.

Dr Theivanayagam Chairman Deivaraj

Expertise: Carbon mono oxide resistant eletrocatalysts for direct methanol fuel cells and biomolecule guided nanoparticle synthesis

Chemical and Biochemical Synthesis of Multi-Metallic Nanoclusters

Project Advisor : Prof Lee Jim Yang (Singapore)
Duration : April 2002 to April 2004

Project Abstract :

Multi-metallic nanoclusters with potential application

values in catalysis and electrocatalysis are prepared via various molecular and biomolecular templating methods. Work has been initiated to exploit the hybridization of complementary DNA strands as a means of self-assembling nanostructures from ions in the solutions and from appropriately surface functionalized nanoparticles. Optimization of the synthesis conditions; the effects of synthesis conditions on the properties and the final morphology of the nano-assemblies; and the examination of the mechanistic details of the assembly process, form the three major objectives of this project.

Dr Vetrichelvan Muthalagu

Expertise: Design and organic syntheses of oligomers and conducting polymers, macrocyclic chemistry and supramolecular chemistry

Molecular Engineering of Conjugated Polymers for Biological and Metal Ion Sensor Applications

Project Advisor : Asst Prof Suresh Valiyaveettil (Singapore)
Duration : April 2003 to April 2005

Project Abstract :

Conjugated polymers for chemical and biological sensors are of great interest because of the changes in their optical and conducting properties in presence of analytes. In particular, water soluble polymers offer powerful tools for the trace detection of analytes in biological environments. In general, ionic conjugated polymers have been applied in biosensor schemes; however these systems have some disadvantages: (i) the solution's pH and ionic strength have to be adjusted to prevent aggregation of the conjugated polymers (ii) non-specific electrostatic interaction between ionic polymers and biomolecules such as proteins and DNA will reduce the target specificity. By careful design of conducting polymers incorporated with water solubilizing neutral functional groups, we hope to investigate recognition and sensing of various analytes of different origin (chemical or biological). Another area of this project is focusing on metal ion sensor applications. By considering the good complexing ability of the pyridine, bipyridine, terpyridine, pyrazine molecules with the metal ions, group of polymers consisting of alternate phenylene and pyridine/ bipyridine /terpyridine/ pyrazine molecules are designed. We expect these polymers have effective sensor properties for variety of metals and their lanthanide metal complexation is expected to have the potential applications in photonics.

Dr Victor Wong Vai Tak

Expertise: Plant and mammalian cell cultivation for production of biotherapeutics

Understanding the Effects of Media Supplements in Serum Free Media on Hybridoma Cells via Transcriptional Analysis

Project Advisor : Prof Miranda Yap G. S. (Singapore)
Project Advisor (MIT) : Prof Daniel I. C. Wang

Duration : May 2001 to
April 2003

Project Abstract :

An increasing number of biopharmaceutical products approved for human therapeutic use are produced through mammalian cell cultures. Industrial biologics production is directing towards the use of serum-free media because of the high cost and performance variability associated with the use of serum and the advantage of a reduced burden on downstream purification. Previous work in finding serum-substitutes has generally proceeded via trial-and-error experimentation. In contrast, a better understanding of the intracellular responses and mechanisms when serum-replacement supplements are used will facilitate the development of a more rational approach to media design. By using the DNA microarray, we propose to profile the differential gene expression between hybridoma cells cultivated in different media conditions. This allows the simultaneous analysis of interconnected cellular events, such as cell cycling, nutrient transport, metabolism and glycosylation, which is important for producing a functional antibody product.

Dr Xue Ying

Expertise: Development and application of computational methods in ligand-protein interaction

Development of a Fast-Speed Method for Computing Molecular Descriptors used in Computer Aided Drug Design

Project Advisor : Assoc Prof Chen Yuzong
Duration : February 2002 to February 2004

Project Abstract :

In computer aided drug design, the characteristics of a drug or a molecule are described by a group of descriptors including those computed by quantum chemistry methods. The computation of these quantum-chemistry based descriptors takes too long CPU time for high-throughput computer screening of drugs, which are either ignored or replaced by simplified alternatives and thus may affect the quality of computed results. This project is designed to develop a fast-speed method for computing these quantum chemistry based descriptors. The speed is to be increased by customarily re-design the code to focus on those computations related to the descriptors, and by further reducing the number of iterations in solving Schrodinger equation without significantly compromising the accuracy.

Dr Yao Jia

Expertise: Property and structure of polyelectrolytes

Thermodynamics and Physical Characteristics of Stimuli Responsive Amphiphilic Block Copolymers

Project Advisor : Assoc Prof Tam K. C.,
(Singapore) Michael
Duration : February 2002 to August 2003

Project Abstract :

Well-defined block-copolymers will be synthesized using the ATRP or ring opening techniques. For the delivery of hydrophobic drugs, PEO-PPO-PEO functionalized with LA or CL will be examined. The effect of LA or CA segment length on the microstructure of polymeric micelles in the presence and absence of drugs will be evaluated. For protein drug applications, anionic blocks (e.g. methacrylic acid, acrylic acid) will be used, while cationic blocks (e.g. lysine, vinyl pyridine) are considered for gene and DNA delivery system. In order to achieve our goal, we will evaluate their effectiveness through careful thermodynamics studies using the isothermal titration calorimetry where the interactions between the polymer and drugs under different stimuli will be examined. The structural properties of the complex will be examined using the static and dynamic light scattering system. Detailed mechanism and physics that control the micellization, microstructure and drug/polymer interactions will be developed.

Dr Yao Jun

Expertise: Multiphase flows, computational fluid dynamics

Electrostatics and Attrition in Flow of Granular Materials

Project Advisor : Assoc Prof Wang Chi-Hwa
Duration : August 2003 to August 2005

Project Abstract :

Granular flow in a pneumatic conveying system has been widely used in the energy, chemical, pharmaceutical, and material processing industries although their flow properties and problems have not yet been fully clarified. Present project aims to focus upon two aspects: electrostatics of the granular flow and particle attrition. For electrostatics aspect, present work has proceeded in the following directions: (1). to study the charge generation mechanism in pneumatic conveying systems; (2). to find an effective anti-static method and confirm its working principle. For particle attrition, we study the flow behaviors and properties of the attrited particles in pneumatic conveying systems. In the end, experimental results will be compared and substantiated by numerical simulation.

Dr Yu Shi

Expertise: Design, synthesis, and characterization of magnetic nanostructured materials for drug delivery and bio-separation

Magnetic Nanoparticles for Drug Delivery

Project Advisor : Assoc Prof Chow Gan-Moog
Duration : April 2002 to March 2004

Project Abstract :

While newer and more powerful drugs are continuously developed, increasing interests are being attracted to the methods by which therapeutic

agents can be efficiently delivered to targeting organs and cells. In conventional drug delivery, the drug concentration in the blood rises when the drug is taken, then peaks and declines. Since each drug has a plasma level above which it is toxic and below which it is ineffective, the plasma drug concentration in a patient at a particular time depends on compliance with the prescribed routine. This work focuses on the following potential advantages of targeted drug delivery using magnetic carrier: (a) magnetic carrier can deliver the agents to the target cells in a short period with the aid of an external magnetic field; (b) the delivered drug can be retained at the target area, therefore, the negative side effects of the administered drug are expected to be greatly reduced; (c) drug quantity required to achieve a therapeutic effect may be greatly reduced; (d) the drug release rates can be controlled on demand by application of an oscillating magnetic field at prescribed intervals.