AIBN Master Projects | Professor Andrew Whittaker

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Project 1: Novel Biologically-Responsive MRI Agents

The development of MRI imaging agents has been central to the rise of MRI as a leading medical diagnostic tool. An MRI imaging agent is a molecular adjunct which enables enhanced image definition and reduced imaging times, as well as mapping of specific cell types. In this project new imaging agents will be developed which respond to specific biological triggers relevant to diseases, for e.g. changes in pH, ionic strength, oxygen tension, redox environment and temperature. The project will involve synthesis of novel functional polymers using controlled radical polymerisation methods and testing of these molecules as imaging agents in animal models. The project is supported by the Australian Research Council and the National Health and Medical Research Council and involves extensive national and international collaboration. The student will receive training in polymer chemistry, NMR and MRI and biomedical sciences. *Responsible scientist: Andrew Whittaker*

Project 2: MRI Imaging Agents for Disease Detection

The aim of this project is to develop new magnetic resonance (MR) molecular imaging strategies that will enable the in vivo monitoring of biological processes. Specifically we shall develop novel polymers for imaging of early markers of diseases such as melanoma, prostate cancer, malignant glioma and Alzheimer's disease. Specifically the project involves the synthesis of new partly-fluorinated polymers having controlled architecture for the rapidly developing field of ^{19}F MRI. The project aims to relate the structure of the macromolecules, determined carefully using advanced techniques such as NMR, light scattering, GPC, AFM and electron microscopy, to the performance as imaging agents. The agents will be tested in small animal (mouse) models of disease already developed by this group and our collaborators. *Responsible scientist: Andrew Whittaker, and Hui Peng*

Project 3: Light, pH and Ion Responsive Hydrogels

The ability to actively change shape is essential to all kinds of living organisms. For example, the Venus flytrap closes its leaves in less than seconds to efficiently catch flies, and pine cones open their scales when the environment is dry to release their seeds. Inspired by such phenomena, numerous studies have aimed to develop artificial smart materials which can undergo shape transformations under the action of an external stimulus. Among the various classes of shape-changing materials, hydrogels are particularly attractive because of the potential for significant changes in volume under diverse external stimuli, and the potential for programmable complex shape changes. The interesting properties of hydrogels make them candidates for diverse applications in many fields, such as in soft robotics, artificial muscles, three-dimensional (3D) cell culture and drug or cell delivery devices. In this project we explore an innovative approach to spatially varying properties of hydrogels so that they undergo rapid and reversible shape changes on exposure to external stimuli. *Responsible scientist: Andrew Whittaker*

Project 4: Nanofunctional Surfaces for Control of the Biological Interface

Biomaterials support, repair or protect the human body. The surface of the biomaterial interacts with the body's immune system, or for external devices with pathogens. Control of the surface and how it interacts with the biological system is essential for effectiveness in its intended application. This project aims to develop innovative strategies for surface functionalisation using polymers that can either augment or attenuate the body's response to the material. Two focus applications, namely anti-microbial surfaces and functional titanium alloys have been identified for the development of the novel surface treatments. The projects will build effective pathways from materials science to pre-clinical evaluation, and will provide training in synthetic chemistry, biomaterials science and pre-clinical testing. *Responsible scientist: Hui Peng*

Project 5: Understanding Architecture Effect of Fluoropolymers on ^{19}F MRI Property

Despite the wide use of metal-based MRI contrast agents such as gadolinium chelates in the clinic, safety concerns have been raised regarding their potential toxic effects resulting from long-term in vivo retention. This has driven the development of organic metal-free contrast agents in various forms for use in MRI. Fluoropolymers, polymers containing fluorine, are very promising candidates as organic metal-free MRI contrast agents. However, the clinical application of fluoropolymers as ^{19}F MRI contrast agents has been greatly limited due to insufficient imaging sensitivity of current fluoropolymers. This project aims to boost the imaging sensitivity of ^{19}F MRI by controlling the architecture of synthesised fluoropolymers. The project will highlight the important relationship between the architecture and properties of fluoropolymers, contributing to the development of advanced fluoropolymers as ^{19}F MRI contrast agent with clinical potential. *Responsible scientist: Andrew Whittaker and Changkui Fu*

Project 6: Protection and controlled release of small molecules

Encapsulation is a powerful technique, used in a wide range of industrial applications, to protect and allow for controlled release of active ingredients. Often, polymers are used to form a shell around the active ingredient, however, due to the porous nature of a polymer network, such shells do not effectively protect sensitive active ingredients from moisture and oxygen degradation, and can not prevent diffusion of the active ingredient into favourable bulk conditions. With the micro-plastics ban and drive for more environmentally friendly materials, this project explores the ability of inorganic materials to protect small molecule/sensitive active ingredients efficiently, whilst allowing for controlled release at the desired place and time. Responsible scientist: *Alison White*

Contact the project advisor directly to discuss the project and arrange a meeting or AIBN Events (aibn.events@uq.edu.au) to arrange a visit to the AIBN lab.

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