



Institute of Technology

Ciência sem Fronteiras / Science Without Borders

Postgraduate Project Template

Institution:	Waterford Institute of Technology
Title of Postgraduate Opportunity: (include level of study)	Supercritical Fluid Assisted Cleaning of Medical Polymers for Microstructural Homogenization and Mechanical Performance Enhancement PhD
PI Name & Contact Details:	Dr Austin Coffey / Mr Philip Walsh Convergent Technologies Research Group Dept. Engineering Technology Waterford Institute of Technology, Ireland +353 51 302090 / +353 86 4041666 acoffey@wit.ie
Department/School:	Engineering
Research Centre /Group:	Convergent Technologies Research Group
Research Centre/Group website:	www.ctrg.ie
<p>Brief Summary of PI research / research group /centre activity</p> <p>The Convergent Technologies Research Group (CTRG) is a multi-disciplinary research cluster combining expertise in various fields of technology. The aim is to create a dynamic environment for collaborative research to deliver innovative solutions for convergent applications. Current research activities span a broad spectrum, ranging from infrastructural technologies (water, energy and the environment) through materials development (polymeric formulations, polymer processing and super-critical fluid enabled technologies) to passive and active medical devices (mock cardiovascular loops, catheter technologies and implantable platforms). CTRG has attracted significant funding and support from SFI, Enterprise Ireland, IOTI and multiple industrial partners; in the infrastructural, materials, microelectronic and biomedical sectors.</p> <p>In the medical device industry, among many others, processing of polymers is of the highest importance and influences the manufacture of countless products ranging from drip tubing to angioplasty catheters. In many cases a patient's life may be dependent on the performance of the device, obligating manufacturers to be extremely sensitive to quality concerns; as failure would be catastrophic. In specific instances a zero tolerance approach must be taken regarding defects in the end product. Often times</p>	

this necessitates vigorous opposition to the presence of irregularities (un-reacted monomers, contaminants, residuals etc.), and/or inconsistencies (oligomers, low molecular weight/short chain components) in the polymeric materials from which such devices are manufactured. However, in truth, a degree of erraticism often exists in the micro-structural homogeneity of raw, unprocessed, bulk-polymer which can produce inconsistencies in the mechanical and functional performance of the end product, often leading to unforeseen failures. Novel processing techniques which exploit supercritical fluids represent a truly unique and valuable area of materials science with enormous potential for the enhanced processing of many materials. One area in which the advantages of supercritical fluids are particularly apparent is in the polymeric field. Applications of supercritical fluids are numerous in the field of polymer processing. The ability of supercritical fluids to swell and plasticise polymers is crucial to the impregnation, extraction, and modification of polymeric materials. Plasticisation effects also reduce viscosity therefore improving processing ability due to dramatically reduced shear stresses. Through the exploitation of such techniques many opportunities exist for enhancing the processability of numerous polymeric-based materials ranging from textiles to food and biomaterials. However, the subject of polymer solubility in supercritical solvents, and the phase behaviour of polymer-supercritical fluid solutions, have not been fully defined, metricised or parameterised resulting in relatively slow uptake of the technology in commercialisation and high volume manufacturing environments. The premise of this research is to investigate supercritical fluid 'cleaning' of polymeric materials with a view to enhancing microstructural homogeneity through the removal of undesirable components and the normalisation of molecular weight distributions; subsequently enhancing the mechanical and functional performance of manufactured polymeric products. In doing so this work will act as a stimulus for further research into the applications of supercritical fluid assisted processing within the disciplines of polymer science and engineering and, if successful, is expected to have significant commercialisation potential in the manufacture of medical device products such as angioplasty balloon catheters and implantable inflation devices.

Key Attributes of Project for Brazilian Postgraduate Students

Supercritical fluid assisted polymer processing can add significant commercial value to traditional polymer processing technologies. These include, but are not limited to:

Processing of thermo-sensitive materials

Incorporation of additives and reinforcing agents, previously resulting in the polymer system becoming un-processable

Incorporation of active ingredients (for the Pharma or Medical Device industry) into polymer matrices

Processing of previous "un-processable" materials, including metals and ceramics

The Convergent Technologies Research Group (CTRG) has recently acquired a state-of-the-art supercritical fluid polymer processing system, including extrusion, injection moulding, reaction vessels and is soon acquiring a custom made reaction injection moulding system. This is the only processing suite of its kind in Ireland, UK and most of Europe.

Significant industry interest, especially from the Medical Device community has resulted, especially for the modification of polymer materials to result in finished products with tailored mechanical properties and for drug encapsulation, for example, comfort ingredients into contact lenses.

The CTRG is an academic partner of one of the foremost SCF equipment producing companies in the world, SCF Processing Ltd., and also has very strong ties with the University of Florida, US in this area. This technology, while already identified as a critical source of support and development to industry in

Ireland, can add unique advantages to a PhD student from Brazil in knowledge transfer and upskilling regional industry in Brazil in the highly lucrative area of medical devices.

Name and contact details for project queries, if different from PI named above:

Dr Austin Coffey, acoffey@wit.ie

Please indicate graduate disciplines which are eligible for application:

Polymer Engineering

Materials Engineering

Mechanical Engineering

Electronic Engineering

Chemical Engineering

Physics

Alignment with Science Without Borders Priority Areas:

Please indicate the specific programme priority area under which the proposed postgraduate project fits – choose only one (tick box)

Engineering and other technological areas	<input checked="" type="checkbox"/>
Pure and Natural Sciences (e.g. mathematics, physics, chemistry)	<input type="checkbox"/>
Health and Biomedical Sciences	<input checked="" type="checkbox"/>
Information and Communication Technologies (ICTs)	<input type="checkbox"/>
Aerospace	<input type="checkbox"/>
Pharmaceuticals	<input type="checkbox"/>
Sustainable Agricultural Production	<input type="checkbox"/>
Green Chemistry	<input type="checkbox"/>
Oil, Gas and Coal	<input type="checkbox"/>
Renewable Energy	<input checked="" type="checkbox"/>
Minerals	<input type="checkbox"/>
Biotechnology	<input type="checkbox"/>
Nanotechnology and New Materials	<input type="checkbox"/>
Climate Change	<input type="checkbox"/>
Biodiversity and Bioprospection	<input type="checkbox"/>
Marine Sciences	<input type="checkbox"/>
Productive Inclusion and Social Technologies	<input type="checkbox"/>
Housing and Sanitation	<input type="checkbox"/>