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Xiang Zhang

University of Cambridge, UK

New concept of bioresorbable polymer-based ceramic hybrids for cardiovascular stent applications

This presentation will introduce new theories and industry practice for design and development of polymer-based ceramic hybrids. The evolution from pure polymer-based medical devices to polymer-based ceramic hybrids is to meet unmet market needs for better clinical performance over existing systems. There are many factors that can affect medical implant performance and, historically, most of them have been well studied, such as bioactivities and biocompatibility. In this presentation, new concept will be mainly addressing issue surround biomechanics, biofracture mechanucs and biofunctionality for design and development of new hybrid biomaterials for implant applications. It will report the principles on formulations for two type of the new systems. One family is of biodegradable and bioresorbable hybrids and 2nd is of non-biodegradable hybrids. It will be followed by design and development of medical devices in view of industry practice with clinical performance considerations of medical devices. The main topics covered in the presentation include: (a) New concepts and synthetic pathway of polymer-based ceramic hybrids; (b) Nano/Micro mechanics and nano/micro fracture mechanics; (c) Industry practice – two case studies will be used to demonstrate on how to design and develop polymer-based ceramic hybrid biomaterials and relevant processing technology for the applications of medical implants. Cardiovascular stent, as an example is traditionally made of metal such as Bare Metal Stents (BMS) or with drug coatings, i.e. Drug Eluting Stents (DES). There are, however, clinical complications associated with these technologies, such as, early stage restenosis, very late thrombosis and risk associated with revision surgery. In light of these challenges research focus has turned to the development of bioresorbable vascular scaffold (BVS) technologies. We have developed new bioresorbable polymer-based ceramic stent that has been reinforced resorbable therapeutic cardiovascular stent to address the known limitations of cardiovascular technologies. We have developed a bioresorbable stent with intrinsic toughness for handling and deployment via balloon angioplasty, radial strength, controlled drug-release technology to suppress restenosis and surface functionalisation to promote endothelialisation to reduce risk of thrombosis. We present the novel synthetic polymer-ceramic composites developed as candidate stent-core materials, both their preparation and the characterisation of their mechanical behaviour, in vitro degradation will be presented.

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Recent Publications

1. Science and Principles of Biodegradable and Bioresorbable Medical Polymers - Materials and Properties, 2016 by Elsevier
2. Inorganic Controlled Release Technology, 1st Edition - Materials and Concepts for Advanced Drug Formulation, 2015 pub. by Elsevier
3. Inorganic Biomaterials: Structure, Properties and Applications, 2014 pub. By Smithers Rapra
4. Polymer, 41 (2000) 3797-3807, X C Zhang, M F Butler and R E Cameron, "The Ductile – Brittle Transition of Irradiated Isotactic Polypropylene Studies Using Small Angle X-ray Scattering and Tensile Deformation"
5. Advanced Materials, 12 December 2015, Yongjiu Lei, Ruize Sun, Xiangcheng Zhang, Xinjian Feng, Lei Jiang, "Oxygen-Rich Enzyme Biosensor Based on Superhydrophobic Electrode"

6. Polymer, 41 (2000) 3797-3807, X C Zhang, M F Butler and R E Cameron. "The Ductile – Brittle Transition of Irradiated Isotactic Polypropylene Studies Using Small Angle X-ray Scattering and Tensile Deformation"

Biography

Xiang Zhang, Royal Society Industry Fellow of University of Cambridge, has over 34 years combined academia (17 years) and industrial (17 years) experience in advanced materials science and technology, an expert in polymer and polymeric hybrid materials science and technology. Prof. Zhang is also Head of the Lucideon Cambridge School of Advanced Materials and Head of Medical Materials and Devices. He is the author of three books "Inorganic Biomaterials", "Inorganic Controlled Release Technology" and "Science and Principles of Biodegradable and Bioresorbable Medical Polymers - Materials and Properties". As a materials scientist, he is passionate on "Science for Industry "and believes fundamental but applied sciences are the keys to industry R&D and problem solving. Prof. Zhang undertook his PhD and postdoctoral research at Cranfield University where he studied materials physics and nano/micro-mechanics and nano/micro-fracture mechanics of polymeric hybrid (organic and inorganic) materials. After spending a further four years on research for industrial applications, he was awarded an industrial fellowship at the University of Cambridge in 1995, where he carried out research on fundamental nanomechanisms of polymeric ductile to brittle transitions, which is first time in the world ever employing synchrotron SAXS, WAXS (wide angle and small angel X-ray scattering) to study in situ deformation and fracture down to nanometre scales, the results of which lead to completion of ductile to brittle transition theories in view of nano-mechanics and nano-fracture mechanics. Prof. Zhang's industry experience was gained in leading international healthcare companies, where, as Principal Scientist/Technologist, his work covered almost all aspects of medical materials and devices from R&D and manufacturing support to failure analysis and QC. Prior to joining Lucideon, Prof. Zhang worked as Director of a technology company, in the field of nano-conductive materials and diagnostic medical devices.

Xiang.zhang@lucideon.com