NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

School of Materials Science and Engineering

Seminar Topic:
Thermogels for Biomedical Applications

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Abstract

Thermogels are valuable soft materials for biomedical applications. At low temperatures, they remain as solutions which can be used to entrap therapeutic payloads such as drugs and proteins within their solvated polymer matrices. Upon injection into the body, higher body temperatures cause the solutions to gelate in situ at the site of injection, allowing localized placement for applications such as drug delivery. Herein, we present our three-component thermogelling polyurethane technology comprising of biocompatible polyethylene glycol (PEG), poly(propylene glycol) (PPG) and a third component, which can be poly(caprolactone) (PCL), poly(tetrahydrofuran) carbonate (PTHF) or poly[(R)-3-hydroxybutyrate-(R)-3-hydroxyhexanoate] (PHBHx), as a unique platform for biomedical applications. Our thermogels loaded with anticancer drugs were highly effective for inhibition of tumour growth in vivo using mice models. Docetaxel-loaded PEG-PPG-PHBHx thermogels showed enhanced anti-melanoma effects on solid melanoma tumours compared with the free drug, whilst exhibiting excellent biosafety and no apparent harm to organs. With doxorubicin-loaded PEG-PPG-PTHF thermogels, sustained drug release for 16 days in vivo successfully inhibited growth of hepatocellular carcinoma. Impressively, incorporating a dye capable of aggregation-induced emission into the polymer structure allowed it to be used to track in-vivo doxorubicin release status and gel degradation, revealing valuable insights on the drug transportation pathways. Recent efforts on PEG-PPG-PCL thermogels are concentrated on their unprecedented use in vitreoretinal surgery as a vitreous substitute and an internal tamponading agent. The thermogel showed long-term biocompatibility in rabbit vitrectomy models, and was an effective endotamponade in a non-human primate surgical retinal detachment model. This is likely attributed to the thermogel providing support for the retina and preventing subsequent re-detachments. Intriguingly, there is reformation of a vitreous-like body that mimics the property of natural vitreous as the polymer biodegrades over three months. Thermogels offer vast scope for customizable tuning of their mechanical properties for various biomedical applications. We have also successfully modified the polyurethane synthesis conditions using different monomer ratios together with novel catalysts, which allowed thermogels of vastly improved stiffness and mechanical strength to be accessible. Studies are currently underway, and this opens up new and exciting avenues for our thermogels to be used in further biomedical applications requiring higher mechanical strength.

Biography

Adjunct Professor Loh Xian Jun graduated with a PhD from the National University of Singapore. He is a polymer chemist with 20 years of scientific experience working in the inter-disciplinary field of biomaterials. He is currently the Executive Director at the Institute of Materials Research and Engineering (IMRE) as well as Director of Graduate Affairs in A*STAR/SERC. His main research interests are in the design of supramolecular and stimuli-responsive polymers and hydrogels for biomedical and personal care applications. Currently, he is the author and co-author of >200 journal papers, 19 patents, 45 book chapters and 6 books, publishing mainly in the area of biomaterials. He serves on 6 editorial boards and is consulted extensively by major funding bodies. He is the current Vice President of the Singapore National Institute of Chemistry.

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Live Streaming Link: https://ntu-sg.zoom.us/j/91521959777
Meeting ID: 915 2195 9777 Passcode: 6t668e
Hosted by: Professor Chen Xiaodong

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