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3D Biofabrication of polyvinyl alcohol/maghemite nanofiber scaffold for hard tissues

The development of scaffolds has been possible by adopting processing techniques such as electrospinning which is simple, versatile and has the capability to produce nanofibers. The spun nanofibers have submicron diameters structures that mimics the extracellular matrix (ECM) of natural human tissue. The limitation with electrospinning lies in the scaffold thickness and strength due to the nature of the process. Thus, in most cases a combination of two or more processes in series is adopted to overcome the problems. Processes such as fused deposition modelling (FDM), three-dimensional (3D) printing and vapor sintering are some of the options available. In some cases, the electrospinning collector is redesigned and modified, the cold plate collector is used instead of the rotating collector. In this particular study, polyvinyl alcohol (PVA) which has good mechanical, chemical and thermal stability is combined with maghemite nanoparticles whose function is to enhance cell growth. The fundamental corrugated shape was produced via fused deposition modelling (FDM) 3D printing using commercialized PVA (partially hydrolysed PVA) as the filament material which ultimately becomes the template for the next step. The formed template was then placed into the mould packed with the required fully hydrolydsed PVA/maghemite (γ-Fe_2O_3) solution. Upon solidification the whole structure was submerged in water where dissolution of partially hydrolysed PVA template occurred. The new 3D formed structure which takes the shape of the template was then further layered with electrospun PVA/maghemite (γ-Fe_2O_3) nanofibers by placing onto the rotating collector of electrospinning machine. The resultant final 3D scaffold possessed both milli and microporous internal structure with a nanoporous external structure due to the electrospun layer. Mechanical analysis revealed sufficient compressive strength greater than 75MPa and a Young's modulus of approximately 1.5 GPa, which satisfies the anticipated range for hard tissue engineering scaffolds. In vitro test revealed human fibroblast cells can grow well inside and outside the 3D scaffold indicating cell growth is facilitated as intended.

Speaker Biography

Ani Binti Idris is a Professor in the Department of Bioprocess and Polymer Engineering, Faculty of Chemical and Energy Engineering at Universiti Teknologi Malaysia and also holds a cross appointment as a Fellow in Institute of Bioproduct Development. She is also a founder of MEMTEC PLT a spinoff company of Universiti Teknologi Malaysia. She was awarded as Malaysia Top Research Scientist in 2015. She is a Chartered Chemical Engineer and also a Professional Engineer. She has published more than 140 impact factor journals relating to her research area, obtained over 2253 citations, H- index 26 and has 6 patents granted.

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