Transforming Fibronectin Structures with Customized 3D Molecular Architectures for Advanced Polymeric Surfactants

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Abstract

Polymeric microparticles (MPs) are a simple 3-Dimensional (3D) structures that have numerous healthcare applications including tissue engineering, diagnostics and drug delivery.[1,2] However, a common problem with the production of particles, regardless of the production technique, is the inclusion of unwanted surfactants which cover the surface of particles and are very difficult to remove.[3] This presents a problem for biomaterials, as numerous studies have shown that biological-surface interactions are dependent on surface chemistry.[1,2,4] For example, the presence of residual surfactant, such as the commonly used poly(vinyl alcohol-co-vinyl acetate) (PVA), has been shown to mask surface chemistry and impact on the resultant bacterial attachment properties. Thus, new approaches are required to produce particles which exhibit diverse surface chemistries where the process of preparation does not interfere with surface chemistry.[3]

In this seminar, a new method of producing highly functional MPs with selected surface chemistry is described. Polyethyl acrylate (PEA) candidate materials have been synthesised in the form of polymeric surfactants for the stabilisation of oil-in-water emulsions within a droplet-based microfluidics process to produce highly monodisperse MPs in flow. PEA has shown, in previous study, to trigger the spontaneous assembly of fibronectin (FN) molecules into biological networks.[5] The surfactants in this study were produced by copolymerising the target ethyl acrylate monomer with a cationic hydrophilic co-monomer, 2-(dimethylamino) ethyl methacrylate (DMAEMA), which bears a tertiary amine in the side chain. Finally, the tailored cell-instructive surfactant-based coatings were delivered by arranging the hydrophobic/hydrophilic segments in the form of either a statistically or block format. Thus, a surface analysis was conducted to study how the surface chemistry and copolymer molecular structure, when applied to both a 2D (glass coverslip substrate) and 3D (MPs), influenced the capability of the coated surface to modify the response to mammalian fibroblast, FN (bone fixation promotion) and *S. aureus* attachment (biofilm prevention).

[1] *Alvarez-Paino et al. ACS applied materials & interfaces, 11(38), 34560-34574, 2019*

[2] *Latif, Fisher and Dundas et al. Advanced Materials, 2208364, 2022*

[3] *Husler et al. RSC Advances, 8(28), 15352-15357, 2018*

[4] *Dundas and Cuzzucoli Crucitti et al. Advanced Functional Materials, 30(36), 2001821, 2020*

[5] *Llopis-Hernández et al. Science Advances, 2(8), 1-10, 2016*