Template-assisted fabrication of poly(vinyl alcohol) nanostructures for cell studies

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Hydrogels play an important role in the field of biomedicine due to their three-dimensional polymer network structure, high swelling ratio and mechanical properties [1, 2, 3]. Dyes and drugs can be incorporated into the network to be later released by diffusion or due to biodegradability of the polymers [4]. The high water content results in soft materials similar to biological tissue [5]. It is also known that biointerfaces may determine cellular behavior and functions [6]. By influencing the properties of tailor-made hydrogels, biological tissue is mimicked and tuned to favorable cell-hydrogel interactions.

In this work, poly(vinyl alcohol) (PVA) was chosen for the fabrication of hydrogels because of its excellent biocompatibility. PVA hydrogels are generated by repeating freezing-thawing cycles (FT-cycles) to physically cross-link the aqueous polymer solution. The stiffness of the PVA hydrogel is varied by the number of FT-cycles. In addition, topographic nanostructures with tunable aspect ratio are included in the hydrogel by replicating anodic aluminum oxide (AAO) templates. The hexagonally aligned, nano-sized pillars are released from the porous template after physically cross-linking by a peeling-off process.

Bare PVA hydrogel lacks cell-adhesive properties, due to its hydrophilicity that inhibits the adhesion of cell adhesion proteins. Attachment of 3-aminopropyltriethoxysilane and fibronectin to the PVA hydrogel was therefore applied to promote cell adhesion and proliferation of NIH 3T3 fibroblast cells and PaTu 8988t pancreatic cancer cells. On this basis, the dependence of cell-hydrogel interactions on hydrogel stiffness and topography were unveiled.

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