

Capillary Force-Driven Self-Organization of Polymeric Microcubes: Reconfigurable Assemblies for Multifunctional 3D Cell Microenvironments

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Abstract

In this contribution, a recently reported strategy for the fabrication of asymmetric multifunctional microenvironments is presented, which was established based on capillary force-assisted assembly of hydrophobic microscale cubes [1-4]. Polystyrene (PS) microcubes were fabricated via nanoimprint lithography (NIL). By controlling the wettability of five sides of the cubes with self-assembled monolayer coatings on the one hand as well as the surface tension of the aqueous subphase on the other hand, the cubes were observed to prefer different orientations at the water/air interface, namely face up, edge up and vertex up orientation, respectively (Figure 1). Driven by capillary forces, cubes that exhibit different orientations formed distinct aggregates with ordered structures, which could be changed *in situ* by altering the surface tension or exploiting the LCST behavior of grafted polymer brushes. Using this strategy, asymmetric multifunctional 3D cell microenvironments were established by transferring and fixing the close-packed hexagonal aggregates, which were self-assembled at the water/air interface, onto a solid support. By grafting passivating poly(acrylamide) (PAAm) brushes from selected side walls of the microwells, protein adsorption and protein mediated cell attachment were shown to be varied according to the (a)symmetry of the 3D microenvironment. The random assembly of distinctly different cubes from a library comprising microcubes that are pre-functionalized or surface-structured exclusively on their top surface opens a pathway to generate a multitude of different microenvironments in a massively parallel combinatorial manner, enabling future systematic structure-property relationship studies with cells.

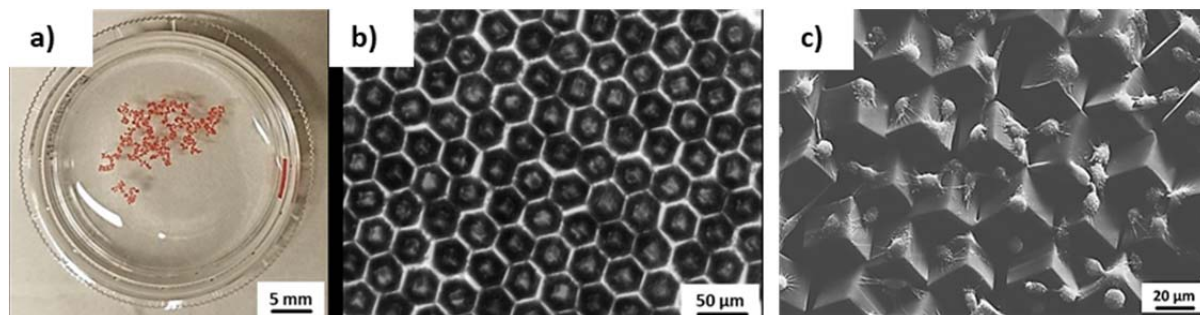


Figure 1. (a) Optical microscopy as well as (b,c) SEM images of assemblies of PS microcubes at the air-water interface, after transfer to a solid support and after incubation with cells, respectively.

Acknowledgements

The authors gratefully acknowledge financial support from the European Research Council (ERC project ASMIDIAS, Grant no. 279202) and the University of Siegen. Part of this work was performed at the Micro- and Nanoanalytics Facility (MNAF) of the University of Siegen.

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