Generation of gelatin-based hydrogel foams with controllable pore sizes and pore openings

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ABSTRACT

Hydrogels of biopolymers such as gelatin are widely accepted as functional materials in the field of biomaterial science due to their inherent biocompatibility and biodegradability [1]. However, as mesh sizes in chemically cross-linked hydrogels usually range from a few nanometers to tens of nanometers, diffusion of larger molecules through hydrogels is severely hindered. An approach to overcoming diffusion limitations is to introduce additional interconnected pores in the micrometer range into the hydrogels, i.e. to produce hydrogel foams. To this end, liquid foam templating can be used [2]. Microfluidic bubbling with different microfluidic chips can be used to generate monodisperse liquid foams with bubble sizes ranging from 110 µm to 390 µm. The continuous phase consists of methacryloyl-modified gelatin which enables solidification of the liquid foam by UV-initiated radical cross-linking. As the viscosity of aqueous solutions of methacryloyl-modified gelatin is much lower than that of non-modified gelatin, concentrations of up to 20 wt. % can be obtained [3]. The control of the foam morphology, i.e. of both the pore size and the pore opening size, is essential for potential applications such as tissue engineering. The pore size of the foam can be controlled precisely by tailoring the bubble size of the liquid template. This can be achieved by tuning the liquid flow rate and the gas pressure during microfluidic bubbling. The pore opening, on the other hand, can be tailored via the liquid fraction of the foam. Pore openings between 62 µm (Fig. 1, left) and 35 µm (Fig. 1, right) were obtained. The ability to control the structure of the foam allows examining its influence on the behavior of specific cell types in cell culture.

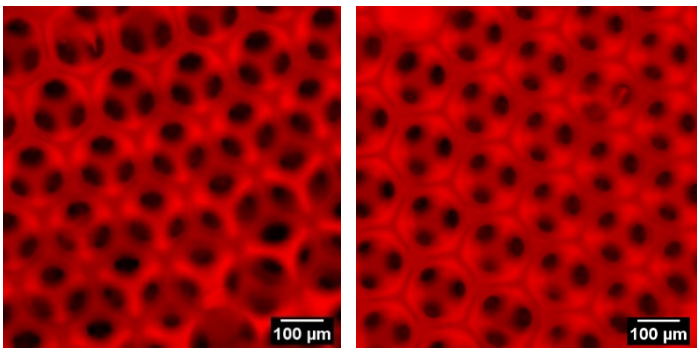

Figure 1: Fluorescence microscopy images of foams with tailored pore openings of 62 µm (left) and 35 µm (right), respectively. The average pore size is 170 µm.

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[3]: E. Hoch, C. Schuh, T. Hirth, G.E.M. Tovar, K. Borchers, J. Mat. Sci.: Mat. Med., **2012**, *23*(11), 2607 – 2617.