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Bulk Modification of Poly(Dimethylsiloxane) for Biomedical Applications

Authors : A. Aslihan Gokaltun, Martin L. Yarmush, Ayse Asatekin, O. Berk Usta

Abstract : In the last decade microfabrication processes including rapid prototyping techniques have advanced rapidly and achieved a fairly matured stage. These advances encouraged and enabled the use of microfluidic devices by a wider range of users with applications in biological separations, and cell and organoid cultures. Accordingly, a significant current challenge in the field is controlling biomolecular interactions at interfaces and the development of novel biomaterials to satisfy the unique needs of the biomedical applications. Poly(dimethylsiloxane) (PDMS) is by far the most preferred material in the fabrication of microfluidic devices. This can be attributed its favorable properties, including: (1) simple fabrication by replica molding, (2) good mechanical properties, (3) excellent optical transparency from 240 to 1100 nm, (4) biocompatibility and non-toxicity, and (5) high gas permeability. However, high hydrophobicity (water contact angle ~108°±7°) of PDMS often limits its applications where solutions containing biological samples are concerned. In our study, we created a simple, easy method for modifying the surface chemistry of PDMS microfluidic devices through the addition of surface-segregating additives during manufacture. In this method, a surface segregating copolymer is added to precursors for silicone and the desired device is manufactured following the usual methods. When the device surface is in contact with an aqueous solution, the copolymer self-organizes to expose its hydrophilic segments to the surface, making the surface of the silicone device more hydrophilic. This can lead to several improved performance criteria including lower fouling, lower non-specific adsorption, and better wettability. Specifically, this approach is expected to be useful for the manufacture of microfluidic devices. It is also likely to be useful for manufacturing silicone tubing and other materials, biomaterial applications, and surface coatings.

Keywords : microfluidics, non-specific protein adsorption, PDMS, PEG, copolymer
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