World Academy of Science, Engineering and Technology
International Journal of Bioengineering and Life Sciences
Vol:11, No:04, 2017

A Facile One Step Modification of Poly(dimethylsiloxane) via Smart Polymers for Biomicrofluidics

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Abstract : Poly(dimethylsiloxane) (PDMS) is one of the most widely used materials in the fabrication of microfluidic devices. It is easily patterned and can replicate features down to nanometers. Its flexibility, gas permeability that allows oxygenation, and low cost also drive its wide adoption. However, a major drawback of PDMS is its hydrophobicity and fast hydrophobic recovery after surface hydrophilization. This results in significant non-specific adsorption of proteins as well as small hydrophobic molecules such as therapeutic drugs limiting the utility of PDMS in biomedical microfluidic circuitry. While silicon, glass, and thermoplastics have been used, they come with problems of their own such as rigidity, high cost, and special tooling needs, which limit their use to a smaller user base. Many strategies to alleviate these common problems with PDMS are lack of general practical applicability, or have limited shelf lives in terms of the modifications they achieve. This restricts large scale implementation and adoption by industrial and research communities. Accordingly, we aim to tailor biocompatible PDMS surfaces by developing a simple and one step bulk modification approach with novel smart materials to reduce non-specific molecular adsorption and to stabilize long-term cell analysis with PDMS substrates. Smart polymers that blended with PDMS during device manufacture, spontaneously segregate to surfaces when in contact with aqueous solutions and create a < 1 nm layer that reduces non-specific adsorption of organic and biomolecules. Our methods are fully compatible with existing PDMS device manufacture protocols without any additional processing steps. We have demonstrated that our modified PDMS microfluidic system is effective at blocking the adsorption of proteins while retaining the viability of primary rat hepatocytes and preserving the biocompatibility, oxygen permeability, and transparency of the material. We expect this work will enable the development of fouling-resistant biomedical materials from microfluidics to hospital surfaces and tubing.

Keywords : cell culture, microfluidics, non-specific protein adsorption, PDMS, smart polymers
Conference Title : ICBMM 2017 : International Conference on Biomaterials, Microstructure and Macrostructure
Conference Location : Boston, United States
Conference Dates : April 24-25, 2017

Open Science Index, Bioengineering and Life Sciences Vol:11, No:04, 2017 publications.waset.org/abstracts/69953.pdf