World Academy of Science, Engineering and Technology
International Journal of Biomedical and Biological Engineering
Vol:11, No:07, 2017

Influence of Surface Wettability on Imbibition Dynamics of Protein Solution in Microwells

Authors : Himani Sharma, Amit Agrawal

Abstract : Stability of the Cassie and Wenzel wetting states depends on intrinsic contact angle and geometric features on a surface that was exploited in capturing biofluids in microwells. However, the mechanism of imbibition of biofluids in the microwells is not well implied in terms of wettability of a substrate. In this work, we experimentally demonstrated filling dynamics in hydrophilic and hydrophobic microwells by protein solutions. Towards this, we utilized lotus leaf as a mold to fabricate microwells on a Polydimethylsiloxane (PDMS) surface. Lotus leaf containing micrometer-sized blunt-conical shaped pillars with a height of 8-15 µm and diameter of 3-8 µm were transferred on to PDMS. Furthermore, PDMS surface was treated with oxygen plasma to render the hydrophilic nature. A 10µL droplets containing fluorescein isothiocyanate (FITC) - labelled bovine serum albumin (BSA) were rested on both hydrophobic (θa = 108o, where θa is the apparent contact angle) and hydrophilic (θa = 60o) PDMS surfaces. A time-dependent fluorescence microscopy was conducted on these modified PDMS surfaces by recording the fluorescent intensity over a 5 minute period. It was observed that, initially (at t=1 min) FITC-BSA was accumulated on the periphery of both hydrophilic and hydrophobic microwells due to incomplete penetration of liquid-gas meniscus. This deposition of FITC-BSA on periphery of microwell was not changed with time for hydrophobic surfaces, whereas, a complete filling was occurred in hydrophilic microwells (at t=5 mins). This attributes to a gradual movement of three-phase contact line along the vertical surface of the hydrophilic microwells as compared to stable pinning in the hydrophobic microwells as confirmed by Surface Evolver simulations. In addition, if the cavities are presented on hydrophobic surfaces, air bubbles will be trapped inside the cavities once the aqueous solution is placed over these surfaces, resulting in the Cassie-Baxter wetting state. This condition hinders trapping of proteins inside the microwells. Thus, it is necessary to impart hydrophilicity to the microwell surfaces so as to induce the Wenzel state, such that, an entire solution will be fully in contact with the walls of microwells. Imbibition of microwells by protein solutions was analyzed in terms fluorescent intensity versus time. The present work underlines the importance of geometry of microwells and surface wettability of substrate in wetting and effective capturing of solid sub-phases in biofluids.

Keywords : BSA, microwells, surface evolver, wettability
Conference Title : ICMN 2017 : International Conference on Microfluidics and Nanofluidics
Conference Location : Prague, Czechia
Conference Dates : July 09-10, 2017