A LASER-POLYMERIZED THIN FILM SILICA SURFACE MODIFICATION FOR SUPPRESSION OF CELL ADHESION AND ELECTROOSMOTIC FLOW IN MICROCHANNELS

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Abstract

A laser-polymerized thin film for silica surface modification is presented. This technique enables photopatterned surface charge modification consistent with optical tweezer techniques. This charge modification may be applied for chip-based cell techniques and multi-dimensional separation techniques that require nonuniform zeta potential on a microfluidic chip.

Keywords: surface modification, zeta potential, cell adhesion

1. Introduction

Silica surface charge interferes with a number of microfluidic chip-based techniques (*e.g.,* capillary isoelectric focusing (cIEF)) by inducing unwanted electroosmotic flow (EOF); this surface charge can also interfere with chip-based cell techniques by causing cells to electrostatically adhere to cell walls. Two-dimensional separations may require selectively eliminating zeta potential (ζ) on one part of a microfluidic chip while ζ is retained in other sections. Use of optical tweezers for cell manipulation on-chip [1] further requires that surface modifications be nonabsorbent and nonscattering at the laser wavelength.

2. Surface Modification Mechanism

An aqueous mixture of 3-(trimethoxysilyl)-propyl acrylate (Aldrich) and acetic acid is applied to pretreat the silica surface (Figure 1), covalently bonding the acrylate intermediary to exposed surface charge sites. This intermediary affects ζ only slightly, and hence does not inhibit electroosmotic flow. Following this pre-treatment, frequency-tripled Nd:YAG laser emission (355 nm) is used to locally polymerize acrylamide to the intermediary. Flushing the solution leaves a photopatterned acrylamide thin film.

3. Measurements

Streaming potential was used to measure ζ in silica capillaries with and without surface modifications. For 1 mM phosphate buffer solutions (K+ cation, pH 7.3 +/- 0.2), ζ was measured at –83 +/-3 mV, -75 +/- 3 mV, and 0 +/- 1 mV for untreated, pretreated, and polymerized surfaces, respectively; the photopatterned polyacrylamide thin film

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creates an uncharged (ζ=0) surface but the pretreat step does not significantly affect ζ. A solution containing murine bone marrow mast cells (d=10 μm), glucose, and phosphate buffer was brought into contact with untreated and polymerized silica surfaces on glass cover slides and a wet-etched glass chip (30 x 150 μm channels). Cell adhesion was inferred from images after flushing with solution. On cover slides, cells appear post-flush only if adhered to the surface (Figure 2). In microchannels, adhered cells appear the same regardless of flow rate, while cells in the bulk appear only as a faint background in the flowing image. Figure 3 shows cell solutions in microchannels with and without flow (flowrates as high as 20 cm/s were used). The polyacrylamide thin film prevents mast cell adhesion.

References

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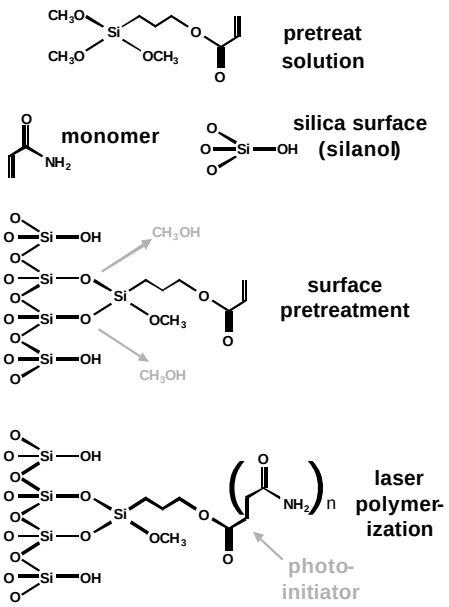

Figure 1. Surface pretreatment and laser-polymerization steps.

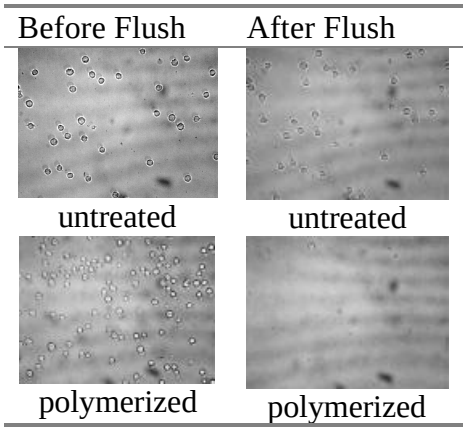

Figure 2. Cell adhesion on cover slides.

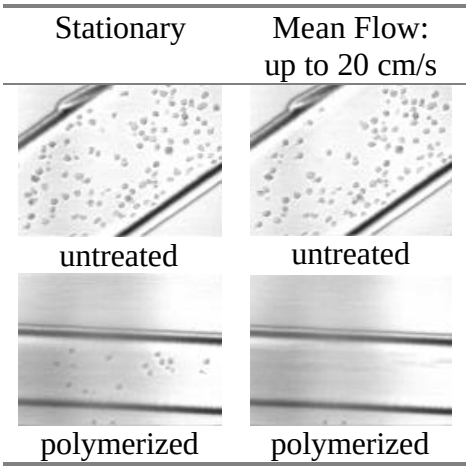

Figure 3. Cell adhesion in glass microchannels.