Microfluidic Protein Patterning on Silicon Nitride Using Solvent Extracted Poly(dimethylsiloxane) Channels

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Abstract

Biomolecular patterning is essential for the creation of sensing motifs that rely on receptor-ligand binding for selectivity. Microfluidic devices have the potential to aid in the development of simple, robust methods for biomolecular patterning and therefore contribute to the generation of protein, DNA, and cell microarrays. In microfluidic patterning, the choice of both substrate and microfluidic channel material is essential for control of both the receptor binding for maximal signal generation as well as non-specific adsorption that acts as chemical noise. In this

study, polystyrene, glass, silicon nitride, and poly(dimethylsiloxane) (PDMS) were evaluated as substrates for protein patterning using two types of PDMS microchannels for patterning, native PDMS and solvent-extracted PDMS (E-PDMS). E-PDMS microfluidic channels resulted in better patterning characteristics than native PDMS channels as determined by a higher fluorescence intensity of immobilized protein on all substrate types tested. Microfluidic patterning was then applied to perform two- and four-layer immunoassays.

Keywords: Microfluidic; protein patterning; PDMS; immunoassay

1. Introduction

Understanding and controlling the interaction of proteins with solid surfaces is important for many applications, including fabrication of protein microarrays, development of affinity binding biosensors, cell patterning, and synthesis of biocompatible materials **[1]**. Because of this significance, many approaches have been developed for protein patterning and the study protein adsorption / desorption kinetics on solid surfaces **[2]**. The emergence of microfluidic devices and microfluidic channels provides an intriguing way to study these interactions in a simple low-volume approach **[3]**. The small channel dimensions (from micron to submicron scale) ensure laminar flow conditions in the channels. The surface-to-volume ratio is also much higher in microfluidic channels than in traditional benchtop patterning systems, and this effect makes bulk-surface interactions more efficient. The reagent requirements for microfluidic patterning are typically no more than a few microliters, making the approach cost-effective when dealing with expensive antibody or DNA systems and limited sample volumes **[4]**. Through use of a microfluidic channel, a well-defined region on a surface can be patterned for constructing adsorbed protein layers. This approach allows specific control of surface patterning with minute sample size.