Micropatterned Fluorinated Polymer Surfaces for Positional Encoding of Cells

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Understanding cellular activity and communication at the single cell level is a topic of great interest. However, conventional cellular arrays are too complex for single cell detection; this necessitates the fabrication of a biosensor which confines and precisely directs the position and orientation of individual cells. The optimal array design will encourage the cells to grow within a defined area, which will contain a Raman sensor platform to obtain an analysis of the spectroscopic signature of cell processes.

Devices are designed by fabricating a patterned glass substrate that features a cytophobic (or cell repelling) surface, with regions of cytophilic (cell attracting) windows. This cytophobic surface is commonly comprised of polymers that demonstrate certain properties which reduce cell adhesion, such as Teflon-like fluoropolymers. The hydrophobic properties of the fluoropolymer cause very poor adhesion, which consequently gives the polymer the desirable cell-repellent behaviour. By patterning this polymeric surface, the underlying substrate is exposed, creating the windows for selective cell growth.

The fabrication of these devices is performed entirely in the Nanofabrication Facility at Western. After preparation of the glass substrate, high resolution patterning is achieved through the use of photolithography. A positive photoresist is spin coated into a thin film on the glass substrate, which is then exposed to UV light through a mask featuring triangular arrays. The exposed photoresist is then developed, to reveal the patterned array of triangles (Fig. 1).

The next step is the process is the deposition of the polymer surface. The fluoropolymer film is the result of a modified process using an Alcatel 601E deep silicon etching machine, in which the etching step is removed, allowing for the deposition of the fluorocarbon passivation layer. After subsequent cleaning of the underlying photoresist triangles, the surface is now comprised of the hydrophobic fluoropolymer surface, with triangular areas in which the glass substrate is exposed (Fig. 2).

The bioactivity of this device was then assessed through the growth of cells on the surface. The cells were shown to grow preferentially in the exposed glass windows, and tended to avoid the fluoropolymer surface, as desired (Fig. 3). Finally, as an application using these devices, fluorescent imaging of the cells can be performed, wherein different cell components can be stained and imaged using confocal fluorescence microscopy (Fig. 4: actin filaments (red) and focal adhesions (green)).

To conclude, cell positioning devices can be successfully fabricated through the use of a wide variety of instruments, all available in the Nanofabrication Facility. This work has been presented in a poster presentation at the 2009 Canadian Society of Chemistry Conference in Hamilton, Ontario.

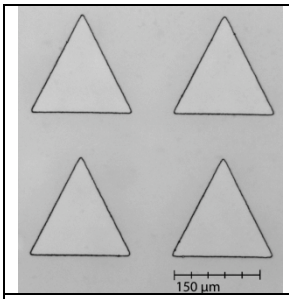

Figure 1: Optical image of the photoresist triangles

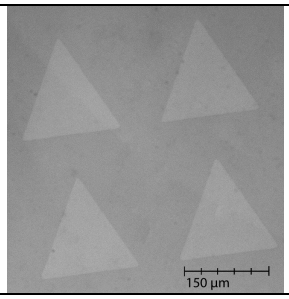

Figure 2: Optical image of triangular windows in the polymer surface

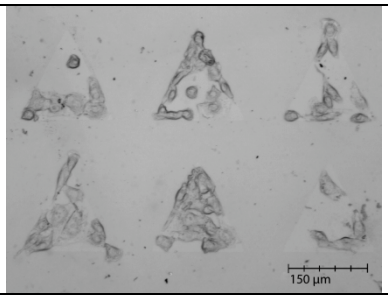

Figure 3: Optical image of cells growing within the windows

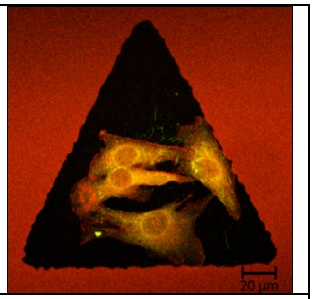

Figure 4: Confocal image of cells grown in a triangle window