Virginia Commonwealth University

Photochemical Modification of Cyclic Olefin Copolymer Microfluidic Chips for Biomolecule Microarrays and Surface Property Patterning

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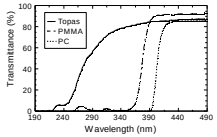
Overview

Cyclic olefin copolymer(COC) was used for fabrication of bio-chips. The surface of COC, either outside or inside the micro-channels was modified/patterned with UV initiated surface grafting polymerization of acrylic monomers for obtaining different hydrophilicity, surface charge and reactive groups. DNA, avidin and biotin arrays were made through carboxylic patterns.

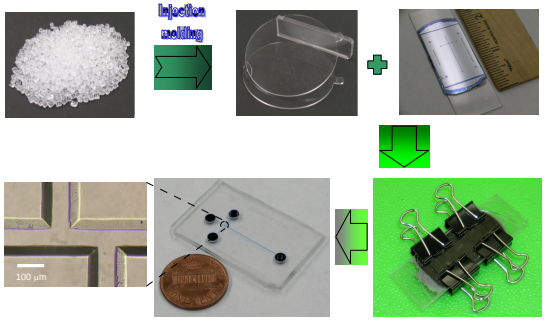
Introduction

Why plastic?
- ✓Low manufacturing cost;
- ✓Potential for mass production;
- ✓Biocompatibility;
- ✓Disposable.

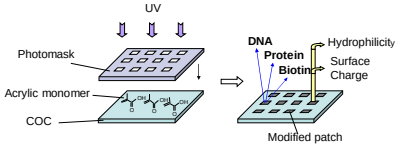
Why COC?
- ✓UV transparency;
- ✓Good resistance toward organic solvents;
- ✓Ease of fabrication;
- ✓Ease of UV-photo grafting.



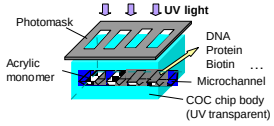
Methods



For patterns on the surface

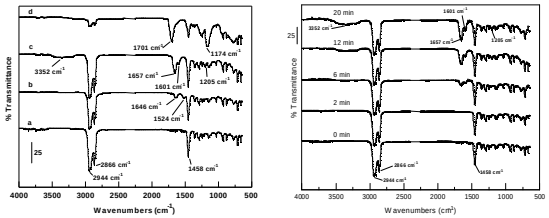


For patterns inside channels



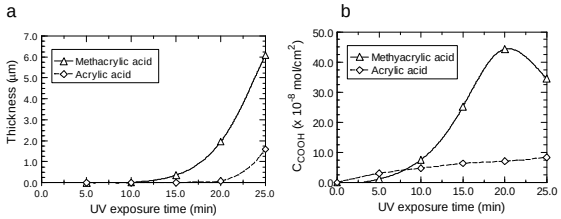
Other methods:
ATR-FTIR
Fluorescence microscopy

Results

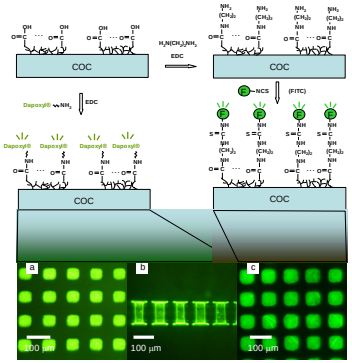


Left: ATR-FTIR of surface of (a) COC and that modified with (b) N-[3-(dimethylamino)propyl]methacrylamide, (c) methacrylamide and (d) methacrylic acid. (UV 12 min)

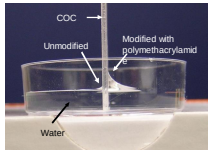
Right: ATR-FTIR of surface modified with methacrylamide for different time.
Photochemical reaction solutions contain 10 % (w/v for solids and v/v for liquids) of monomers and saturated benzophennone as a photoinitiator, UV power is 0.15 W/cm^{-2}.



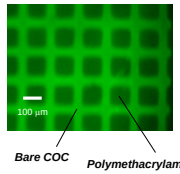
Dependence of (a) the thickness of the modification film and (b) the surface concentration of the carboxylic group on UV exposure time.



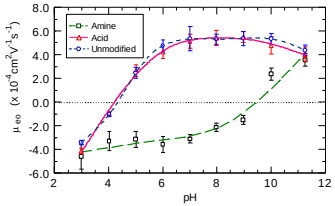
Fluorescent images of patterned poly(methacrylic acid) (a) on a COC sheet and (b)inside a channel of a COC microchip which labeled with Dapoxyl® dye. Image (c) was obtained by treated the pattern with ethylenediamine and then labeled it with a primary amine reactive dye, FITC.



Comparison of hydrophilicity with and without modification

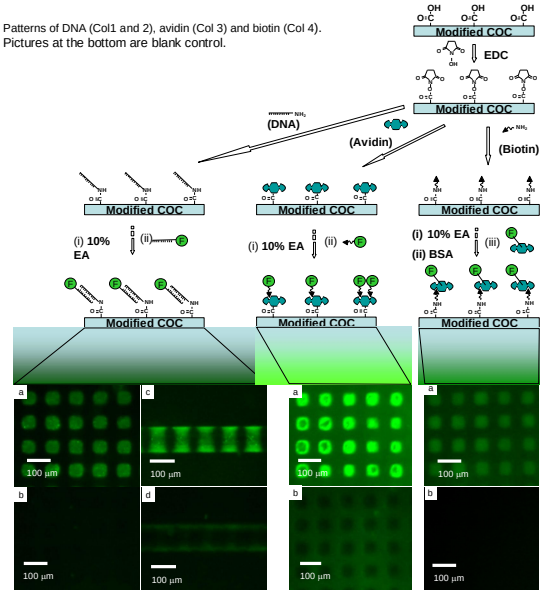


Reduce protein adsorption through modification with polymethacrylamide. Fluorescent indicator: FITC-BSA



Electroosmotic flow mobility at different pH for unmodified COC microfluidic channel and that modified with poly(methacrylic acid) (Acid) and poly[*N*-[3-(Dimethylamino)propyl]methacrylamide] (Amine).
UV irradiation time is 15 min for amine and 8 min for acrylic acid.

Patterns of DNA (Col1 and 2), avidin (Col 3) and biotin (Col 4). Pictures at the bottom are blank control.



Conclusion

COC is advantageous over other plastics with regard to surface modification and patterning. It is potential to tail EOF inside micro-channels for special electrokinetic pumping and/or mixing, to attach specific biomolecules for various bioassays and to integrate complicated functions within the same channel network.

Acknowledgement

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