Surface Micro-Patterning and Bio-Passivation Using Reactive CVD Coatings

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Surface effects dominate the properties of microfluidic devices and must be controlled to achieve desired performance of bioanalytical devices. Patterning surfaces with specific molecules or biological ligands, such as antibodies, is highly desirable. Several approaches have been described for surface modification of microfluidic devices, including plasma treatment, layer-by-layer adoption of polyelectrolytes, adsorption of detergents or quaternary amines, and pre-coating with proteins. However, such modified surfaces often slowly return to their original state via surface instabilities and/or desorption of previously adsorbed molecules due to non-covalent binding modes. Unlike glass substrates, for which surface modification using silane chemistry has been well established, the development of routine, simple, well-defined surface modification protocols for polymers is still a challenge. An approach to overcome these limitations may be the deposition of reactive thin polymer films that establish chemically defined interfaces. We are specifically investigating the growth of functionalized poly(p-xylylene) by Chemical Vapor Deposition (CVD) polymerization, a room-temperature process, which requires no catalyst, solvent or initiator, and ideally, no byproducts are created. The procedure and can be applied to a wide range of substrates such as polymer, glass, and silicon. Moreover, these polymer interfaces provide reactive functional groups for immobilization of biomolecules and may be used in cell- and antibody based bioassays. We have demonstrated the use of reactive coatings, that is poly(p-xylylene carboxylic acid pentafluorophenolester-co-p-xylylene) (PPX-PPF) and poly(p-xylylene-2,3-dicarboxylic acid anhydride).

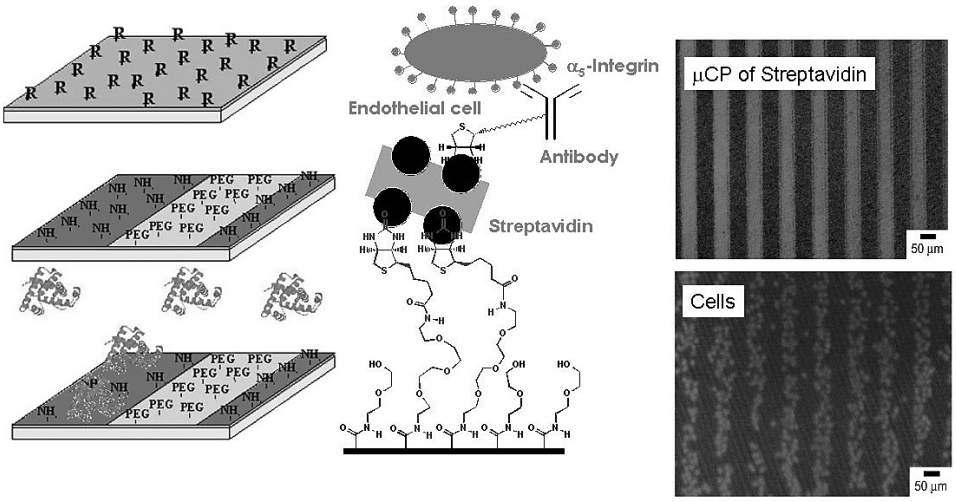

Fig. 18: Surface modifications for controlled biological activity by chemical vapor deposition of reactive parylene films and subsequent modification of this film by microcontact printing (left panel). Binding strategy for specific attachment of endothelial cells (middle panel). Patterned streptavidin (top) and cells (bootom) (right panel).

Without the need for further activation, the high chemical reactivity of their functional groups supports rapid reaction with biological ligands or proteins, including surface patterning using microcontact printing (see Figure 18). We are currently exploring applications such as affinity capturing, cell trapping and sorting, charge patterning for electrokinetic flow, and surface biopassivation.