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MULTIPLEXED BIOFUNCTIONALIZED SURFACES BY CMOS PROCESSING FOR BIOSENSING AND CELL-SURFACE INTERACTION

Semiconductor microfabrication technology, with its evolution over the past half century, has been identified as one of the pillars in lab-on-a-chip (LOC) platforms. Thus, considerable efforts have been made to integrate biomolecular immobilization techniques with microfabricated devices and surface topographies. However, microfabrication processes for use in biomolecular patterning are limited by their requisite harsh process conditions, which include the use of organic solvents, vacuum processing, and extreme pH. Soft-lithography, dip-pen nanolithography, and inkjet printing have been employed but are limited by alignment issues, low resolution, and slow processing speeds affecting their integration in high-volume manufacturing. If the harsh conditions of conventional semiconductor processing can be overcome, LOC technologies may be greatly enhanced from the well-established infrastructure and current advancements in semiconductor materials research.

During my doctoral research I have developed robust wafer-level biologically friendly microfabrication processes that can potentially be scaled-up for the high-volume manufacturing of integrated LOC devices. Top-down standard microfabrication techniques including electron-beam, reactive ion etching, metal deposition, photochemistry and photolithography have been integrated with bottom-up strategies for chemical protection of surface reactive groups, layer-by-layer chemical & material synthesis, on-chip polymerizations and organic transformation, protein and DNA surface patterning.

Multiplexed and monoplexed protein molecules have been immobilized in micron scale dimensions through their primary amine groups on microfabricated surface topography using carbodiimide chemistry on photo-generated acid groups in hydrogel biomaterials. DNA molecules have also been immobilized using Schiff base chemistry followed by reductive amination on e-beam patterned aldehyde terminated self-assembled monolayer. Preliminary results on the interaction of mammalian cells with chemical and physical surface microstructures will also be discussed.