Microfluidics as a tool to understand build-up mechanism of polyelectrolyte multilayers and to pattern surfaces for tuning cell-surface interactions.

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The layer-by-layer (LbL) deposition, which acts a versatile tool in altering the surface properties of materials, has vast potentials in biomedical engineering, especially in the design of functional biomaterials. LbL made up of Poly-L-Lysine/HyaluronicAcid (PLL/HA) are exponentially growing systems that can act as potential reservoir for DNA and other biomolecules, as against the classical linearly growing systems. A microfluidic approach using PDMS-glass combination for deposition, followed by the removal of the coverslip containing patterned layers has been established. The difference in deposition trend between linear and exponential PEM systems can be compared by online fluorescent imaging, followed by the analysis of coated coverslips by AFM and CLSM. By varying the microfluidic parameters like deposition speed, time of interaction of the polymers with the surface, polymer concentration, etc., the layer properties could be controlled accordingly in a precise manner and thus, the build-up mechanism studied effectively. L929 cells when seeded on the micro-patterned PLL/HA layers selectively adhere over the non-coated patterns, but not on the regions containing the soft films.

The surface properties of such PEMs have a profound impact on cell adhesion, proliferation and further events like differentiation, in applicable cases. In our present study, a very narrow cell-friendly window has been proposed, between 12-15 bilayers for the PLL/HA system, below which the layers are not homogenous, and above which the cell growth is hampered. This effect holds true for many cellular types studied like 3T3 and L929 mouse fibroblasts, human embryonic kidney cells, primary fibroblast cells and even mouse embryonic stem cells. The difference is attributed to the mechanical properties of the microenvironment in which the cells grow and the mechanism by which such cues are transduced to biological responses in terms of adhesion and proliferation. Extension of such concepts could also be interpreted to mimic the extracellular matrix (ECM) environment and understand the keys to mechanobiology. Moreover, surface-mediated transfection, targeted release of growth factors and mimicking with ECM components, etc. could be other potential applications of controlling the deposition parameters of PEM followed by cell growth on their surfaces.