Combination of Nanosphere Lithography (NSL) and Atom Transfer Radical Polymerization (ATRP) to Direct Cell Adhesion on Biomaterial Surfaces*  

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Introduction and Objective

Cell adhesion requires the presence of specific biological cues providing adhesion and fostering signal transduction into the cell interior as prerequisite of successful colonization of implants or tissue engineering scaffolds. It has been discovered recently, that nanostructures on biomaterial surfaces in the size range of cellular adhesion receptors may provide a tool to control cell adhesion and proliferation as well. Here, two methods are presented to design nano-structured surfaces.

- Nanosphere lithography (NSL) generates well-defined nanoparticulate structures of gold depending on the used polystyrene (PS) particle size before electron beam physical vapor deposition (EBPVD) of gold. Subsequent modification of gold areas with adhesive cues is possible.
- Surface-initiated atom transfer radical polymerization (ATRP) is used to graft 2-hydroxyethyl methacrylate (HEMA) to design non-adhesive areas to allow only adhesive interactions of cells with activated gold structures.

The present work was aimed to obtain well-defined nanoparticulate gold structures. Further, first attempts were performed to graft HEMA under defined polymerization conditions to plain biomaterial surfaces. Both techniques shall be combined later to design unique surfaces for the control of cell behavior.

Materials

- Silicon wafers cut to 15x15 mm
- Monomodal spheric polystyrene (PS) particles of different diameter
- 2-hydroxyethyl methacrylate (HEMA)
- Organic solvents for ATRP (toluene, chlor benzene, dichlormethane)
- Initiator for ATRP (2-bromoisobutyryl)
- Catalyst for ATRP (copper (II) bromide)
- 3-aminopropyl)-triethoxysilane (APTES)
- 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide (EDC)
- N-hydroxysuccinimde (NHS)

Methods

- Scanning electron microscopy (SEM)
- Confoocal laser scanning microscopy (CLSM)
- Static water contact angle measurement (WCA)
- Atomic force microscopy (AFM)
- Ellipsometry
- Fourier transform infrared spectroscopy (FTIR)

Combination of NSL and ATRP

NSL creates distinct surface structures
- Blocking of free substrate surface with HEMA to hinder protein adsorption
- Activation of gold particles to create charged surface
- Adsorption of adhesion molecules or application of LbL to provoke cell adhesion and growth

NSL is a simple method to design nano-structured surfaces for control of cell adhesion and growth
- ATRP leads to differences in thickness, wettability and surface morphology
- Control of ATRP process parameters leads to distinct surface features
- Combination of NSL and ATRP might lead to a system for precise control of cellular behavior

Conclusion

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