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Modification of polyelectrolyte multilayer coatings using nanoparticles to optimize adhesion and proliferation of different cell types

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Introduction

Adapting characteristics of biomaterials specifically for *in vitro* and *in vivo* applications is becoming increasingly important in order to control interactions between material and biological systems. These complex interactions are influenced by surface properties like chemical composition, charge, mechanical and topographic attributes. In many cases it is not useful or even not possible to alter the base material but changing surface, to improve biocompatibility or to make surfaces bioactive, may be achieved by thin coatings. An already established method is the coating with polyelectrolyte multilayers (PEM). To adjust adhesion, proliferation and improve vitality of certain cell types, we modified the roughness of PEM coatings. We included different types nanoparticles (NP's) in different concentrations into PEM coatings for controlling surface roughness. Surface properties were characterized and the reaction of 3 different cell types on these coatings was tested.

Materials and Methods

To generate different coatings the layer-by-layer (LbL) technique was used. Wells of cell culture plates and silica wafer were alternating covered with solutions of the polyelectrolytes polystyrene sulfonate (PSS) and polyallylamine hydrochloride according to the following scheme: $(PSS/PAH)_5$ + NP + $(PSS/PAH)_2$.

Coatings with polystyrene or functionalized Fe_3O_4 NP's (f = 100 nm) with different concentrations of NP's and coatings without NP's were generated. Layer build up and the amount of bound NP's was monitored by QCM (quartz crystal microbalance). Additionally the surface was characterized by AFM imaging. The reaction - adhesion and proliferation - of different cell types on the different surfaces was tested in cell culture experiments.

Results and Discussion

We could generate different uniformly NPs-coated LbL-surfaces, with different roughness as well as different chemical characteristics and surface charge. Depending on the concentration of the NP in suspensions different numbers of NPs were bound into the coating. According to difference in charge between the different types of NPs, they built up varying surfaces characteristics. In first experiments, endothelial, smooth muscle cells, and fibroblasts showed diverse reactions to the surface modifications with NPs. So this technique may offer a way to adjust surfaces specifically for growth of different cell types.