Polyelectrolyte multilayers as a tool for local drug delivery and controlled interaction with biological tissues

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The development of new and the optimisation of the existing biomaterials is a challenge which needs input from the contemporary materials sciences. The biomaterials are important part of the competitive market of medical devices. New knowledge is required to better understand the interactions between materials and the biological systems. This allows for construction of materials with enhanced biological performance. The present work summarise results which aim at better understanding of the vitality of endothelium cells (EC) when they are in contact with specifically coated biomaterials. Cardio-vascular stents for treatment of coronary heart disease were used as an example of biomaterial (Fig. 1). The stents were coated with a polyelectrolyte (PE) multi layer films (PEM).

The PEM were build via consecutive deposition of natural PE. They were used as a vehicle which offers area specific release of therapeutics and also improves the interactions with the cells in the biological surrounding. PEM can be used to control the location of nanoparticles with nanometer-scale precision and the amount of incorporated nanotherapeutics. The obtained in the present study results concern particles obtained by complexation of chitosan (Chi) and siRNA (small interfering RNA) which specifically inhibits the synthesis of designated target proteins. These particles stabilise the siRNA molecules and can promote the cellular uptake of siRNA. The release of the siRNA/Chi particles is a result of continues degradation of the PEM when it is in contact with blood and other biological liquids.

The PEM were also used to control (promote) the adhesion and proliferation of endothelium cells mostly by changing the charge of the PEM and their mechanical properties which fits to the “requirements” of the biological tissue.

We have tested the stability of prepared PEM coatings, their ability to incorporate siRNA/Chi particles and to release them in controlled manner. The release kinetics of siRNA from the PEM in PBS was determined by fluorescence measurement (Fig. 2). The stability of the coatings against mechanical disturbances was also tested.

The results show formation of very stable layers on top of the implants. In cell culture, PEM containing nanoparticles show low cytotoxicity. Moreover, the cellular uptake of the nanoparticles resulted in a clear uptake in the cell cytoplasm analysed by fluorescence microscopy. A pronounced dependence of the EC viability on the mechanical properties of the PEM was observed.

PEM prepared from natural PE can be successfully used for biological refinement of implants as a cross-sectional technology, to bind siRNA as a bioactive molecule to a variety of medical implants and thereby to foster clinical therapy and regeneration.