Summary

The ideal vascular or skin substitute is able to simulate the functions of original vascular or skin tissue. To reach this goal, the tissue substitute should be based on a biomaterial scaffold of an appropriate structure and desirable physical and chemical properties. These properties strongly influence successful implantation of the substitute to the patient's organism, substitute durability in the organism, and the desired colonization of the scaffolds with cells. These properties have a great impact on the adhesion, proliferation, differentiation, and desired phenotypic maturation of cells. Most of the biomaterials used for constructing clinically used tissue substitutes do not have appropriate properties for sufficient cell colonization, and thus their surface modification is needed. This thesis focuses on the improvement of biomaterial surface properties for successful cell colonization by plasma treatment, or by grafting and coating biomaterials with bioactive substances and extracellular matrix proteins.

The modification of polyethylene (PE) foils by Ar^+ plasma discharge showed a positive effect on the spreading, proliferation, and phenotypic maturation of vascular smooth muscle cells (VSMC). Subsequent grafting of the plasma-activated surface with bioactive substances further influenced cell behavior. Grafting with Gly or polyethylene glycol (PEG) predominantly promoted cell spreading and the formation of focal adhesion plaques. PE grafted with bovine serum albumin (BSA) or BSA with carbon nanoparticles (BSA+C) enhanced the growth and desired phenotypic maturation of VSMC, manifested by a higher concentration of contractile protein α-actin and SM1 and SM2 myosin. However, BSA grafted on polymer surface hampered cell proliferation in the cell culture medium without a serum supplement.

In order to improve the attractiveness of nanofibrous membranes for skin cells, the membranes were treated by oxygen plasma or coated with extracellular proteins (collagen, fibronectin, or fibrin). The plasma-treated membranes enabled better attachment, spreading and proliferation of human HaCaT keratinocytes. Fibrin nanocoating on nanofibrous membranes improved the adhesion and proliferation of human dermal fibroblasts, whereas collagen nanocoating positively impacted the behavior of human HaCaT keratinocytes. In addition, the fibrin combined with ascorbic acid added into the cell culture medium stimulated fibroblasts to synthetize and deposit collagen I in the form of a fibrous extracellular matrix. Fibronectin attached on the fibrin or collagen nanocoating further enhanced cell adhesion.