Abstract

Graphene (G) and nanocrystalline diamond (NCD) are carbon allotropes and promising nanomaterials with an excellent combination of their properties, such as high mechanical strength, electrical and thermal conductivity, possibility of functionalization and very high surface area to volume ratio. For these reasons, G and NCD are employed next to electronics in biomedical applications, including implant coating, drug and gene delivery and biosensing.

For a fundamental characterization of cell behavior on G and NCD, we studied osteoblast adhesion and proliferation on differently treated G and NCD. Generally, both G and NCD exhibited better properties for osteoblast cultivation than control tissue culture polystyrene. Better cell adhesion but lower cell proliferation were observed on NCD compared to G. The most surprising finding was that hydrophobic G with nanowrinkled topography enhanced cell proliferation extensively, in comparison to hydrophilic and flat G and both NCDs (hydrophobic and hydrophilic) with slightly higher roughness. Promoted cell proliferation enables faster cell colonization of G and NCD substrates, meaning faster new tissue formation which is beneficial in biomedical applications.

Furthermore, it was shown that osteoblast adhesion was promoted in the initial absence of fetal bovine serum (FBS); however, osteoblast proliferation was suppressed regardless of the material used. As a follow-up to this difference, we characterized cell adhesion to tissue culture polystyrene in the presence and absence of FBS with three different cell types. Consistently for all tested cell types, no classic focal adhesions were formed during cell adhesion in the absence of FBS proteins. Moreover, signaling within these cells proceeded in an unusual manner. In contrast, FBS absence affected cell shape, area and number variously in the tested cell types. For the first time, the cell-substrate contact in the absence of serum proteins for anchorage-dependent cells was described in detail.

In the last part of this thesis, the use of sericin (silk protein) as a replacement for FBS in freezing medium for osteosarcoma cell line and primary human mesenchymal stem cells (hMSCs) was evaluated. It was shown that 1 % sericin could substitute for 25 % FBS in the freezing medium for hMSCs, in contrast to osteosarcoma cell line. Moreover, hMSCs could be cryopreserved in a growth medium containing only 10 % DMSO with adequate results. Finally, different freezing formulas should be evaluated for different cell types to find the most satisfactory results.