



Nanostructured Biomimetic Surfaces of Polymer Biomaterials for Tissue Engineering

What can polymer science do for more intelligent biomaterials

František Rypáček, Eliška Třesohlavá, Štěpán Popelka, Vladimír Proks

Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic
Heyrovsky Sq. 2, 162 06 Prague, Czech Republic

ryp@imc.cas.cz

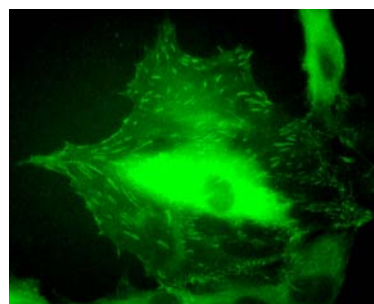
www/en/imc/index.html

www/en/imc/scidep.html

Abstract

For more than fifteen years a concept of tissue engineering is being developed, based on combining living cells with a supporting structure – a scaffold – to form a new tissue or to guide tissue regeneration. Very often the scaffold is made from an organic polymer material, either of synthetic or natural origin. Despite enormous effort and rapidly growing number of teams entering this field worldwide, the present time applicable achievements rarely reach beyond the level already achieved in pioneering works years ago. It becomes increasingly evident that besides a supporting, mechanical and shape-forming role, the scaffold must also contain a certain information that is vital for the cells and transfer it unscrambled through a cell-biomaterial interfacial communication.

In tissues, the cells receive key solid-phase signals from the extracellular matrix (ECM) through interactions of their trans-membrane recognition proteins with specific domains on ECM molecules. Therefore, biomaterials to be used as scaffolds for guided tissue regeneration should exhibit corresponding recognizable structures, either as whole ECM molecules or their fragments, typically peptides, on their surfaces. A number of evidence shows that not only the presence but also, and probably most importantly, the molecular organization of peptide ligands on the surface represents a key factor in functional communication at cell/biomaterial interfaces. The importance of spacing of fibronectin-peptide mimics on a tens-of-nanometers scale to produce functional integrin clustering into focal adhesions has already been demonstrated on planar model substrates, such as silica.



The work presented in the lecture focuses on problems related to creation of nanoscale organized surfaces on biodegradable polymer materials, such as polyesters (e.g., PLA, PLGA), through techniques which would be applicable to real 3D scaffolds. To achieve distribution of peptide motifs on a scale comparable with the size of individual transmembrane macromolecules, e.g., integrins, a "molecular printing" technique, based on deposition of a molecular layer formed by well-defined functional block copolymers was developed. The molecular characteristics of copolymer films and the surface topology of biomimetic groups obtained through molecular assemblies of copolymers were characterized. The applicability of the technique to polyester surfaces is discussed. The positive effect of clustering of fibronectin-derived peptides through association of functionalized copolymer molecules on the cell adhesion and phenotype differentiation in cell cultures was demonstrated.

Biography



Professor František Rypáček is Chief Research Fellow and Director of the Institute of Macromolecular Chemistry of the Czech Academy of Sciences, where he is heading the Dept. of Bioanalogous & Special Polymers. He also holds a position as Affiliate Professor at the Department of Pharmaceutics of Virginia Commonwealth University, VA, USA and has long-standing research collaborations with the Research Institute for Science and Technology in Medicine at Keele University. The research in Frantisek's group is focused on bio-analogous macromolecular systems and the interactions of macromolecules at bio/material interfaces. Biodegradable polymers and bio-analogous systems are studied for biomedical and pharmaceutical applications, e.g., as polymer biomaterials for tissue engineering and controlled drug delivery systems.