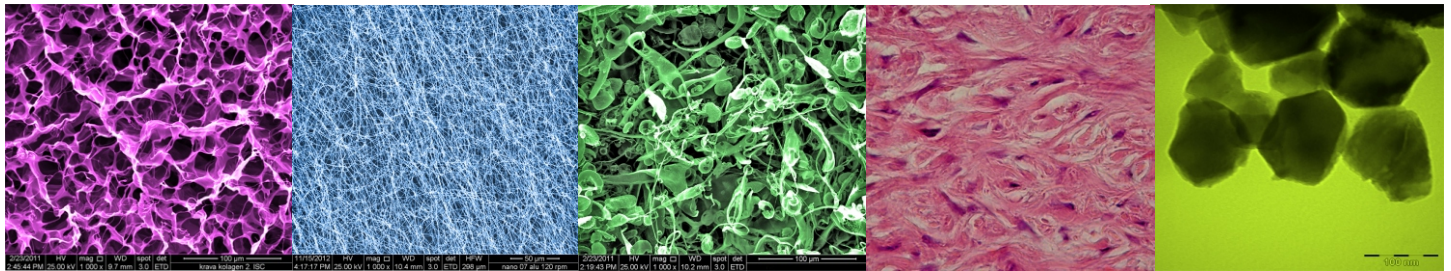


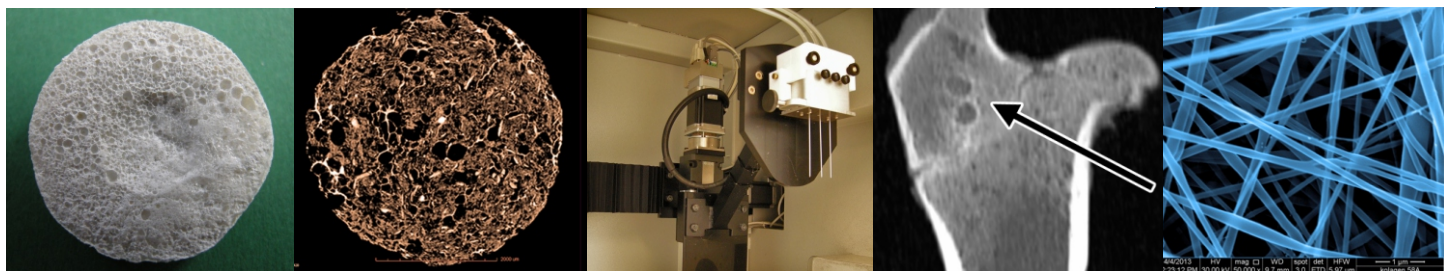
BIOCOMPOSITE SCAFFOLDS FOR BONE TISSUE REPLACEMENT

There is an increasing need for new therapies to treat bone defects that arise from trauma and disease. Although autografting and allografting are clinically considered as good therapies, they have their limitations. It is often difficult to harvest sufficient bone from the donor, and allografting can moreover be connected with pathogen transfer. As an alternative, synthetic biomaterials have been developed and clinically used as bone grafts, but most of them differ substantially from natural bone, either compositionally or structurally. Therefore it remains a great challenge to design an ideal bone graft that mimics the features of natural bone, both in the main composition and in the hierarchical microstructure. An ideal bone scaffold material should be biodegradable, with non-toxic degradation products, supportive for cell attachment and remodelable by the local cells. Thus the aim of this project is to prepare composite scaffolds with suitable structural and mechanical properties for colonization with mesenchymal stem cells promoting the regeneration of defective bone tissue with the required rate of safe biodegradation. In order to use this scaffold for further clinical application, a thorough interdisciplinary approach for developing and for characterizing its physico-chemical properties needs to be systematically applied.



Aims of the Project

1. Prepare biodegradable composite scaffolds promoting the regeneration of bone tissue. The composite scaffolds will consist of biodegradable PDLLA electrospun nanofibers, natural collagen matrix isolated from fish skin (*Cyprinus Carpio*), supplemented with sodium hyaluronate, and calcium phosphate nano-sized particles isolated from bovine bone.
2. Optimize the preparation process, aiming at an interconnected and homogeneously porous material with a nano/microstructured surface.
3. Optimize the mechanical properties and the stability of the inner structure by crosslinking the collagenous part of the scaffold, aiming at an assessment of controlled degradation.
4. Adjust the optimal biodegradable properties by adjusting the volume fraction ratios and/or optimizing the orientation of the fibers and/or by combining various PDLLA nanofibers.
5. Characterize the cell interaction with the proposed composite scaffolds *in vitro*, with a view to specific cell adhesion, proliferation and differentiation, and also with a view to differences between 2D and 3D environments.
6. Develop the process of colonizing the composite scaffolds (3D structures) with human and pig mesenchymal stem cells.
7. Evaluate the promising composite scaffolds colonized with pMSCs *in vivo* (pig model); evaluate bone-implant interactions, bone ingrowth and the rate of biodegradability of the proposed scaffolds, using CT and X-ray imaging techniques, histological evaluation, and nanoindentation of histological thin sections.



The Department of Composites and Carbon Materials has long-term experience of investigating composite materials of various compositions and structures. The team is experienced in preparing fiber-reinforced and particulate composites based on constituents of synthetic or inorganic materials (e.g. polymers, carbon, etc.) and materials of biological origin (collagen, gelatin, polylactides, calcium phosphates, etc.), and is also experienced in evaluating their physico-chemical properties and in making biological evaluations. The team is also experienced in isolating collagenous materials and calcium phosphates from various animal genera and sources, and in preparing structures and composite structures based on these constituents by various techniques (e.g. electrospinning, molding, solvent casting and particle leaching, freeze-drying, etc.).

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JOINT PROJECT SUMMARY FORM
THE MATCHMAKING EVENT IN PRAGUE
PRAGUE, 30 – 31 MAY, 2013

Introduce your idea – your project (be short and clear)

Brief summary about your project for a potential joint project partner (1 page in English):

Name of the Organisation:

Department of Composites and Carbon Materials, Institute of Rock Structure and Mechanics,
Academy of Sciences of the Czech Republic, v.v.i.

Priority Research Area:

Health – Interdisciplinary, Bone Tissue Engineering

Research Field (Project Focus):

Basic research/Experimental development

Name of the Project

Biocomposite Scaffolds for Bone Tissue Replacement

Main Objectives:

Prepare novel nanocomposite scaffolds with suitable structural and mechanical properties for colonization with mesenchymal stem cells (MSC) promoting the regeneration of defective bone tissue with the required rate of safe biodegradation. Optimize the preparation process, aiming at an interconnected and homogeneously porous material with a nano/microstructured surface, outstanding mechanical properties and a controlled rate of biodegradation capable of withstanding dynamic culture conditions and encouraging homogeneous MSC colonization.

Main Activities:

- Electrospinning of nanofibers based on various natural collagenous precursors and polymers.
- Isolate and prepare various kinds of natural calcium phosphates.
- Prepare degradable composite scaffolds, evaluate their structural and physico-chemical properties, and make a biological and preclinical evaluation.

Estimated Total Budget (in EUR)

approx. EUR 200.000

Planning Outputs/Results

Bio-inspired composite scaffolds for promoting the regeneration of defective bone tissue with the required rate of biodegradation. Their proposed composition will imitate the real bone structure and will combine the advantages of nanofibers, aliphatic polyesters, collagen and also the bioactive inorganic component.

Contact Persons (telephone, e-mail/web page)

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