AKB 30 Biomaterials

Zeit: Freitag 17:30–19:00 Raum: TU H2013

AKB 30.1 Fr 17:30 TU H2013

Proteoglycan conformation and mechanical properties: A molecular modeling investigation — •Mark Bathe[1], Gregory C. Rutledge[2], Alan J. Grodzinsky[2], and Bruce Tidor[2] — [1]HMI Berlin, Germany — [2]MIT Cambridge MA, USA

Proteoglycans (PGs) play a central role in determining the structural and biomechanical properties of tissues ranging from articular cartilage to the central nervous system. They are high molecular weight comb biopolymers consisting of anywhere from one to one hundred glycosaminoglycans (GAGs) (anionic polysaccharides) grafted to a linear protein backbone. PG chemical composition varies considerably with the disease state of tissues, making it of fundamental importance to biology to understand their composition-function relationship.

Towards this aim, we simulate PG conformation and osmotic pressure using a coarse-grained molecular model. GAG molecular weight, degree of sulfation, and grafting density affect significantly the apparent persistence length of PGs, whereas GAG sulfation type (4 vs. 6) and pattern do not. Similarly, GAG osmotic pressure is influenced primarily by its sulfation density. Our results reaffirm that variations in PG composition may be used to alter significantly the structural and biomechanical properties of a variety of tissues, and provide quantitative new insight into the structure-function relationship of this important class of biomolecules.

AKB 30.2 Fr 17:45 TU H2013

The Influence of the Thermal Treatment of Hydroxylapatite Scaffolds on the Physical Properties and the Bone Cell Ingrowth Behaviour — •Alexander Woesz[1], Monika Rumpler[1], Inderchand Manjubala[1], Christine Pilz[1], Franz Varga[2], Nadja Fratz-Zelman[2], Paul Roschger[2], Klaus Klaushofer[2], Juergen Stampfl[3], and Peter Fratzl[1] — [1]Max Planck Institute of Colloids and Interfaces, Dept. of Biomaterials, Potsdam , Germany — [2]Ludwig Boltzmann Institute of Osteology, 4th Medical Department, Vienna, Austria — [3]Institute of Materials Science and Technology, University of Technology, Vienna, Austria

The usage of rapid prototyping (RP) methods and ceramic gelcasting enables the production of 3D scaffolds as future bone replacement materials with almost arbitrary architecture from bioceramics like hydroxylapatite. A suspension of synthetic hydroxylapatite powder in water was cast into a mould produced by RP-methods. After demoulding the ceramic particles were sintered. Sintering temperature and atmosphere affected the physical properties like phase composition and surface roughness as well as the cell ingrowth behaviour, which was assessed in cell culture experiments using a pre-osteoblastic cell line. With increase in sintering temperature decomposition of the synthetic hydroxylapatite into tricalciumphosphate increased, the sintering atmosphere seemed to influence the surface roughness, but had no impact on the phase composition. Cell ingrowth was observed to be highest at a sintering temperature of 1300°C in nitrogen atmosphere followed by a post-treatment at 1200°C in air.

AKB 30.3 Fr 18:00 TU H2013

Bone Remodelling is regulated by a Mechanical Feedback Loop — •M. A. Hartmann[1], R. Weinkamer[1], Y. Brechet[2], and P. Fratzl[1,3] — [1]MPI-KGF, Dept. Biomaterials, 14476 Potsdam-Golm, Germany — [2]ENSEEG, LTPCM, 38402 Domaine Universitaire de St. Martin d'Heres, Cedex, France — [3]LBIO, Hanusch Hospital and UKH-Meidling, Vienna, Austria

Biological processes can be regulated by a mechanical feedback loop, i.e. the mechanical loading is sensed by cells and this information is fed back to control the action of other cells. A prominent example is the (re)modelling of bone. Despite many years of intensive research many of the properties of this feedback still remain unclear: What exactly is the mechanical stimulus the cells are sensing? How do the cells respond to this stimulus (i.e. the remodel law)? How is the stimulus sensed by the cells? In [1] we proposed a model to study trabecular bone remodelling and ageing governed by mechanical feedback. Our approach is to study the effect of different remodel laws (like a continuous, linear vs. a discontinuous, step-like response) and its influences on bone histomorphometric parameters. Depending on the remodel law we found differences in bone volume fraction and the geometry of the bone structure. Comparing the simulation results to data from real bone, we try to draw indirect conclusions on the underlying feedback loop.

[1] Weinkamer et al., PRL, 2004

AKB 30.4 Fr 18:15 TU H2013

Nitric Oxide Production in Mechanosensitive Osteocytes — •Daisuke Mizuno[1], Aviral Vatsa[2], Theo H. Smit[3], Jenneke Klein-Nulend[2], Frederick C. MacKintosh[1], and Christoph F. Schmidt[1] — [1]Dept. Physics, Vrije Universiteit, Amsterdam, NL — [2]Dept. Oral Cell Biol., ACTA, Vrije Universiteit, Amsterdam, NL — [3]Dept. Clin. Phys.&Informatics, Univ. Hospital, Vrije Universiteit, Amsterdam, NL

Osteocytes are a type of bone cells that are embedded in the bone matrix, and whose main function is believed to be mechanosensing. If bone is mechanically loaded, activated osteocytes produce nitric oxide (NO) which controls in a sophisticated control network the activity of other types of bone cells which deposit or resorb bone matrix. This single-cell level mechanosensing and chemical signaling is essential for bone repair and adaptation. In this study we 1) apply well characterized mechanical stimuli to single osteocytes and 2) quantify the resultant chemical signaling with NO at the single cell level. Results were: i) Intracellular NO increased up to about 10 μM after stimulation with forces on the order of 10 pN generating about 1% strain. ii) The cell membrane is not a significant diffusion barrier for NO. iii) Surrounding cells occasionally more than 100 microns away from a stimulated one were seen to react rapidly (within 10s) to the stimulation.

AKB 30.5 Fr 18:30 TU H2013

Influence of Water on the mechanical Properties of wood investigated by X-ray diffraction — •Ingo Grotkopp[1], Henrik Lemke[1], Klaas Kölln[1], Sergio S. Funari[2], Martin Domach[2], and Martin Müller[1] — [1]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel — [2]HASYLAB, DESY, Hamburg

The influence of water on the mechanical behaviour of wood is tremendous. Softwood was investigated by means of X-ray diffraction during tensile tests with different moisture contents. In this way, the influence of the water molecules on the changes in the orientation of the cellulose crystals could be observed. A second mechanism found in these experiments is the deformation of cellulose crystals. Here a comparison between single cells, small wood samples and large timber at different humidity is carried out and first conclusions are developed.

AKB 30.6 Fr 18:45 TU H2013

Plant Cell Walls for Hygrosensitive Switches — •Helfried Mollay[1], Ingo Burgert[1], Peter Fratzl[1] und Josef Eberhardsteiner[2] — [1]Max-Planck-Institute of Colloids and Interfaces, Department of Biomaterials, 14476 Potsdam, Germany — [2]Vienna University of Technology, Institute for Mechanics of Materials and Structures, A-1040 Vienna, Austria

Wood is an anisotropic and hygroscopic biomaterial which can absorb water and swells or shrinks due to changes of humidity. On the one hand, the resulting deformations can lead to severe complications with respect to the utilisation of wood. On the other hand, from a biomaterials point of view, the coherence between water absorption and structural modification is a matter of particular interest. The objective of our study was to make use of the hygroscopic behaviour of wood at the microscale by constructing wood-based switches. Thin wood tissue sheets of different ability to swell and shrink were combined as such as a bimetal. Thus, the wooden bi-layer bent during humidity changes and could be used in terms of a hygrosensitive switch.