MI 1: Microanalysis and Microscopy of Biological Materials

Chair: S. Henning, Halle

Time: Monday 9:30–11:45 Location: EMH 225

Invited Talk MI 1.1 Mon 9:30 EMH 225

High-resolution electron cryo-microscopy of macromolecular protein complexes — •Werner Kühlbrandt — MPI of Biophysics, Frankfurt, Germany

We are witnessing a revolution in determining the structure of large protein complexes by electron cryo-microscopy (cryo-EM), precipitated by a new generation of direct electron detectors. The sensitivity and fast readout rate of these new cameras means that beam-induced movements can be overcome routinely. Three-dimensional density maps of a quality similar to or better than that achieved by x-ray crystallography are obtained. Two examples will be presented: the 3.3 Å structure of the nickel-iron hydrogen transferase Frh, an archaeal multi-enzyme complex involved in methanogenesis, and the 6.2 Å structure of an intact, functional mitochondrial F1-Fo ATP synthase. Both have defeated protein crystallography for years or decades.

The mitochondrial ATP synthase is an ancient nanomachine in the energy-converting membranes of all living organisms. In order to understand how this massive multiprotein assembly works in the cellular context, it is necessary to obtain detailed views of it in the membrane, which was achieved by electron cryo-tomography (cryo-ET) of whole mitochondria. The new direct electron detectors enabled us to obtain an 18 Å map of the ATP synthase in situ, doubling the resolution attained with conventional CCD detectors. Our results provide unique new insights into the functional arrangement of large membrane protein complexes in biological energy-converting membranes.

Invited Talk MI 1.2 Mon 10:15 EMH 225

Electron Cryotomography of Archaea — •Bertram Daum — Max-Planck Institut für Biophysik, Frankfurt/Main, Deutschland

Electron cryotomography is an electron microscopic technique capable of visualising cellular structures in three dimensions. By combining newly developed direct electron detectors and subtomogram averaging of repetitive particles, it is possible to acquire in situ structures of proteins complexes at sub-nanometre resolution. We employ this powerful technique to investigate membrane protein complexes involved in cell-cell interactions as well as viral infection of Archaea, a group of microorganisms that next to Bacteria and Eukaryotes forms the third branch of evolution, and often populates extreme environments.

MI 1.3 Mon 11:00 EMH 225

Microstructure diagnostics of fluoride interaction with human dental tissue — •Matthias Petzold, Lutz Berthold, and Andreas Kiesow — Fraunhofer Institute for Mechanics of Materials IWM Halle, Walter-Huelse-Strasse 1, 06120 Halle, Germany

In dentistry, fluoride compounds play a crucial role particularly for caries prevention. Topical treatments of teeth using e.g. fluoridated tooth pastes or mouth rinses result in surface microstructure changes. In addition to clinical and (bio-)chemical studies, methods like electron microscopy and X-ray analyses allow contributing to establish more substantiated models of how fluorides interact with the tooth surface. In the presentation, a short introduction is given on current understanding of topical fluoridation of dental enamel and dentine. Results of case studies on calcium fluoride-like precipitate formation on dental enamel after treatment with amine fluoride-containing products will be presented. In addition, findings from HR-TEM/EDX studies comparing different fluoride compounds are discussed that contribute to a deeper understanding of the effects of pH and fluoride compound on fluoride interaction modes. In addition to calcium fluoride-like reaction products formed at the tooth surface, attention is also given to the microstructure of the dental enamel beneath the surface layers. The results presented will be compared to current models published in literature regarding the mode of action of fluorides. In this context, open questions and future research needs regarding fluoride interaction with dental enamel and dentine will also be highlighted.

MI 1.4 Mon 11:15 EMH 225

Characterizing the Material Bone by Combining Microscopy Methods and X-ray Scattering — •Wolfgang Wagermaier — Max Planck Institute of Colloids and Interfaces, Department of Biomaterials, Potsdam, Germany

The structure of bone at all hierarchical levels continuously adapts during growth and healing. The local characteristics of mineral particles and the organic matrix in bone can be investigated to elucidate basic biological processes. Scanning electron microscopy is used to quantify the amount of mineral, while size and orientation of mineral particles are characterized using small and wide angle X-ray scattering. A combination of rhodamine staining and confocal laser scanning microscopy enables a three-dimensional visualization of voids in bone, housing blood vessels and bone cells. This combination of methods enables a visualization of soft and hard tissue components and to estimate their properties in relation to the spatial tissue organization.

MI 1.5 Mon 11:30 EMH 225

Mikromechanische Untersuchungen zur Mikrorissbildung im Knochen in TEM und ESEM — •Jessica Klehm[1], Jörg Brandt[2] und Sven Henning[1] — [1]Fraunhofer Institut für Werkstoffmechanik IWM Halle — [2]Department für Orthopädie, Unfall- und Wiederherstellungschirurgie; Universitätsklinikum Halle (Saale)

Mikromechanische Analysen zu mikro- und nanoskopischen Strukturveränderungen bei Deformation und Bruch sind ein wichtiges Werkzeug zur Aufklärung von Struktur-Eigenschaftsbeziehungen in Werkstoffen und Biomaterialien. Die elektronenmikroskopische Untersuchung von Risseinleitungs- Risswachstums- und Rissstoppmechanismen im Knochen trägt dazu bei, den Einfluss von Erkrankungen des Stütz- und Bewegungsapparates (z.B. Osteoporose oder nekrotische Veränderungen) oder medikamentöser Therapieen auf das Frakturrisiko besser abschätzen zu können. Dabei werden in vivo entstandene Mikrorisse mit experimentell unter mikroskopischer Beobachtung erzeugten Deformationsstrukturen verglichen und mit der lokalen Mineralkonzentration und der Nanostruktur des Knochens am Ort der Messung korreliert.

Das Material "Knochen" wird dabei als biolgisch synthetisierter Nanokomposit-Werkstoff behandelt, bei dem eine organische, duktile, faserartige Komponente (Kollagen) mit steifen, plättchenförmigen Nanokristalliten (Hydroxylapatit) kombiniert ist. Als eigenschaftsbestimmendes Strukturelement wird die mineralisierte Kollagenfibrille identifiziert. Der dominierende mikromechanische Prozess wird als crazeartiger Prozess beschrieben.