

Selected research topics in Biomedical Engineering:

Medically Relevant Experiments with Synchrotron Radiation

Location: Grosser Hörsaal, ZLF, University Hospital Basel

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Microimaging of tissues and dental implants

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Abstract. Biocompatible materials including porous bioactive calcium phosphate ceramics or titanium are regularly used in dental surgery. Ceramics are used to promote bone regeneration in larger defects with the final aim to place a dental implant. The gold standard for bone reconstruction is the use of autogenous bone grafts. Guided bone regeneration using bioactive calcium phosphate ceramics, however, has become a reliable surgical approach. Here, high-resolution microtomography combined with three-dimensional image analysis has been applied to investigate the degradation of the bone substitute material and related bone formation in a three-dimensional manner, extending the knowledge beyond the limits of conventional histology. Following bone regeneration, titanium-based implants have been inserted. Compared with laboratory sources, the synchrotron radiation-based radiography yields higher spatial resolution and better contrast. Therefore, one gets access to micro-gap formation at interfaces in two-piece dental implants under mechanical load. We proved the existence of micro-gaps for implants with conical connections and of the mating zone of conical implants during loading. The micro-gap can result in failure, i.e. bacterial leakage can induce an inflammatory process. This presentation will further outline the potential of synchrotron radiation-based microimaging along selected examples such as tomography of cartilage under axial load or virtual histology of a mouse kidney.

Curriculum. Alexander Rack, born in Berlin, Germany, studied physics at the Technical University of Berlin and received the title Dr.-Ing. in 2006. For his thesis, he received the Ernst-Eckhard-Koch prize in 2008. His first post-doc position was at the ANKA synchrotron light source (Karlsruhe, Germany), where he established synchrotron instrumentation for hard X-ray microimaging. Since 2008, he has worked at the European Synchrotron Radiation Facility (ESRF) in Grenoble, France. Initially working at the micro-diffraction and microscopy beamline, Alexander Rack soon joined the microtomography beamline ID19, which he has been heading as responsible beamline scientist since 2016. Present research interests are the study of time-resolved phenomena by means of ultra-fast hard X-ray imaging including shock and crack propagation in dense matter as well as materials processing such as additive manufacturing.