Time- and Position-resolved X-ray Scattering of Bone and Cartilage

Peter Fratzl[a], Himadri S. Gupta[a], Wolfgang Wagermaier[a], Paul Roschger[b], Aurélien Gourrier[a], Oskar Paris[a], [a]*Max Planck Institute of Colloids and Interfaces, Department of Biomaterials, Potsdam, Germany*. [b]*Ludwig Boltzmann Institute of Osteology, Wien, Austria*. E-mail: fratzl@mpikg.mpg.de

Most biological tissues including bone and cartilage are hierarchically structured and dynamically remodelled, and as a consequence, are heterogeneous in space and time. For a better understanding of the mechanical properties of these tissues, as well as for the characterization of bone diseases, it is essential to cover many length scales in structural investigation. X-ray diffraction and/or small angle scattering can be used to study the orientation and size of mineral particles as well as the spacing and orientation of collagen fibrils. When the specimen is scanned across a narrow X-ray beam, the micron and the nanometer scales are covered simultaneously, by the scanning procedure and the analysis of diffraction patterns, respectively. We have used this scanning technology to characterize individual trabeculae or osteons in intact macroscopic bone sections, as well as the bone cartilage interface and the dentin-enamel junction. One of the great advantages of the scanning diffraction approach is that the same specimens can be used for additional characterisation with other imaging techniques, such as electron, infrared or Raman imaging, as well as nanoindentation. Complementary to the scanning approach, *in-situ* methods utilize the high brilliance of synchrotron radiation to carry out time-resolved measurements at the fibrillar and molecular level to study deformation mechanisms in bone and biomineralized tissues.

Keywords: biomineralization, microbeam analysis, SAXS