New avenues in studying hierarchical biological tissues with X-ray Microbeams

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Load bearing biological tissues with optimized mechanical properties are mostly hierarchically structured from the atomic/molecular level up to macroscopic length scales. Typical examples are bone, wood, or arthropod cuticle, and many technical solutions benefit from the imitation of such natural materials by biomimetic principles. Structural investigations of such materials require new experimental techniques with a position resolution covering several length scales. The high beam brilliance available at third generation synchrotron radiation facilities together with novel X-ray optics can be used to extend the position resolution to the micrometer regime by using microbeam scanning techniques in combination with small- and wide-angle X-ray scattering (SAXS/WAXS). New developments at dedicated microfocus beamlines allow for instance to map simple structural parameters deduced from SAXS/WAXS on-line. Future developments of on-line data analysis promise to obtain real time images of complex structural parameters such as local texture, strains or phases by WAXS as well as local size, shape and orientation of nanometre particles by SAXS.

The present contribution presents recent results from microbeam SAXS/WAXS imaging studies on several biological tissues, conducted at the microfocus beamline ID13 at ESRF in the framework of a long term proposal, and at the new microbeam SAXS/WAXS/Fluorescence station at the μ-Spot beamline at BESSYII in Berlin. We put also some emphasis on important technical aspects such as the necessity of online data reduction and visualisations, as well as the inevitability to cope with radiation damage in biological tissues.