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Some introductory remarks on microbeam diffraction in nanobiosciences

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It is generally accepted and broadly recognized that one of the principal techniques for studying protein structures is synchrotron radiation diffraction. There are, however, many other areas in the field of nanobiosciences which increasingly make use of sophisticated synchrotron radiation techniques such as microbeam diffraction. The meeting on *Synchrotron Radiation and Nanobiosciences* covered some aspects of this topic and had as Co-Chairmen Professor Claudio Nicolini, Director of the Nanoworld Institute in Genova and President of the Fondazione Elba, and Professor Peter Fratzl, Director of the Max Planck Institute for Colloids and Interfaces in Potsdam.

The major aim of the meeting was to start a new quality of cross-disciplinary discussion between scientists involved in synchrotron radiation microbeam instrumentation on the one hand and a broad research community interested in functional properties of hierarchical biological systems. The meeting attracted about 30 scientists from seven European countries, working in the areas of synchrotron radiation instrumentation, synchrotron radiation optics, biomechanics, fibrous materials, hierarchical nanocomposites, and biotechnology in confined environment.

One of the main issues of the meeting was the structural basis of mechanics on a smaller scale. *In situ* deformation of complex hierarchical biomaterials such as bone, collagen or wood requires microbeam techniques covering several length scales from the unit-cell level to several hundred micrometres. A strong link exists between such biocomposites and some high-performance synthetic materials such as polymer and carbon fibres, which were also discussed. A second point of focus covered the template-controlled synthesis of novel materials such as mesostructured silica composites or nano-engineered polymer capsules. The enormous potential of these materials lies in the capability of tailoring functional properties by mesoscale ordering using biomimetic principles. Finally, in a similar spirit, the use of nanostructured surfaces or microfluidics for detailed control of protein crystal growth was discussed in view of its fascinating new promises.

The methodology-related part of the meeting provided a comprehensive overview of the current state-of-the-art microbeam instrumentation and X-ray optics developments. Scanning microbeam diffraction with beam sizes down to 1 µm, extending from the wide angle (WAXS) into the small angle (SAXS) regime, is becoming routine practice. Combined with two-dimensional scanning, the methods can thus cover, in principle, the whole range of hierarchies from around 0.1 nm to the millimetre range, *i.e.* seven orders of magnitude. Besides the dedicated microfocus beamline ID13, several other ESRF beamlines frequently use advanced micro-optics for microbeam diffraction, and several other European synchrotron radiation centres are constructing or planning dedicated beamlines (BESSY II, Diamond, PETRA III). Future instrumental developments promise nanobeams extending beyond 100 nm and confocal scattering geometries, both having already been demonstrated in other areas. A challenge will be the development of high-throughput on-line data analysis and visualization, which currently limits microbeam diffraction from being recognized as a real imaging technique. The upgrowth of nanobeams will furthermore require new developments in sample preparation and sample environment including nanomanipulation. Finally, radiation damage is by far one of the biggest problems in nanobiosciences using synchrotron radiation of ever increasing brilliance, and entirely new ways will have to be explored to tackle this dilemma.