MS28 O1

The Development of Instrumentation for Diffraction Experiments using Sub-100-Nanometer X-ray Beams

Manfred Burghammer, Laurent Eybert, Miguel Nicola, Christian Riekel *European Synchrotron Radiation Facility*

Keywords: Diffraction; Synchrotron Radiation, Microcrystals

The employment of x-ray micro-beams for diffraction experiments with high spatial resolution went hand in hand with the development of third generation synchrotron radiation sources offering the high brilliance input beams which are indispensable for efficient focusing. Applications of beams in the micron range have already entered routine operation in the past few years [1]. Evidently there is a strong demand for even higher resolution and thus for smaller beams. Where the production of a 50 nm beam has been demonstrated earlier at ID13 [2] the development of adapted instrumentation in order to meet the extreme requirements imposed by the nanometer scale is still ongoing. There is a whole plethora of problems to be solved, with positional stability of sample, x-ray optics and beam (e.g. thermal drift, vibrations) being only the most obvious. We will discuss an integrated concept dealing with the above mentioned problems while leaving enough modularity for a large variety of nano-prefix experimental techniques, like nano scannig-diffraction, nano-crystallography, nano-SAXS, nano-GISAXS, and more. Examples of possible applications will be proposed covering a wide range from polymer science (e.g. biopolymers) to nano-beam protein crystallography [3].

[1] C. Riekel, *Rep. Prog. Phys.* **63** 233-262 (2000)
[2] C. Schroer et al., *Appl. Phys. Lett.* 87 (12) Art. No. 124103 (2005). [3] C. Riekel et al., *Curr. Opin. Struct. Biol.* 15 (5) 556-562 (2005)

MS28 O2

Combing Laser Tweezer and Micro-diffraction: New Possibilities for *In Situ* Manipulation

Heinz Amenitsch[a], Dan Cojoc[b], Michael Rappolt[a], Barbara Sartori[a], Benedetta Marmiroli[a], Peter Laggner[a], Enrico Ferrari[b], Valeria Garbin[b], Enzo Di Fabrizio[b], Manfred Burghammer[c], Christian Riekel,[c] [a]*Institute of Biophysics and Nanosystems Research, Austrian Academy of Sciences, Graz, Austria.* [b]*CNR-INFM, TASC National Laboratori, Trieste, Italy.* [c]*ESRF, Grenoble, France.*
E-mail: amenitsch@elettra.trieste.it

Keywords: X-ray microdiffraction, optical manipulation, liposomes

In this presentation we show how optical trapping can be used to fix and manipulate individual micron-sized samples and at the same time investigate their internal nanostructure by X-ray microdiffraction. Multilamellar liposomes in the form of highly diluted colloidal dispersion were trapped by light tweezers in single or multiple positions in the optical path of a 1 μm X-ray beam and analyzed by scanning microdiffraction in the plane perpendicular to the X-ray beam. The validity of this technique is demonstrated for clusters of about 30 multilamellar liposomes (3 x 6 μm large cluster). The signal to background ratio shows that single liposome measurements are feasible. Moreover, this technique not only allows investigating single sample entities, but also changing simultaneously by remote control microfluidics the environmental conditions (pH, salinity, chemical potential by other interacting molecules etc.). Single particle chemistry becomes feasible. Further, multiple traps of different samples enables to induce the interaction between them, once they are brought into contact by the optical tweezers. Examples, possibilities and potential of this new technique are presented and discussed.

[1] Amenitsch H., Cojoc D., Rappolt M., Sartori B., Laggner P., Ferrari E., Garbin V., Burghammer M., Riekel C., Di Fabrizio, E., *AIP Conference Proceedings*, 2007, 879, 1287.
[2] Cojoc D., Ferrari E., Garbin V., Di Fabrizio E., Amenitsch H., Rappolt M., Sartori B., Riekel C., Burghammer M., *Proceedings of SPIE - The International Society for Optical Engineering*, 2006, 6326, art. no. 63261M.

MS28 O3

Strain mapping by non destructive method : Laue microdiffraction

G. Geandier[a], B. Malard[b], Ph. Goudeau[a], N. Tamura[c] [a]*LMP – Université de Poitiers, France,* [b]*ILL, Grenoble, France,* [c]*ALS-LBNL Berkeley, USA*. E-mail: guillaume.geandier@univ-poitiers.fr

Keywords: X-ray diffraction, strain-stress measurements, Laue method

Scanning X-ray microdiffraction [1] combines the use of high brilliance synchrotron sources with state-of-the-art achromatic X-ray focusing optics and large area detector technology. Using either white or monochromatic beams, it allows for orientation and strain/stress mapping of polycrystalline materials with large grain size (bulk materials) using white beam and small grain size using monochromatic beam (ion beam sputtered thin films) with submicron spatial resolution.
Evolution of strain fields in materials conducted by external loading conditions (tensile or compressive testing) can be studied by performing in situ testing. White microdiffraction can then be used to study metallurgical alloys with grain size greater than the beam spot (typically 1x1 micron).
Evolution of the stress field in shape memory alloys has been characterized using white beam Laue diffraction. It allows following the evolution of the strain/stress field in a grain, surrounded by other grains and subject to external loading. When the internal load reaches a critical value, the austenitic phase transforms to martensite in order to accommodate the stress field and reduce internal load in the primary phase. With the sub-micron resolution of the microdiffraction, we are able to follow the stress field evolution in a single grain and also between the martensite variants during the whole transformation of the grain due to the external loading.
Due to the experimental, Laue microdiffraction beamlines allows changing from white to monochromatic beam without position change on the sample. So it is possible to use both techniques to characterize samples with grain size lower than the beam spot, as thin film on substrate:
Delamination mechanisms of a thin metallic film (such as gold) adherent to a substrate can be analysed in situ by applying compressive stress to the substrate covered by the thin metallic film (500nm thick) during white beam and monochromatic microdiffraction scanning. White