Microsymposium

MS71.O03

Exploring fibrous materials with micro/nanobeam scanning diffraction techniques

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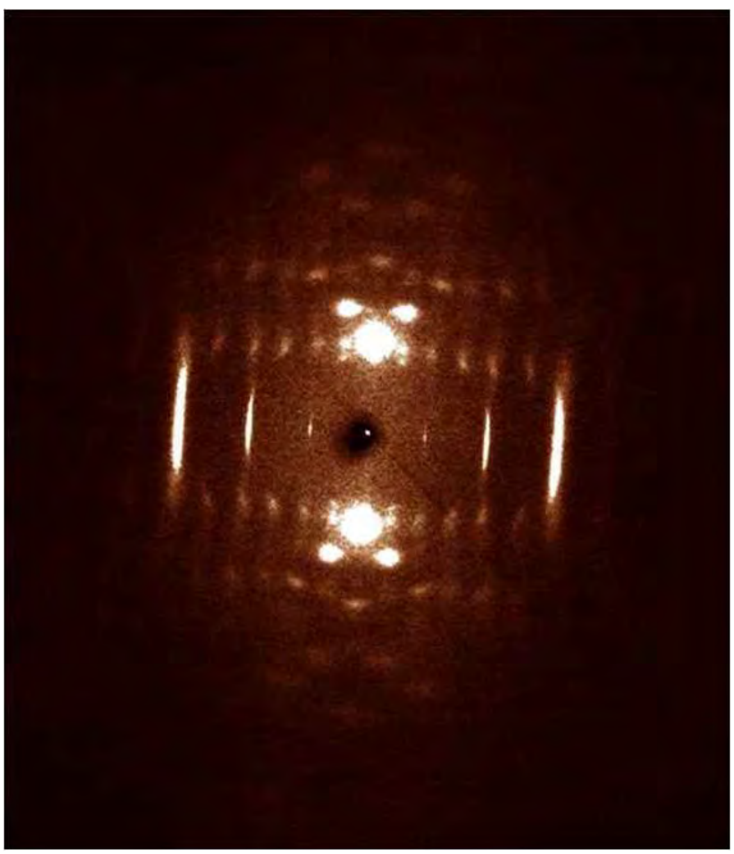
Fibrous materials play an important role in many fields of research spanning from industrial applications to life sciences. They are typically organized in hierarchical arrangements of structural features on multiple length scales. Employing focused monochromatic x-rays combined with scanning diffraction, such samples can be studied obtaining rich information in reciprocal space (molecular to mesoscale level) and direct space simultaneously [1][2]. The resolution of the latter is mainly limited by the focal spot size ranging from a few microns down to 100 nm and less. The arrival of fast, sensitive pixel array detectors during the past years and the availability of high performance focusing optics enable in-situ studies on weakly scattering specimen like single polymer fibers and bio-composite materials (e.g. wood, bone tissue, ...) controlling environmental parameters such as humidity, temperature, and mechanical deformation. In this contribution we will present in a first part the state of the art of instrumentation for such experiments at the ESRF Microfocus Beamline, illustrated with recent examples. The figure below shows an example of a single fiber diffraction pattern of a high performance polymer (KEVLAR®) obtained from a 20 ms exposure with a 1.5 micron beam (Frelon CCD detector, 2k x 2k pixels, 13 keV photon energy). In the second part, future opportunities for scanning diffraction experiments emerging from potential upgrades of 3rd generation synchrotron radiation sources, as currently explored at the ESRF and elsewhere, will be discussed.

[1] *M. Rosenthal, G. Bar, M. Burghammer, et al., Angewandte Chemie, 2011, 50, 38, 8881-8885,* ***[2]*** *G.B. Perea, C. Riekel, G.V. Guinea, et al, Scientific Reports, 2013, 3, 3061*



Keywords: micro-diffraction, fibrous materials, nano-beams