The Pan African Conference on Crystallography (PCCR2)
and
The African Light Source Conference (AfLS2)

Contribution ID: **290** Type: **Oral Presentations**

X-ray diffraction using the Synchrotron light for molecular materials

Tuesday, 29 January 2019 14:00 (30 minutes)

X-ray scattering is well known as a powerful and relevant technique to probe the structural properties of matter. While X-ray diffraction techniques are widely used in laboratories, the specifics of the synchrotron light make it a valuable tool for the most difficult cases. For examples, the high brightness of the source allows the study of very small single crystals or/and with low diffracting power. Parralelism of the beam gives access to the ultimate resolution in powder diagrams. The tunability of the wavelength allows to change the contrast between adjacent elements in the periodic table (resonant diffraction). The pulsed nature of the synchrotron light benefits structural dynamics studies down to the ps time scale. Furthermore, new diffraction techniques using the coherent property of the beam are emerging tools to probe the structural strain and stress at the nanoscale.
The CRISTAL beamline at synchrotron SOLEIL is a dedicated beamline to X-ray diffraction [1]. It offers its users a wide range of diffraction techniques for probing the structural properties of matter at different spatial and temporal scales, possibly in non-ambient conditions. In particular, molecular materials are extensively studied using the different techniques available at the beamline, by a very wide diversity of scientific communities, to answer all kinds of questions concerning the analysis of the structural properties of this kind materials.
Among the accessible techniques, high angular and/or spatial resolutions (ab initio powder structure, electronic densities, incommensurate crystals, quasi-crystals), determination of the pair distribution function, anomalous diffraction, grazing incidence diffraction are available in non-ambient conditions, thanks to the development of various (unique) sample environments, giving access, for example, to the structural contributions during phase transitions.
Coherent diffraction imaging techniques (Bragg coherent diffraction, ptychography) are also proposed, to map the deformations, stress states of micro/nano objects. Structural dynamics can also be tackled over a very large time scale: the temporal resolution extending from the millisecond to the sub-picosecond. In situ measurements, operando (e.g. battery), pump-probe experiments (e.g. photo-induced excitations) are among the techniques used to probe the dynamical aspects of the structural properties.
Therefore, in this talk, several examples illustrating the benefit of the synchrotron light for the structural characterization of molecular materials will be addressed, using different techniques such as high resolution powder diffraction, pair distribution function analysis, resonnant diffraction, diffraction under extreme conditions, coherent diffraction or time-resolved diffraction.

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Session Classification: PCCr2

Track Classification: PCCr2