AFC 2008 Rennes

(www.afc2008.univ-rennes1.fr)

Colloque VA : Cristallochimie

Gavin Vaughan

ESRF, Grenoble, France

Diffraction Studies at the ESRF

A wide variety of diffraction experiments are carried out at ESRF beamlines, utilizing essentially all techniques derived from single crystal and powder diffraction. Single crystals with sizes below 10 μm^3, or volatile and highly imperfect crystals can be studied du to the intense flux available from the synchrotron source. The energy tunability of the incident beam means that anomalous diffraction techniques may be used to detect elemental or oxidation state ordering. The high flux and low background allows the possibility to measure many orders of magnitude of diffracted intensity, necessary in studies of weak superlattices, charge density, etc.

Powder diffraction experiments may be carried out with very high temporal, spatial and/or angular resolution depending on the needs of the system under study. The best time resolution is available for stroboscopic studies of highly reversible systems, but due to improvements in detector technology it is now possible to collect data on irreversible systems with millisecond time resolution. Alternatively, very high angular resolution can also be achieved with analyser crystal arrangements, allowing the collection of data for which instrumental effects are negligible, enabling the best possible structural refinements, as well as detailed peak-shape analysis. Developments in X-Ray focussing technology and beam and sample metrology now allow the essentially routine use of micron scale beams, with beams down to 100 nm exploitable in some cases. At these levels, the sample are rarely ideal powders, so methods are used to treat them as an ensemble of single crystals, and in this way characterize not only their average properties, but all the *distribution* of these properties.

A variety of methods (reviewed in [1]) based on high-energy X-Ray diffraction have been developed to characterize crystalline samples on length scales ranging from 100s of nm to mm. These methods have been used to characterize a variety of systems of interest to materials science such as metals and alloys, ceramics, hydrogen-storage materials and components from the microelectronic industry. All of these materials have in common that their performance or macroscopic properties are heavily influenced by sub-micron characteristics such as grain boundaries, crystallite orientations, stoichiometry gradients, etc., and in order to fully understand these systems characterization on several length scales is necessary.

[1] Juul Jensen D., Lauridsen E.M., Margulies L., Poulsen H.F. , Schmidt S., Soerensen H.O., and Vaughan G.B.M., Materials Today, 2006, 9(12), 18.