High Pressure XAS at the I20-EDE beamline at Diamond Light Source

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The I20-EDE beamline at Diamond Light Source (UK) is dedicated to Energy-Dispersive X-ray Absorption Spectroscopy (XAS). I20-EDE shares the I20 straight section of the Diamond ring with the I20-scanning branch, which is also dedicated to XAS but in energy scanning mode. Each branch has its own wiggler source, optical elements, experimental hutch and control cabin, and can therefore operate independently and simultaneously.

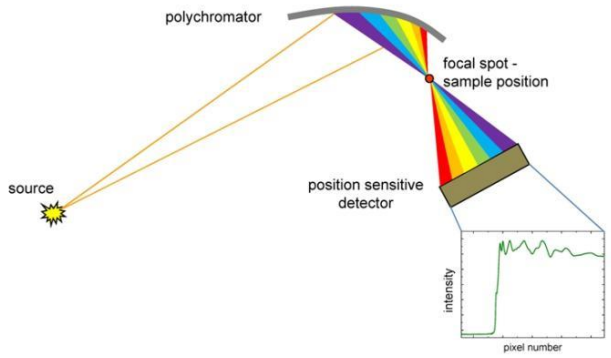

Figure 1. The principle of energy-dispersive XAS.

The I20-EDE source is a variable gap, hybrid wiggler, with 1.3T peak field. It delivers a continuous white beam spectrum with enough horizontal divergence to fully illuminate a 250mm long polychromator crystal. The polychromator is a long thin silicon crystal that is dynamically curved to the required ellipse, to select a bandwidth of energies focused at the sample position and diverging to a position-sensitive detector. Si(111) and Si(311) crystals are available to study absorption edges of energies between 6keV and 26keV, with dispersive bandpass of ~10% at all energies and photon flux of 10^{12} ph/s at 10keV. The position-energy relation established allows for the whole absorption spectrum to be acquired in a single shot. This characteristic of the energy-dispersive configuration, together with the availability of fast detectors, gives the beamline the ability to perform time-resolved XAS. Processes with timescales ranging from hours all the way down to microseconds can be studied.

The beamline characteristics make it suitable for XAS measurements at high pressure; in particular the small focal spot of ~ 30 µm, the high flux, and the beam stability over the whole energy range, have been exploited for performing XAS experiments in the Diamond Anvil Cell (DAC). The fast data collection allows for quick alignment of the DAC for extended range of glitch-free data with standard single-crystal diamond anvils at selected absorption edges. It also enables time-resolved measurements in the DAC and thus the study of rate-dependent phenomena - the study of the kinetics of phase transitions and metastable phases at various compression rates.

The beamline is equipped with a PACE 5000 remote digital pressure controller to control the membrane-driven DAC, and a Horiba iHR320 spectrometer with 532nm laser for on-line Raman and pressure measurements. Transmission and fluorescence mode XAS are available. The experimental set-ups will be presented as well as examples of the first successful experiments performed.