The Joint Engineering, Environmental and Processing Beamline at the Diamond Light Source, UK

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Introduction

The Joint Engineering, Environmental and Processing Beamline (JEEP) at the Diamond Light Source (UK) is being designed for research primarily in the fields of Material Science, Engineering Science, medical and environmental studies. The beamline is to become operational by April 2009.

Using high-energy x-rays in the spectral range between 50 keV and 150 keV relevant materials of significant thickness can be studied. As well, environnmental chambers necessary to performing processing studies can easily be added.

The x-ray source is a super-conducting multi-pole wiggler with likely parameters 4.0 T for magnetic field of and 50 mm for period-length. The anticipated flux is 10^{11} photons per second in the central square millimetre at sample-position at a relative energy band-width of 10^{-3}, at energy of 100 keV.
JEEP has a two hutch concept allowing to set-up processing experiments in a second experimental hutch whilst delivering beam into the first one. Both, white beam and monochromatic beam will be available in both hutches. For later beam mode bent crystal Laue monochromators with adaptable bending will be employed.

Two main types of experiments are considered, which are imaging and diffraction. Imaging will be feasible in monochromatic and white beam mode. Computed tomographic reconstruction is foreseen for both beam modes.
Monochromatic diffraction using large area 2D detectors and energy-dispersive diffraction with Ge solid state detectors will become available.

This collection of experimental set-ups will make JEEP a multi-purpose beamline suitable for a large variety of x-ray studies in different scientific fields. Most prominently, Material and Engineering Science may profit from high photon fluxes which allow performing of in-situ experiments, both, in imaging and diffraction and, for instance, facilitate the study of service conditions while monitoring internal stress state and structure simultaneously.

In general, JEEP can gain insight into the microstructure of material on microscopic and nanometre scale in real space and reciprocal space, respectively. Microstructure is the most important factor to understand the mechanics of materials, and it summarises characteristics such as structural integrity, phase separation, grain mechanics, dislocations, micro-strain, and so on.

Finally, focusing the monochromatic x-ray beam by using a combination of bent crystals and refractive x-ray lenses will extend experimental options in two ways.

Focusing the beam onto the sample position will allow collecting local diffraction, for instance from single grains or from interfaces within compound materials. Focusing onto the detector, on the other hand, will considerably enhance the resolution in reciprocal space.