Soft X-ray microscopy opportunities at SOLEIL: HERMES: a beamline dedicated to XPEEM and STXM microscopies

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There is a tremendous and growing need to explore detailed structural, morphological, magnetic, electronic and chemical properties of heterogeneous matter at the nanometer scale. This is almost true in all the field of science such as material and nanoscience, biology and medicine, chemistry, earth and environmental science etc.

The high brightness of third generation synchrotron radiation sources has opened the way to X-ray imaging with resolution in the 10 nm ranges[1–4], with the perspective of further instrumental developments in the nanometer ranges. Experimentally, there are two different approaches and both are developed at HERMES beamline (Synchrotron SOLEIL-FRANCE). The first uses a well-focused photon beam that is scanned across the sample (STXM)[5]. The second employs parallel imaging techniques making use of adapted low energy electron optics (XPEEM)[6].

The originality of the HERMES[7] beamline is to combine these two approaches on the same beamline with the goal to reach spatial resolution below 20 nm. This original approach will offer two complementary microscopy techniques to the users community. On one hand XPEEM is photon-electron based and is intrinsically a surface–interface microscopy method with an ultrahigh-vacuum sample environment. On the other hand, STXM is a photon-in/photon-out based microscopy that allows to essentially investigate 'bulk' properties of materials with a more versatile sample environment.

The combination of these two microscopies opens up the scientific case of the beamline, which covers a broad range of the science developed at SOLEIL. The specifications of the beamline have been therefore finely optimized to fulfill the technical requirements of all the scientific areas covered by the beamline, in terms of energy range and resolution, spatial resolution, photon flux, beam size etc.

The commissioning results of the XPEEM branch will be reviewed together with the specifications of the X-ray beam in term of flux, size and energy resolution. The beamline allows to achieve very high photon flux (up to 10^{13} photons/s), micro-sized beamspot (<15 μm) and high resolving power (> 10,000) over a broad energy range (70 eV – 2.5 keV). Important issues such as vibration, stability, carbon contamination, spectral purity etc. will be also discussed. The specifications and the description of the two branches, along with the associated XPEEM and STXM microscopes will be also presented, both in the imaging and local spectroscopy modes.

Finally, examples of the first user experiments will be given, together with additional newly developed capabilities (time resolved, dedicated sample environment, multi-detection.....).

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