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X-ray Tomographic Microscopy at the SLS: a powerful tool for non-destructive investigation of new materials

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Synchrotron-based X-ray Tomographic Microscopy (XTM) is nowadays a powerful technique for the non-destructive, high-resolution investigation of a broad kind of materials. High-brilliance and high-coherence of modern third generation synchrotron radiation facilities allow micrometer and sub-micrometer three dimensional imaging within very short time and extend the traditional absorption imaging technique to edge-enhanced and pure phase-sensitive measurements. At the Swiss Light Source an XTM station is serving more than 20 users groups working in very different research areas. The detector is based on a scintillating screen optically coupled to a CCD camera. Different configurations are available, covering a field of view ranging from 7.15x7.15 mm^2 down to 715x715 μm^2 for magnifications going from 4x up to 40x corresponding to pixel sizes down to 0.35x0.35 μm^2. A low-noise fast-readout CCD camera transfer 2048x2048 pixels within 250 ms and a dynamic range of 14 bit to the file server. Raw data are processed on the fly and full volume reconstruction is provided within minutes after the end of the scan. For this purpose we use a PC cluster with 42 GHz CPU power and a graphical workstation with 6 Gb of RAM.

In the materials science, XTM has been used for the in situ 3D observation of intergranular corrosions in aluminum aerospace alloys, to gather information from geologic samples in order to simulate fluid migration and dissolution, for crack detection in hardened Portland cement, to investigate soil aggregates or to visualize gas diffusion layers in fuel cells. In the biological field, XTM has been the best suited tool for studing the age dependent vascular alterations in genetically modified mices (modelling the Alzheimer's disease), to investigate the effect of tenascin C deficiency in the alveolarization process during the postnatal lung development, or for failure assessment of whole bones and the visualization of bone vasculature in genetically distinct mouse strains.

For all these experiments additional ad-hoc equipment and software like high-precision alignment systems, conditioning chambers, micro-loading devices and 3D navigations tools have been designed and implemented.

In order to investigate weak absorbing materials new phase contrast techniques have been developed: a differential phase contrast method based on shearing interferometry has been proved to delivery quantitative phase information while a refined, pure 3D algorithm technique is providing very promising results.

XTM is becoming more and more important at the SLS: presently an XTM dedicated beamline is under construction and will be operative at the beginning of 2006.

The talk will give an overview on the XTM technique, presenting results from the heterogeneous palette of experiments carried out at the SLS. A brief insight into the expected performances and future experiments planned at the XTM dedicated beamline will also be given.

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