Tomographic and radiographic imaging with X-rays and neutrons

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Organiser	Institution	Contact
Alexander Rack	European Synchrotron Radiation Facility 6 rue Jules Horowitz 38000 Grenoble France	**arack@snafu.de**
Timm Weitkamp	Synchrotron Soleil L'Orme des Merisiers Saint Aubin - B.P. 48 91192 Gif sur Yvette France	**timm.weitkamp@synchrotron-soleil.fr**

Summary

Imaging methods using penetrating radiation provide insight into heterogeneous materials or engineering components. In combination with tomography they yield a fully three-dimensional representation of the object structure. Using X-rays from laboratory sources or synchrotrons, and neutrons from nuclear reactors or spallation sources, hidden structures can be revealed in a non-destructive manner. In addition, as the systems under study become increasingly complex, multi-modal imaging techniques and hierarchical multi-scale studies are rapidly gaining importance.

Recent developments in X-ray tomography using laboratory-based sources have pushed the spatial resolution to values that previously required synchrotron radiation. As a result, microtomography is more and more frequently applied as an analytical tool in many fields, and its user community is constantly growing. Synchrotron light sources are nowadays boosting X-ray tomography up to nano-resolution, combined with novel contrast schemes which allow correlating the internal morphology of samples with the distribution of chemical species, grain orientation or crystalline phases. The high photon flux density in combination with the coherence properties of synchrotron light gives access to unprecedented time resolution: tomography scans can be acquired in times down to 100 ms and thus resolve dynamic processes in four dimensions: 3D space and time. Time-resolved 2D projection radiography, making use of the isolated bunch structure of the synchrotron, even yields snapshot images with a time resolution in the 100-picosecond range.

On the other side, neutron radiography and tomography have also been developed further in terms of spatial resolution and contrast modalities and now enable researchers to exploit the unique contrast mechanisms associated with neutrons, including magnetic and nuclear interactions, to benefit of the long penetration depth, e.g., for imaging massive objects in engineering, and of the strong contrast given by hydrogen and other light elements. Periodic movements can be imaged with neutrons in a time-resolved manner via stroboscopic techniques.

The aim of the symposium is to provide and exchange information on the rapidly developing experimental techniques with respect to novel potential applications. Tomography and radiography using different radiation sources for materials science, applied physics and various areas of engineering will be presented. As tomography heavily relies on a mathematical foundation, namely the process of data reconstruction and algorithms allowing us to extract information from images, a further focus is put on volume data processing and analysis.

Selected articles from this symposium will be published as a special issue of the International Journal of Materials Research.