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Invited talk "X-ray imaging for spatiotemporally resolved studies of micro-structure evolution during technological and biological processes"

Wednesday, 17 June 2015 09:00 (50 minutes)

The talk will focus on developments at Karlsruhe Institute of Technology in the context of current challenges in materials and micro-system technologies and life sciences, where state-of-the-art X-ray imaging techniques provide spatiotemporally resolved information about micro-structure and its evolution during technological and biological processes.

X-ray laminography has been developed for defect recognition in extended objects [1-4], permitting in situ and in operando studies from defect generation up to failure. It enables scanning of complete entities with medium resolution, and zooming into region of interests with high resolution and correlation of various scanning and full field contrast mechanisms [5-8].

An important issue is the development of dose-efficient imaging methods, which enable the visualization of soft tissue, in order to facilitate in vivo and in vitro investigations, e.g. for developmental biology, functional morphology, nano-toxicology and tissue engineering. The opaqueness of many organisms impedes in vivo investigation by light microscopy. In combination with optical flow algorithms, 4D phase-contrast μCT allows following of spatiotemporal movements, e.g. in order to observe tissues and individual cells during embryonic development [9, 10]. To investigate fast structure dynamics with feature sizes in the micron range and with high temporal resolution, we designed X-ray cine-tomography [11]. The technique enables e.g. new insights into the physiology of small animals by tracking the 4D dynamics of anatomical features as demonstrated by the analysis of screw-and-nut type weevil hip joints [12].

Further development will require an increase in dose-efficiency. Promising routes here include improvement of single-distance phase retrieval at large propagation distances, as well as the use of diffraction based magnifying optics combined with single photon counting detectors [13-16].

References

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