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Time-resolved (4D) in situ x-ray tomographic microscopy at TOMCAT: Understanding the dynamics of materials during elevated temperature processes

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Non-destructive synchrotron-based x-ray tomographic microscopy is ideal for studying various materials systems in three and four dimensions, and the TOMCAT beamline of the Swiss Light Source is one of the premier beamlines in the world for such experiments. Spatial resolution ranges from 1-10 μm with fields-of-view from 1-22 mm, and temporal resolution is as fast as 0.1 s for full 3D data acquisition. Contrast varies from standard absorption, typically used in metal and composite systems, to propagation- and gratings-based phase contrast, predominantly used for biological and other traditionally low-contrast materials. The efficient image-processing pipeline provides a full 3D reconstruction within seconds, making visualization close to real time. To exploit these state-of-the-art capabilities, a dedicated laser-based heating system has been developed to explore the dynamics of materials at elevated temperatures. I will summarize these capabilities at TOMCAT and provide examples of its versatility and suitability for various materials systems. This will include a specific focus on understanding recent novel results in 4D directional solidification of dendritic microstructures in metals systems and mimicking volcanic processes in geomaterials.

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