Contribution ID: **12** Type: **Talk**

In-Situ Investigations of Materials Using Ultra-Fast X-Ray Tomographic Microscopy and Laser Heating

Friday, 16 September 2011 15:05 (15 minutes)

Non-destructive synchrotron X-ray tomographic microscopy is ideal for studying the dynamics of materials systems in real time. To exploit the state-of-the-art capabilities at the TOMCAT beamline of the SLS, a moderate to high temperature furnace has been developed. Powered by two diode lasers, it provides controlled, localized heating in a temperature range of 400 to 1600℃. When coupled with the ultra-fast technique, where a full data set of hundreds of projections over 180° can be captured in less than 1s, a user can explore many materials systems and their dynamics in-situ under various thermal modalities. In one mode, the lasers achieve nearly isothermal conditions at a given location with a prescribed time-dependent temperature. This is typically used to study isothermal phase transformations such as nucleation and growth of bubble foams in silicate melts under conditions that mimic volcanic eruptions. In another mode, similar to Bridgman solidification of metals, the power of the laser is fixed and the specimen moves at a constant speed in a user-defined thermal gradient. Examples will be presented indicating the interest and versatility of this novel technique.

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Session Classification: Imaging

Track Classification: Imaging