Fast imaging of powders melting and phase separation in silicate glasses

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Fast in-situ synchrotron tomography has provided unprecedented insights into the evolution mechanisms of many materials under heating or mechanical treatments, as for metallic alloys for example. Silicate glasses, on the other hand, have been less studied by in-situ imaging techniques. In this talk, we will present two examples of high-temperature in-situ tomography studies in silicate glasses.

A first application is the reactive melting of window-glass raw materials. In industrial furnaces, synthesis of good-quality soda-lime glass from grains of quartz sand and carbonates is typically carried out at 1500°C, although typical compositions are completely molten at 1050° C. Defects whose elimination requires heating to these high temperatures include gas bubbles and unmolten sand grains. More insights into the evolution of the microstructure are needed to understand and optimize glass melting. We have carried out high-temperature in-situ microtomography experiments of glass melting on small packings of raw materials at the ID15a and ID19 beamlines of the ESRF. Significant and unexpected rearrangements of grains occur below the nominal eutectic temperature, and several drastically different solid-state reactions are observed to take place at different types of intergranular contacts. These reactions have a profound influence on the formation and the composition of the liquids produced, and control the formation of gaseous and solid defects.

We have also studied phase separation in a barium borosilicate glass. Lots of simple (binary or ternary) glasses exhibit phase separation in their stable liquid or supercooled state. Depending on temperature and composition, either spinodal decomposition (leading to interconnected domains) or nucleation (leading to droplets) can be observed. Using in-situ tomography, we characterize the 3-D morphology of the domains, and their evolution during coarsening.