Laser Heating of Nuclear Materials

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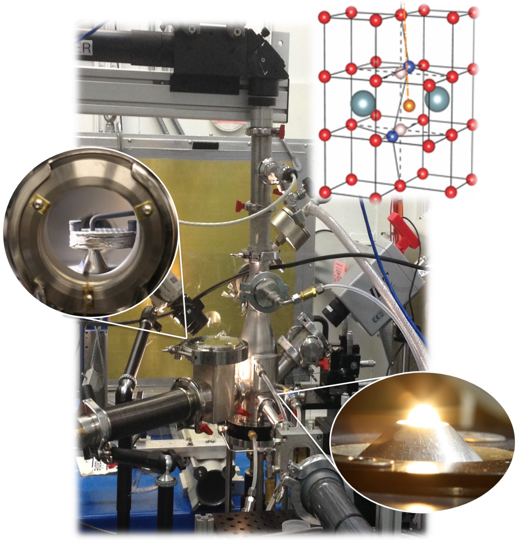
Severe accident scenarios involving the melting of a reactor core leads to the formation of corium lavas which are initially composed primarily of oxidized nuclear fuel and cladding materials [1]. Laser heating of levitated samples is a valuable tool for the characterization of these hazardous materials in at extreme temperatures and under non-equilibrium conditions in a controlled environment [2]. The method enables the study of liquids, formation of novel glasses, amorphous phases as well as stable and metastable high temperature crystalline forms. To this end, an aerodynamic levitator with carbon dioxide laser beam heating was integrated with a hermetically sealed controlled atmosphere chamber and sample handling mechanism [3]. The system enabled containment of radioactive samples and control of the process atmosphere chemistry. The chamber was typically operated at a pressure of approximately 0.9 bars to ensure containment of the materials being processed. Samples 2.5-3 mm in diameter have been levitated in flowing gas to achieve containerless conditions. Levitated samples were heated to temperatures of up to 3500 °C with a partially focused carbon dioxide laser beam. Sample temperature was measured using an optical pyrometer. The sample environment was integrated with a high energy (100 keV) x-ray synchrotron beamline to enable *in situ* structure measurements to be made on levitated samples as they were heated, melted, and supercooled. The system was controlled from outside the x-ray beamline hutch by using a LabVIEW program. Measurements on hot solid and molten uranium dioxide and binary uranium dioxide-zirconium dioxide compositions are reported [4].



Aerodynamic levitator and laser heating system on beamline 6-ID-D at the APS.

References

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