How we can track reactions under a fast laser-processing

Shengmin Guo & Phil Sprunger, Louisiana State University

Award Title:	Consortium for Innovation in Manufacturing and Materials (CIMM)
NSF Award Number:	NSF OIA-1541079
Principal Investigator:	Michael Khonsari
Lead Institution Name:	Louisiana State University
Award Start Date:	August 1, 2015
Award End Date:	July 31, 2020
Highlight Submission Date:	04/15/2020

What is the outcome or accomplishment? (1-2 short sentences describing it and why it is transformative; 50-word maximum suggested)*

Using synchrotron-based, *in-situ* X-ray diffraction, a group of Consortium for Innovation in Manufacturing and Materials (CIMM) researchers have revealed the phase transformations and reaction steps between metallic powders and reactive gases under fast-laser processing conditions.

What is the impact? (1-2 simple sentences describing the benefits for science, industry, society, the economy, national security, *etc.*; suggested 50-word maximum)

The revealed reaction steps give a better understanding about what is happening during the fast laser irradiation process. This will provide a powerful guidance for optimizing both laser surface treatment and laser powder bed fusion additive manufacturing processes.

What explanation/background does the lay reader need to understand the significance of this outcome? (1-2 paragraphs that might include, for example, more on who, when, where; NSF's role; support from multiple directorates/offices; what makes this accomplishment unique; additional intellectual merits; or broader impacts such as education, outreach, or infrastructure improvement that are integral to this outcome; suggested 150-word maximum)

Laser-based material processing, such as laser surface modification and laser powder bed fusion additive manufacturing, is widely used by industry. Laser processes typically have an extremely fast heating and cooling rate. For the majority of research work carried out in this field, the focus is predominantly on the properties and performances of the products after laser processing.

Limited studies can be found on investigating the changes during the fast laser irradiation process. To fill this knowledge gap, CIMM researchers, supported by NSF, established a testing rig based on synchrotron X-ray diffraction for the study of high temperature reactions.

Dr. Guo and Dr. Sprunger's research groups have conducted several studies to reveal the *in-situ* phase changes and reactions for different alloy and reactive gas combinations on a hard X-ray

beamline at the Center for Advanced Microstructures and Devices (CAMD) in Baton Rouge, Louisiana. The results can be used to optimize laser material processing parameters.