Scientists develop a window into the complex, hidden internal structures of metal 3D printed parts

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

Using specialized X-Ray radiation tests, Louisiana researchers have developed a better understanding of the science behind laser-based metal 3D printing, which will greatly improve the quality and integrity of the parts printed with this manufacturing technology.

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

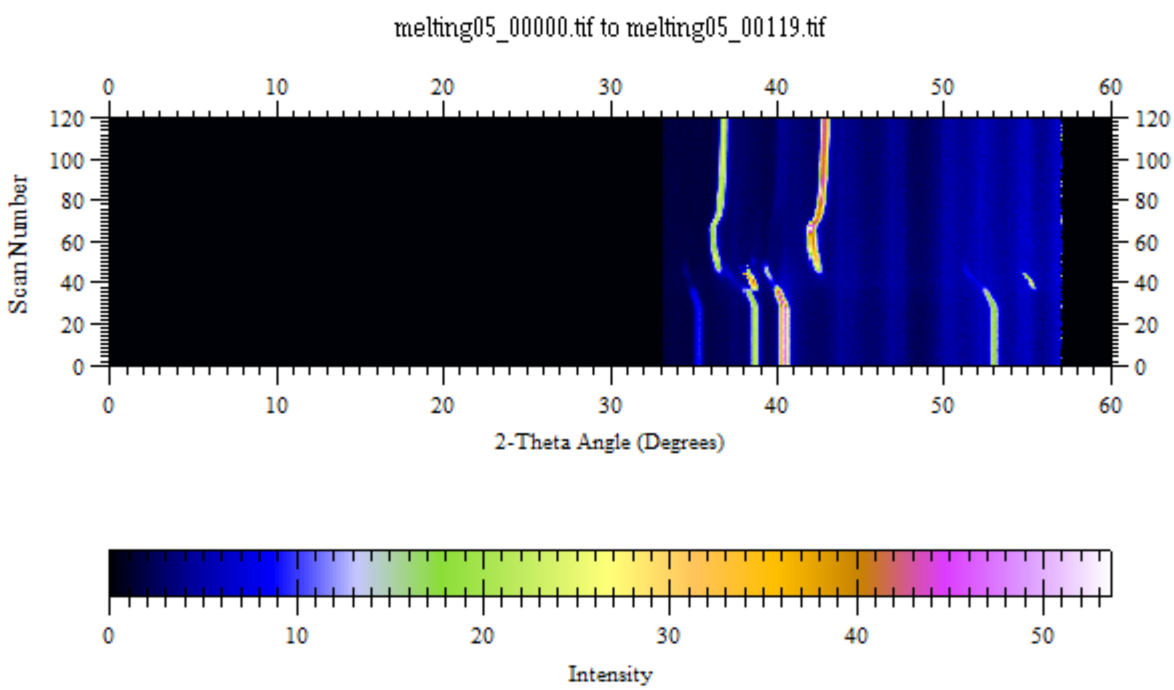
Laser-based metal 3D printing is a modern manufacturing process whose usage is growing exponentially in the manufacturing industry. In one example, this technology has allowed gas turbine nozzle design to be significantly simplified, with 20 parts now printed together in one step as one part. The gas turbine and related industrial sectors alone support hundreds of thousands of U.S. jobs and represent nearly 10% of all U.S. exports.

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)

Due to the small laser spot size used in this printing technology, the heating, cooling and solidification rates are orders of magnitude higher than those observed in conventional metal forming processes. The physics of such rapid cooling rates impacts the quality of printed metal, causing suppressed phase transformations, supersaturated phases, hot cracking, and residual thermal stresses which may affect the integrity of the printed parts. To develop an accurate understanding of the physics at play, researchers are examining these effects using synchrotron radiation. This high brilliance light source with a variable wavelength far surpasses standard laboratory X-Ray sources. The team has successfully collected time-dependent series of diffraction patterns from a variety of alloy samples, before, during, and after laser printing.

Photo:

Louisiana State University Mechanical Engineering graduate student Ms. Hong Yao (right) and Dr. Henry Bellamy (left) study the dynamic laser melting/solidification process at the LSU Center for Advanced Microstructures and Devices. Credit: Dr. Shengmin Guo, Louisiana State University.



Synchrotron X-Ray diffraction with laser induced heating, melting, solidification and chemical reactions on titanium sample under N_2 environment. Credit: Dr. Shengmin Guo, Louisiana State University.