Louisiana EPSCoR
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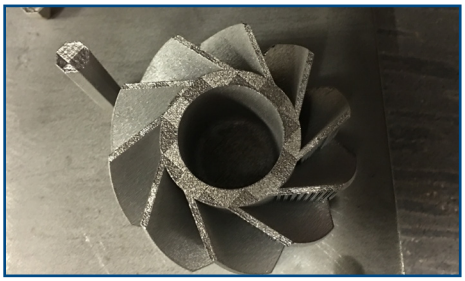
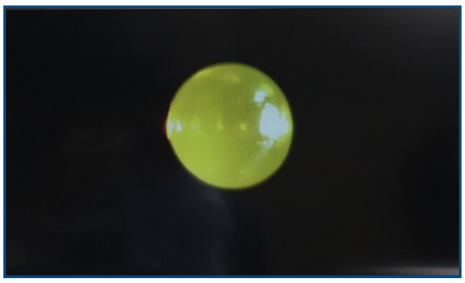
CIMM Building Strong Foundation for 3D Printing Manufacturing Industry

NASA engineers have the ultimate design challenge preparing spacecraft and devices for robotic and human exploration on Mars. Specialized devices and parts are needed that can withstand immense heat, pressure, and torque to protect the mechanical and human cargo. There are lots of strong materials out there, but there is a caveat: the devices must also be small, strong, and lightweight in order to safeguard the trip through space.

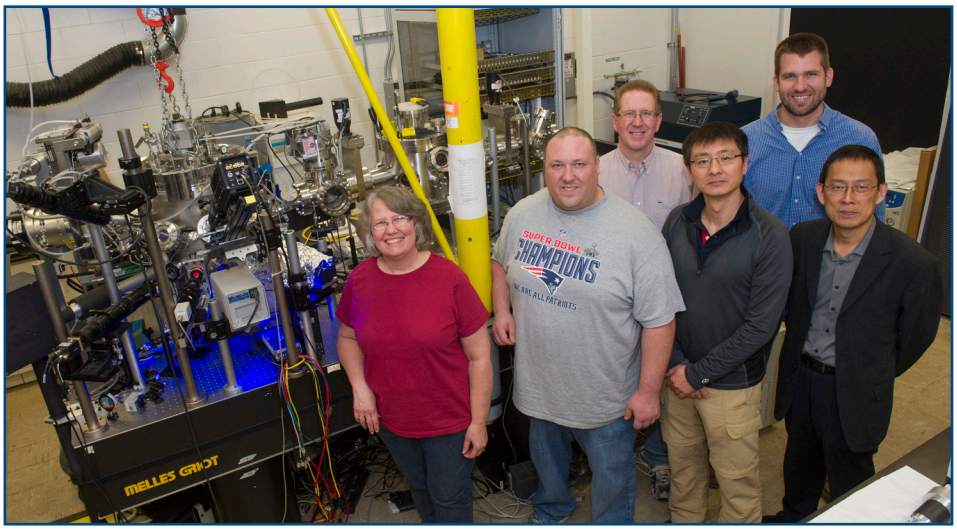
To meet these challenges, many components are being miniaturized and manufactured with 3D printers that use specialized metal powders. Today, Selective Laser Melting (SLM) is the most widely used laser-based 3D printing system in place for complex 3D metal parts.



A 3D printed metal gear printed at the CIMM central user facility at LSU.



A levitated molten metal droplet sample at the NASA MSFC lab.



Pictured (L to R): NASA staff members Trudy Allen, Michael Sansoucie, and Glenn Fountain with CIMM researchers, Dr. Wen Jin Meng, LSU Ph.D. student Jonathan Raush, and Dr. Shengmin Guo in front of the Electrostatic Levitation system at NASA MSFC. Photo courtesy of NASA.

To print a part, a layer of metal powders, tens of microns in diameter, is spread on a building platform, then a focused laser beam is used to melt the metal powders at selective locations. This is repeated over and over until the part is completed.

Currently there is a lack of high quality thermophysical property data for molten metals and alloys. Understanding the thermophysical properties is crucial for optimizing SLM manufacturing processes and launching the U.S. advanced manufacturing industry toward mass production.

To help fill in this knowledge gap, a team of Louisiana researchers with the NSF EPSCoR-funded Consortium for Innovation in Manufacturing & Materials (CIMM) is collaborating with Dr. Michael Sansoucie of NASA Marshall Space Flight Center (MSFC), to measure high-temperature thermophysical property data for liquid metals and alloys.

The research team, led by Drs. Shengmin Guo and Wen Jin Meng, is using Electrostatic Levitation (ESL) to test the materials, which uses an electric field to levitate a molten metal droplet in high vacuum and counteract the effects of gravity. This is especially important for highly reactive alloys such as titanium alloys because chemical reactions will occur between the specimen and a container, causing contaminations. Using levitation ensures the quality of the measured data without the interference of a container.

The resulting data offer important

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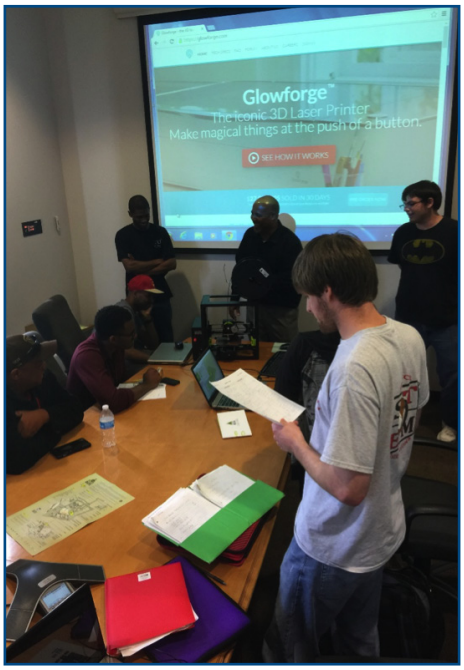
input to supercomputer simulations that researchers will use to develop new materials and processes through LONI, the Louisiana Optical Network Initiative. Supercomputer simulations save immense time and expense by quickly narrowing down the combinations that will have the best results in real lab tests.

To further research and development on laser 3D printing, the CIMM team has acquired and already installed a SLM system from ConceptLaser Inc. in the CIMM central user facility (CUF) housed at Louisiana State University (LSU). The system can handle a variety of commercial metal powders, including stainless steels, titanium alloys, and cobalt-chromium alloys.

To help build Louisiana's advanced materials workforce, CIMM researchers will spend the summers mentoring community college teachers as part of the Research Experiences for Teachers (RET) program. RET participants perform research and will be trained in the software and hardware aspects of 3D printing.

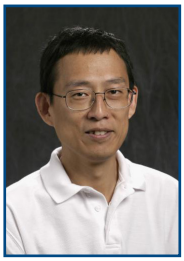
The math, science, and computer science teachers will bring their knowledge back to their classrooms and use their experiences to enhance their STEM curriculum.

To kick off this endeavor, CIMM researchers donated a 3D plastics printer to Baton Rouge Community College (BRCC). The donation has received enthusiastic reception from BRCC faculty and administrators, who will incorporate the 3D printer into a wide variety of curricula.



A BRCC STEM instructor explains to a group of students how to use the donated 3D printer. Photo courtesy of BRCC.

"It is our hope that collaborating with teachers over the summer and providing hands-on 3D printing resources will raise the interest level of community college students toward careers centered around or related to advanced manufacturing," said Dr. Shengmin Guo, Professor of Mechanical Engineering at LSU and CIMM researcher.



Dr. Shengmin Guo, LSU

The BRCC STEM Division Dean, Ms. Ovueraye–Adoghe reported that the donation will allow her faculty to bring images previously taught in 2D into life-like 3D imagery. In fact, the math teachers are already looking forward to using the printer for demonstrating concepts in multidimensional calculus and other math classes.

"Advanced manufacturing is the wave of the future, and CIMM is on the cutting edge of innovative research to come," said Dr. Michael Khonsari, LA EPSCoR Project Director and Associate Commissioner for Sponsored Programs Research and Development at the Louisiana Board of Regents.

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