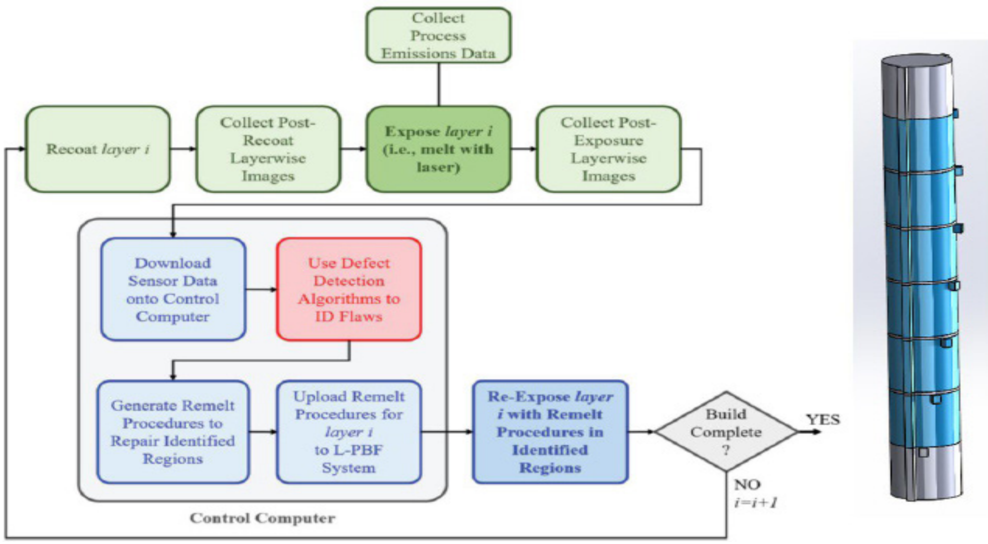
PROJECT SUMMARY **5001.002.001.003**

Strategies for Real-Time Defect Mitigation for Additive Manufacturing (AM) Processes



Flowchart of the proposed methodology for an automated flaw detection and interlayer repair system, including a representative test cylinder for evaluating different remelt strategies.

PROBLEM

Flaws in laser-based powder bed fusion (LPBF) additive manufacturing (AM) components detrimentally affect part quality and thus mechanical performance, thereby limiting applications of the technology in industry. Though OEMs optimize processing conditions to achieve the best possible quality, stochastic flaws persist in AM material. These internal flaws negatively affect fatigue properties, limit the ability to define design limits, hamper qualification efforts, and consequently prevent widespread use of AM in many critical applications.

OBJECTIVE

The objective of this effort is to develop and demonstrate key processes necessary to realize interlayer repair in an LPBF system based on automated flaw detection demonstrated in prior efforts. Specifically, the project seeks to optimize process parameters to repair flaws by remelting between layers and document impact on remaining flaws via post-build computed tomography (CT) scans. Another objective is to demonstrate the ability to realize interlayer repair procedures in a production LPBF system using the software application program interface (API).

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to:

PROCESS

ASTM PROCESS CATEGORY
Powder Bed Fusion

EQUIPMENT
3D Systems ProX 320
Renishaw AM250

MATERIAL
Ti6Al4V

TECHNICAL APPROACH

The Applied Research Laboratory at the Pennsylvania State University (ARL/PSU) is leading the program which includes Moog AMC (Moog) and 3D Systems (3DS). Experiments are being designed to optimize process parameters necessary to achieve successful interlayer remelt repair. One build designed by ARL/PSU is exacerbating formation of stochastic flaws, e.g. parts located near the cross-flow exit. A series of remelt process conditions is being applied to various regions of the part (performed by 3DS). Post-build CT scans are used to assess the effectiveness of each remelt condition by ARL/PSU.

Demonstration of key capabilities necessary to realize an integrated interlayer remelt repair of specified regions is planned. An API designed by 3DS is being employed to remelt specified regions prior to recoating the next layer. An application developed by ARL/PSU is used to specify the remelt region and process parameters with process monitoring data collected before and after the repair operation to confirm operation.

Finally, the ability to realize interlayer repair is assessed with an interrupted build strategy. A build created by Moog with process parameters known to generate defects is removed partway through the build and CT scanned. Interlayer remelt parameters are being applied to the top surface and post-repair CT scans compared to assess effectiveness.

PROJECT START DATE

September 8, 2021

EXPECTED END DATE

May 27, 2022

EXPECTED DELIVERABLES

- XCT data of evaluated test coupons
- CAD models, STLs, and build files
- Build design and process parameters
- Process monitoring data
- Final report

FUNDING

$187,355 total project budget
($130,529 public funding/$56,826 private funding)

PROJECT PARTICIPANTS

Project Principal:
Applied Research Laboratory at the Pennsylvania State University

Other Project Participants:
Moog AMC
3D Systems

Public Participants:
U.S. Department of Defense