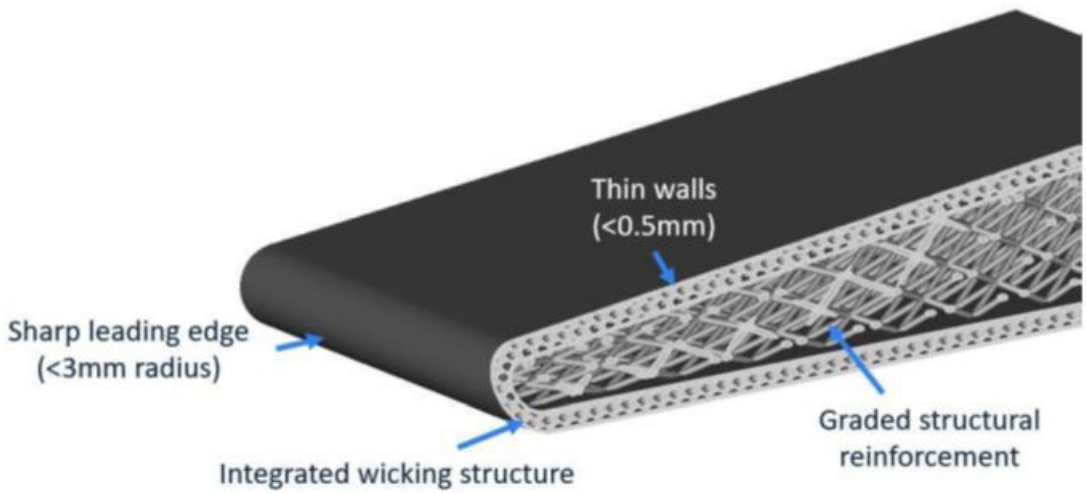
PROJECT SUMMARY 5522.002

Demonstration of AM Solutions for Thermally Managed & Shape-Stable Leading Edge



Novel approaches for integrated thermally managed sharp leading edge solutions to provide application across various platforms.

PROBLEM

Complex cellular and lattice structures are an exciting field of materials development offering revolutionary opportunities in medical devices, lightweighting, and impact protection. The design freedoms offered by additive manufacturing (AM) are uniquely suited for producing lattice structures. There has been a synergistic development cycle between the lattice design and AM communities, but there is an unmet need to understand how the lattice structure integrates with surrounding skin or thin wall material.

OBJECTIVE

The objective of this program is to establish best practices to successfully design and integrate metal lattice structures with a part boundary region such as a thin wall or skin material. A further objective is to develop a design and testing toolkit to enable designers to make better informed and higher performing parts and devices which utilize lattice structures.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to:

DESIGN

ASTM PROCESS CATEGORY	EQUIPMENT	MATERIAL
Dircted Energy Deposition	RPM Innovation Inc. 222XR	AP&C Powder Nb-10W-2.5Zr (Cb 752) 45-150µm

TECHNICAL APPROACH

The Ohio State University (OSU) is leading the technical effort which includes 3Degrees, Elementum, and Lockheed Martin. The researchers are exploring a range of geometric parameters which influence that transition region.Tensile specimens are being designed and simulated using nTopology, building off work previously performed by OSU's Center for Design and Manufacturing Excellence (CDME) on another America Makes project (Tensile Behavior of AM Lattice Stuctures). The best performing designs are being printed on the CDME's Concept Laser M2 using the Elementum A7050 aluminum material. Mechanical testing of these samples is being performed at the OSU Dynamic Mechanics of Materials Laboratory (DMML) using 3D Digital Image Correlation (DIC) and other methods. The results of the testing are then being used to design and print a demonstration component relevant to industry applications. All project data is being managed for implementation with 3Degrees TRACEam software. The RPM Innovation 222XR utilizes "blown powder" laser directed energy deposition.

PROJECT START DATE

August 11, 2021

EXPECTED END DATE

August 10, 2023

EXPECTED DELIVERABLES

- Representative system requirements definition
- Integrated system modeling
- Representative design of leading-edge heat pipe
- Results of experiment investigation for enhanced thin-film evaporation using AM engineered structures
- Results of experimental characterization of enhance capillary wicking of engineered structures
- Demonstration of efficient heat transfer capability with integrated thermally managed leading edge heat pipe
- Results of investigation of attachment of leading edge structures which are different material than the base structure
- Results of evaluation of potential for producing graded materials to facilitate leading edge attachment and mitigation of material degradation from oxidation at operating conditions
- Establishment of a project based digital engineering/design center
- Final report

TOTAL 5522 FUNDING

$10,735,000 total project budget
($9,435,000 public funding/$1,300,000 private funding)

PROJECT PARTICIPANTS

Project Principal:
University of Texas at El Paso (UTEP)

Public Participants:
U.S. Department of Defense