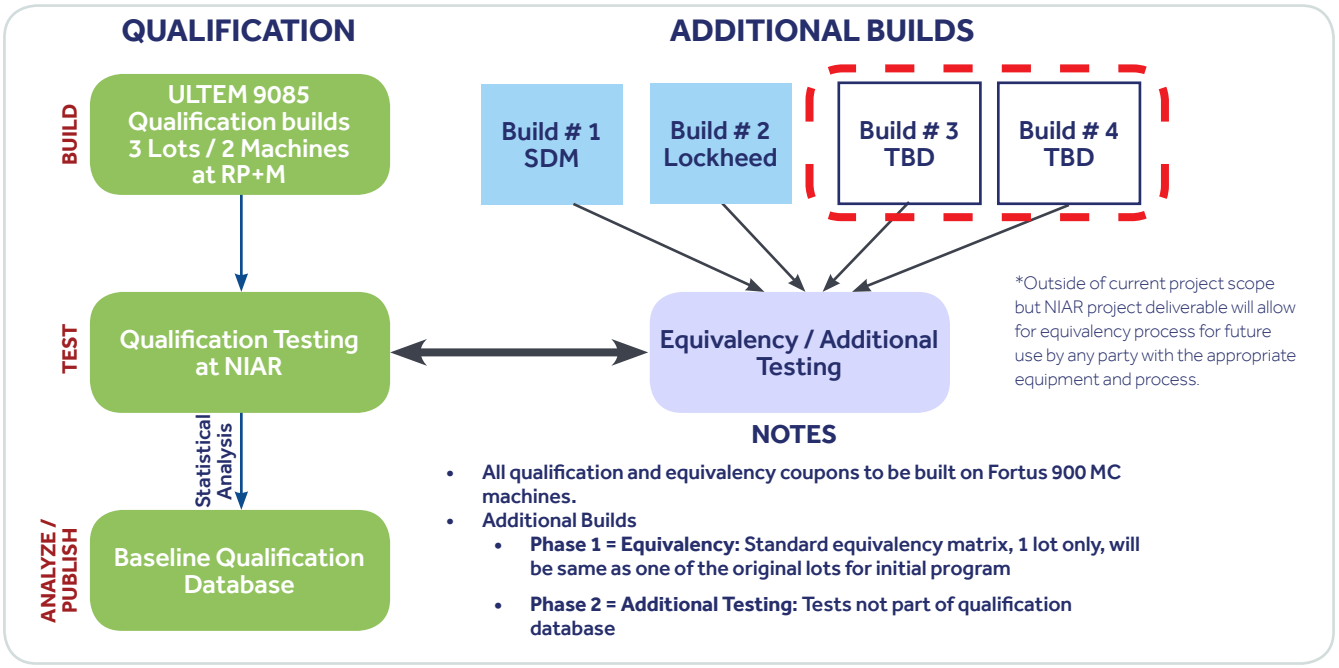
SUCCESS STORY

Establish Complete Database of Material Properties for FDM Printing of ULTEM™ 9085

Reduced Coefficient of Variance for Ultimate Tensile Strength from >25% to <5%



Overview of project plan for qualification and equivalency testing for FDM printing of ULTEM™ 9085.

PROBLEM

ULTEM™ 9085 is a polyetherimide high performance thermoplastic material with application acceptable strength-to-weight ratio and flame, smoke, and toxicity (FST) ratings. This material is often used in aerospace, automotive, and other industrial applications where a high strength thermoplastic material is needed. As this material is one of the only high performance thermoplastic materials available for FDM, it is important to establish a complete database of material properties to further enable use in various commercial and government applications. Such a database is a minimum requirement for deployment of an additively manufactured solution in a production environment and currently does not exist.

OBJECTIVE

The objective of this program was to build upon previous results from America Makes Project Call #1 project entitled "Maturation of Fused Deposition Modeling (FDM) Component Manufacturing" by expanding and creating a supplementary, standalone dataset that addresses the concerns and flaws from the first round of study. The project aimed to offer this dataset to America Makes' members and government partners to enable broad dissemination of the collective knowledge for future part design. A further objective was to enable industry members to use their own design allowable methodologies for statistical data analysis, thereby creating a well utilized and broadly applicable dataset which would create a framework for future materials/processes.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to:

MATERIAL

ASTM PROCESS CATEGORY: Material Extusion

EQUIPMENT: Fortus 900mc Plus

MATERIAL: ULTEM™ 9085

TECHNICAL APPROACH

A material specification was created by Stratasys to define the process for production and certification of ULTEM 9085 for FDM applications. A process control specification was developed by rp+m and Stratasys to outline the process control steps necessary to produce qualified samples and parts via FDM. Once those critical documents were defined, a material allowable test plan and test matrix were established and approved by a peer advisory group. This test matrix and plan outlined a "qualification" program which was designed to demonstrate process control. The test matrix and plan also defined an "equivalency" program to be completed at two additional sites (one machine at each site). The successful completion of this part of the program enabled the equivalency process to be completed by a user with a Fortus 900mc machine, demonstrating broad dissemination of the technology. Coupons manufactured under both the qualification and equivalency portions of the plan were tested according to the test plan at Wichita State University, National Institute for Aviation Research (NIAR) and were completed with oversight from the Federal Aviation Administration (FAA).

ACCOMPLISHMENTS

The project team performed FDM machine process control evaluation and created documentation. The team also developed process parameters (resulting in a published process specification) that included details on machine setup, calibration, and maintenance. A framework for the qualification of materials according to the process specification was developed. Reproducible material properties were confirmed across a well-recognized and accepted methodology for the qualification of aerospace grade manufacturing. This confirmation was enabled through the creation of a complete test matrix, including detail on test conditions, coupon quantities, process parameters, material traceability, and coupon management. The project followed the National Institute of Aviation Research's (NIAR) National Center for Advanced Materials and Process (NCAMP) procedures to generate a baseline set of qualification data, produced at rp+m based in Avon Lake, OH and in accordance with industry standard methods used for statistical reduction, including and complying with CMH-17 – Composite Materials Handbook for Polymer Matrix Composites.

PROJECT END DATE

June 2018

DELIVERABLES

- Final report and data reports
- Process control specification
- Material specification
- Qualification and equivalency test matrix and test plans
- B-Basis allowables – through National Center for Advanced Material Performance

FUNDING

$2.5M total project budget
($767K public funding/$1.8M private funding)

PROJECT PARTICIPANTS

Project Principal:
Rapid Prototype and Manufacturing LLC

Other Project Participants:
Stratasys Inc.
Wichita State University, National Institute for Aviation Research, National Center for Advanced Material Performance
Lockheed Martin Missile and Fire Control

Public Participants:
U.S. Department of Defense
Federal Aviation Administration

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