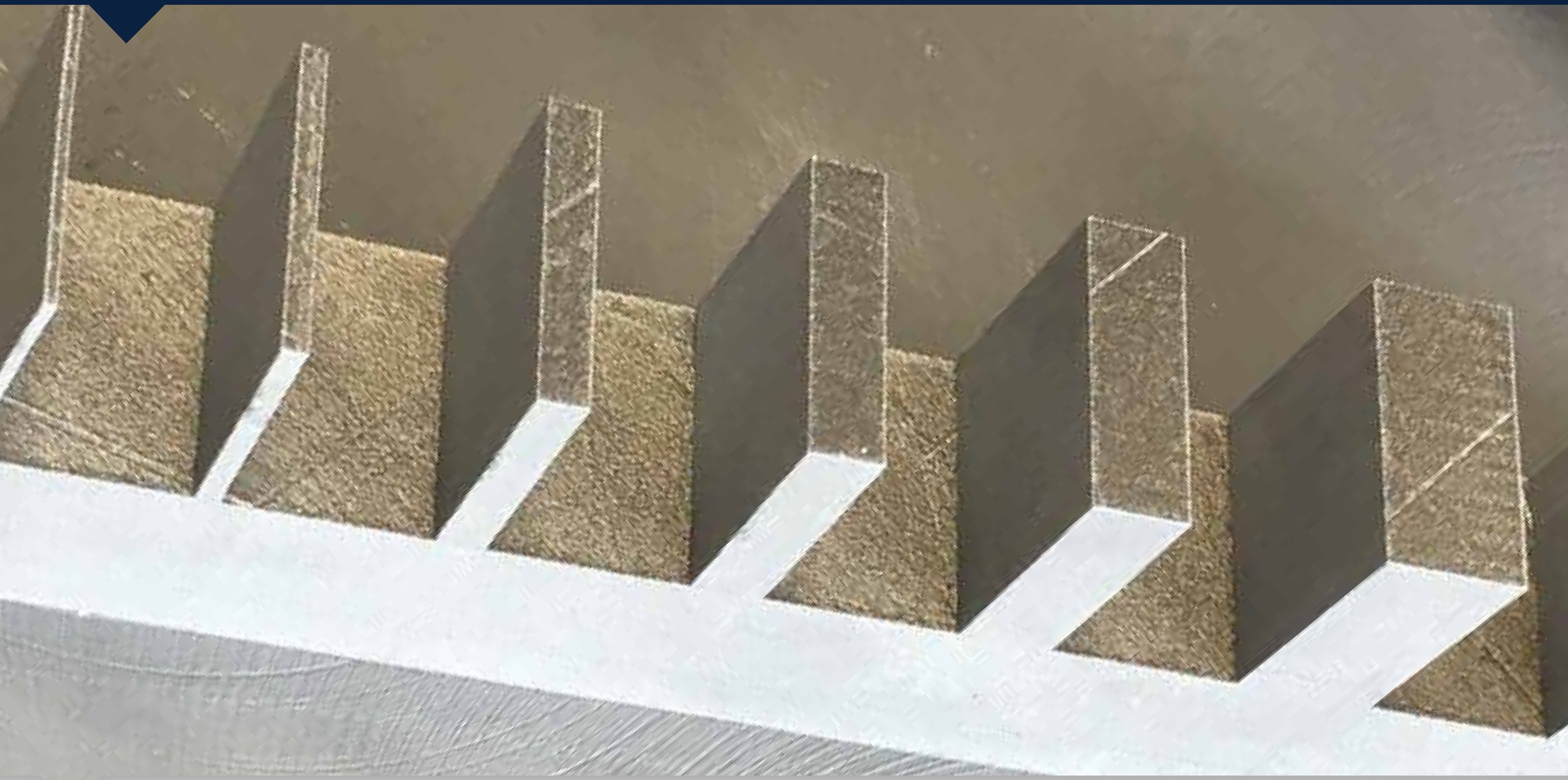
PRATT & WHITNEY ADDITIVE MANUFACTURING CENTER (PW AMC)

INNOVATION PARTNERSHIP BUILDING AT UCONN TECH PARK



About

Pratt & Whitney develops game-changing technologies for the future, such as the PurePower® PW1000G engine, with patented Geared Turbofan engine technology. The company's worldwide large commercial engine maintenance, repair and overhaul network provides innovative services that add value and delight customers around the globe.

Pratt & Whitney's large commercial engines power more than 25 percent of the world's mainline passenger fleet. The company continues to develop new engines and work with its partners in International Aero Engines and the Engine Alliance to meet airline customers' future needs.

Pratt & Whitney has built a long and distinguished record of providing top-of-the-line military engines to 31 armed forces around the world. Our military engines power front line fighters, such as the F-15 Eagle, F-16 Fighting Falcon, F-22 Raptor and F-35 Lightning II, as well as the C-17 Globemaster III military transport and Boeing's KC-46, the U.S. Air Force's new airlift tanker.

Areas of Expertise

- Powder analysis, environmental effects on powder dynamics. PW AMC uses custom rake systems and powder bed equipment to investigate the spreading behavior of powders.
- Ab-initio calculations of surface phase diagrams, surface tension, diffusion pathways.
- Alloy development for additive manufacturing: methodology development combining first-principles calculations with thermodynamic- and kinetic studies as well as experimental validation.
- Microstructure characterization of additively manufactured parts using electron microscopy.
- Control theory for processing development of additive manufacturing machines.
- In-operandi measurement of temperature changes during powder bed heating and solidification with ultra-short time resolution.
- Measurement of thermophysical properties (thermal diffusivity, specific heat, viscosity, thermal expansion) to temperatures between 1,600 °C and 2,800 °C.

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Center Characteristics

Overview

The Pratt & Whitney Additive Manufacturing Center (PW AMC) conducts research to understand fundamental aspects of the additive manufacturing process. These research efforts combine additive manufacturing, a broad range of characterization tools, theory, and simulations. The complexity of additive manufacturing led PW AMC to focus on a subset of research needs, mainly in the areas of materials science aspects of melting and solidification, thermophysical properties, and control theory.

Technology

Commercial powder bed machines, including an Arcam A2X machine, an EOS M270 machine, and a 3DSystems ProX300 machine enable PW AMC to obtain additively manufactured samples and to study powder raking, laser melting and solidification. A research testbed machine has been developed with IPG Photonics and is available in Q2 '18 to study individual aspects of the powder bed process. With this equipment PW AMC is able to measure temperature changes in the powder bed during heating and solidification with ultra-short time resolution. This information feeds into studies of phase formation and microstructure formation during the additive manufacturing process.

Unique Capabilities

Microstructure and phase formation studies are complemented with first-principles calculations of fundamental materials properties and equilibrium phases at metal and alloy surfaces. These calculations use Density-Functional theory and ab-initio thermodynamics calculations. Among the fundamental material properties are thermophysical properties, but PW AMC boasts a unique suite of thermophysical property measurement instrumentation that is geared toward high-temperature measurements. State of the art equipment is available at PW AMC to assess, for example, thermal diffusivities up to 2,800°C, viscosities of metals and alloys to 1,800 °C, thermal expansion behavior to 1,750 °C, and specific heats to 2,000 °C. This suite of high-temperature characterization equipment yields material properties for modeling and simulation of additive manufacturing but also of other manufacturing technologies. PW AMC furthermore operates a Gleeble 3500 system with two mobile conversion units (MCUs). The high-temperature MCU allows continuous physical simulations of thermophysical processes at temperatures up to 3,000 °C. The HydraWedge MCU allows studies of forging processes with an independent multi-hit control of strain and strain-rate.

Innovation

PW AMC furthermore focuses on control theory for processing improvement of additive manufacturing machines. The control theory studies aim at methods to detect defects during the build process and to auto-correct the additive manufacturing process based on fast-forward feedback loops. For instance, surrogate modeling of the laser-material interaction is integrated with in-situ monitoring to counteract early symptoms of over- and under-heating in the melt-pool in real time. Feedforward-based task planning are studied to inform a consistent temperature field in the powder bed, by considering the layer-by-layer thermal dynamics and the structured in-layer beam patterns.

Contact

PW AMC

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