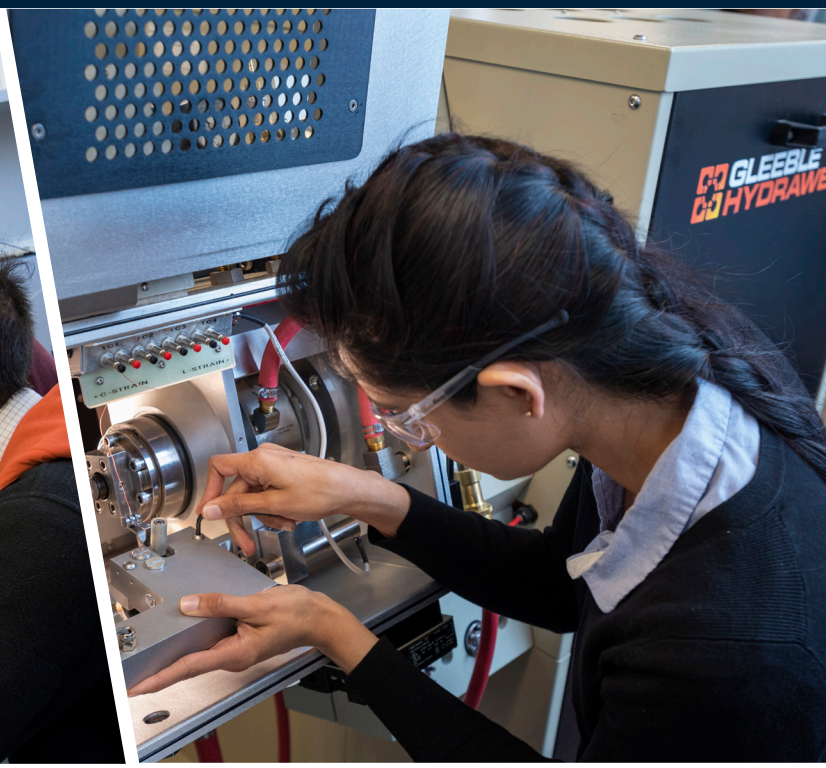
PRATT & WHITNEY ADDITIVE MANUFACTURING CENTER (PW AMC)

INNOVATION PARTNERSHIP BUILDING AT UCONN TECH PARK



About

The Pratt & Whitney Additive Manufacturing Center (PW AMC) was established in April 2013 as a collaborative effort between Pratt & Whitney and UConn. The center's mission is to advance the fundamental understanding of additive manufacturing machine-material-microstructure linkages and to develop students into future leaders of additive manufacturing

Within the complex and broad field of metal additive manufacturing, PW AMC focuses on a subset of materials-related topics. The strong materials focus of PW AMC lends itself to substantial leverage with general materials science capabilities at UConn, notably with the Institute of Materials Science and in particular with the Thermo Fisher Scientific Center for Advanced Microscopy and Materials Analysis.

The research activities at PW AMC align closely with interests in additive manufacturing in the aerospace sector and substantial collaborations exist with Pratt & Whitney and other aerospace companies. Additive manufacturing is also actively pursued in the context of naval applications.

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 powder bed machine custom built by IPG Photonics is available to develop build themes, to study effects of raking procedures, build chamber atmospheres, gas flows, or other details of the additive manufacturing process. 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

Current innovative elements of AMC's research include alloy development and powder management and handling for qualification studies. Alloy development studies combine first principles calculations with experimental, laser-glazing based studies. A particular focus is directed toward solidification cracking and AMC uses a combination of Gleeble and viscosity measurements as well as FlashDSC to advance the understanding of solidification cracking under rapid solidification conditions.

Contact

PW AMC

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