**S2MARTS “Coming Soon” Opportunity (22-11)**

**Manufacturing Advanced Composites for Hypersonics (MACH)**

The Department of the Navy (DoN) is seeking a manufacturing proof-of-concept prototype for high-rate production of composite parts and assemblies with complex geometries for hypersonic vehicle applications that produces trusted quality parts with significant reduction in per unit time.

The purpose of this effort is to advance the domestic manufacturing capacity in support of high temperature capable composite materials including those needed for hypersonic flight. This effort will include advancing innovations in materials science, polymer chemistry, and digital engineering that hold the promise of providing specific improvements to reduce defects, and increase throughput and performance, while driving down the cost per unit.

Most hypersonic weapons require specialized lightweight composite materials capable of withstanding extreme temperatures and flight environments. Currently, there are limitations to the manufacturing capacity and throughput of large carbon composite structures as well as high cost and long lead time.

Accelerated production of hypersonic flight vehicle structures can be achieved through an automated manufacturing capability that takes advantage of digital engineering tools including in-situ nondestructive evaluation, simulation and closed-loop process optimization to reduce defects and speed up the manufacturing process. Of particular importance is reducing the time required for pyrolysis and densification of carbon composite materials and components while achieving consistent final part quality.

The development of novel materials systems supported by digital engineering tools is needed to improve the rate of manufacturing and to make new designs possible. Verification of numerical simulations is needed throughout the manufacturing process, including during pyrolysis and high temperature heat treatment, to enable refinement and to make possible optimization of the manufacturing process. New approaches are needed that apply novel digital engineering techniques, including physics-based, data-driven, and hybrid process models, to every step of the high temperature composites manufacturing process. Advances in in-situ sensing, hybridized models for advanced manufacturing, machine learning, modeling, simulation, control, and design will be applied.

Development of a qualified workforce must be addressed to ensure that domestic manufacturing capability is developed and maintained. Proof-of-concept manufacturing with industrial and government partners is needed for the training of this workforce. An efficient manufacturing environment for high temperature materials and systems will rely on digital tools for simulation, process monitoring and control, nondestructive inspection, and in-situ monitoring to achieve overall process improvement and reduced cost. Demonstration of new manufacturing processes and prototype evaluations would allow for meaningful training and transfer of specialized technical approaches to government and industrial partners.

The state of the practice for manufacturing of high temperature composites relies solely upon legacy approaches and systems with little in the way of digital engineering capabilities. This results in composites being manufactured with long lead times, bound by unknown material defects that lack information feedback and require expensive out of process inspections to validate quality. New manufacturing approaches are required by the warfighter that apply novel digital engineering techniques.

The proposed work is important as it leverages ongoing advances in digital engineering for high-rate composites manufacturing of hypersonic parts. The advancements in digital engineering techniques will increase current understanding of high temperature composites, physics-based modeling, Multiscale Nondestructive Inspection and Evaluation (NDI/NDE), and Structural Health Monitoring (SHM) integrated sensor networks. This will be achieved in parallel with the development of a highly skilled technical workforce to serve the needs of the defense industrial base in support of the Warfighter in this critical technical area.

The development of physics-based and data-driven (in-situ sensing) modeling, simulation, and process control digital engineering will advance hypersonic development across the Department of Defense (DoD) . These advancements will impact the ability to produce high temperature composite structural components and assemblies with complex geometries, fewer defects, and better reliability.

The MACH Other Transaction Authority (OTA) prototype project is anticipated to be released and to be executed in 48-month period of performance.