

Accelerating Hypersonic Test

Breaking the Cost Barrier



*A Proposal
to Begin Building a
Dayton Hypersonics Flight Test Team*

1 November 2023



NEW FRONTIER
AEROSPACE



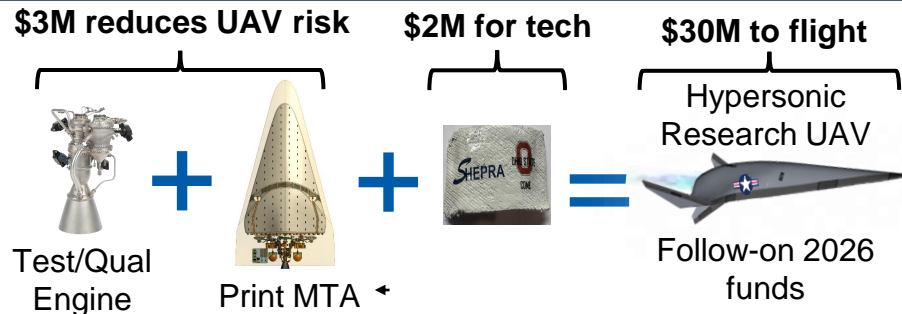
PAC
Powder Alloy Corporation



SHEPRA Inc.

EWI
We Manufacture Innovation

Dayton Area Hypersonic Research Flight Test Team



Prove tech for low-cost Additive Manufacture of near-term hypersonic research UAV – Flight test many Dayton area (and other) technologies for DOD TRMC

Objective: Reduce key risks. then build and flight test a hypersonic research UAV able to support high cadence hypersonic testing for the DOD Test Resource Management Center (TRMC)

Benefits: Advance hypersonic technology via UAV flight testing, enable many follow-on hypersonic dual use operational capabilities

Approach: Leverage multiple Air Force Phase II SBIR / STTR programs in nanotechnology materials for Additive Manufacturing⁰ to prototype a hypersonic UAV (\$5.25 million / 5 programs)

Collaborators: SHEPRA, New Frontier Aerospace, Laser Fusion Solutions, NASA Glenn, Ohio State, Powder Alloy Corp, EWI

Deliverables:

1. Proto-flight qualified Mjolnir Engine – hypersonic flight and space tech/flight
2. Manufacturing Test Article (MTA) – Printed Airframe ground tested with engine
3. Proof of concept Electric Ducted Fan UAV for subsonic envelope expansion
4. Preliminary design of \$35M hypersonic research UAV
5. Follow-on USAF hypersonic ops capability – air mobility, ISR, strike, ...
6. Component technologies for hypersonic flight test, participants will grow
 - Additive manufacture, hot structures, materials, avionics, sensors, leading edges, acreage structure, etc.
 - Addresses DOD S&T and JobsOhio priorities

DoD Science & Technology Priority:

- ✓ Advanced Materials & Manufacturing
 - ✓ Space Technologies
 - ✓ Hypersonics

JobsOhio Priority:

- ✓ Advanced Manufacturing
 - ✓ Aviation & Aerospace
 - ✓ Defense & Federal

Budget Request

Item / Task	FY'25 Funding	Future Efforts Funding
NFA proof of concept tech; print, test engine & airframe	\$3M	
Development & Testing of Hypersonic Structures and Thermal Protection Systems	\$2M	\$1.5M
Hypersonic tech for flight test from Dayton area (DoD Test Resource Management Center)		\$30M
Total	\$5M	\$TBD

FY'25 Congressional Budget Request: \$5M

Why Dayton?

- ✓ Birthplace of aviation
- ✓ Wright-Patterson AFB
- ✓ UAV research Springfield Airport, SkyVision capability installed
 - FAA approved Beyond Line-of-Sight UAV testing (rare offering)
 - Ground static testing and low speed UAV VTOL testing
- ✓ High tech workforce, extensive hypersonic expertise
- ✓ US falling behind, needs Next Gen:
 - Hypersonics – China is kicking our butt, time to leapfrog
 - Additive Manufacturing – New approaches
 - UAVs – Research & demonstrations
- ✓ Many vendors exploring hypersonic tech & manufacturing – BUT \$\$\$ and slow to test
- ✓ Near term, proven tech researched at Wright Patterson AFB
- ✓ Seeking bipartisan support from House Hypersonic Caucus
 - Talking to Rep. Mike Turner and Rep. Adam Smith defense staff leads to build a Dayton-Seattle team, potential to gather support more support as program matures

Make Dayton the Birthplace of Next Gen Hypersonic UAV Research – then Operations

Development of a Low-Cost Near-Term UAV



Testing ongoing
May 2024 hot fire

DC-X



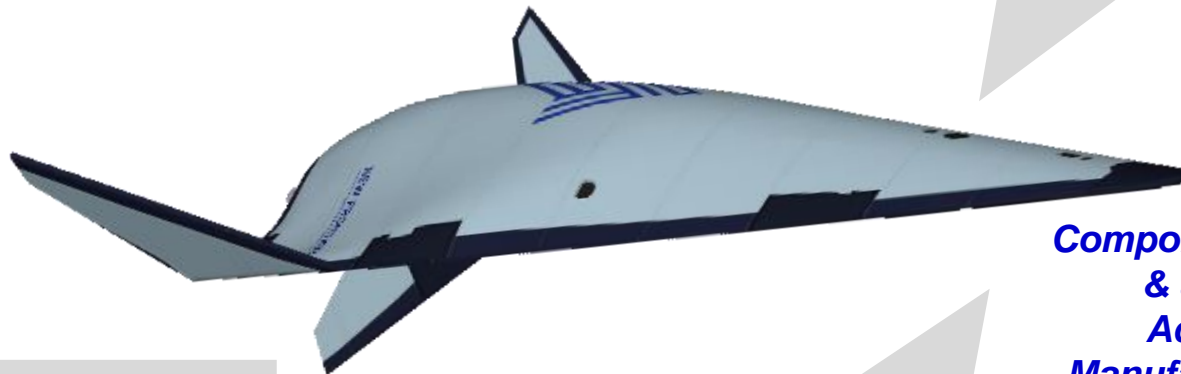
Mjölmir Engine

Simple – 200 parts, 100X < turbojet
Low mass – 25 lbs, 10X < turbojet
Low cost – 80% AM + 10X < costly fuel

Hypersonic Aero-Shape

Waverider – Lift/Drag < SR-71
Low dry mass – 900 lbs, 10X < jets
Low airframe cost – Wire fed AM

Small Size



**Components, engine
& airframe
Additively
Manufactured (AM)**

Flexible VTOL

100 x 100 ft pad
Aircraft operability
Min new infrastructure
Routine remote
operations

X-24 Like Shape

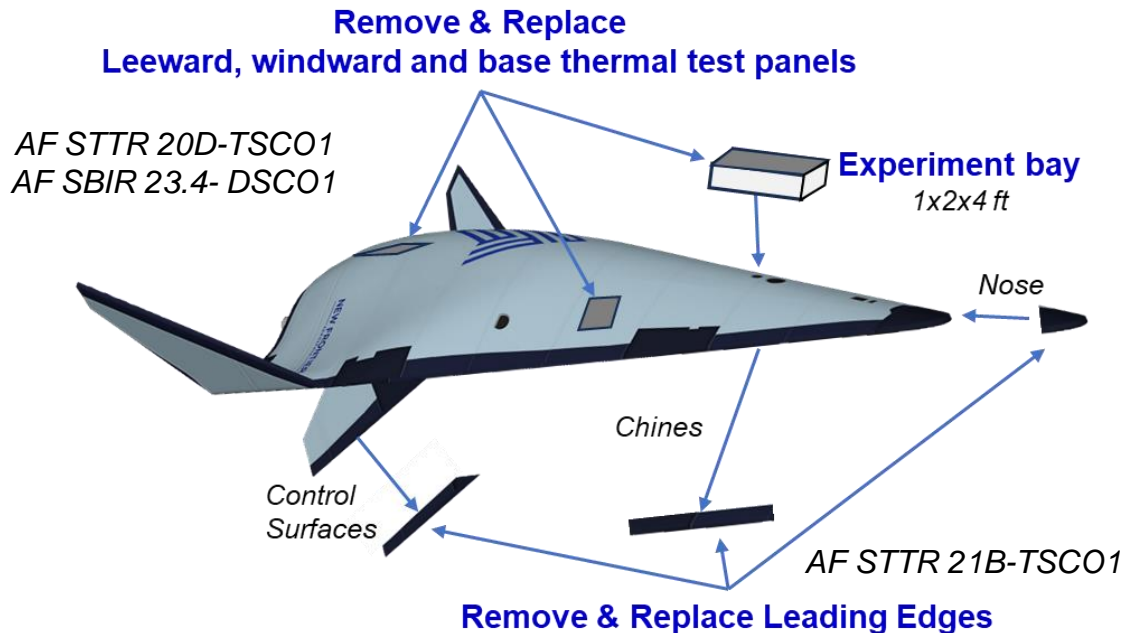


Hypersonic Research UAV ~18 ft long

Low ops cost – aircraft-like operability & cost efficiency
Gas & Go for \$1,000 of “Green” LOX/LNG per flight
Routine research flight up to Mach 10 & 160K ft

Hypersonic Technology Testbed

High cadence cycle - build-fly-test, build-test-fly, ...



Cheaper than high-speed wind tunnel testing
Unvitiated freestream air testing

Integral flight research

- ✓ Dynamic pressures: 100 to 1,000 psf
- ✓ Low heat rate: 0 to 30 BTU/ft²/sec
- ✓ Aero-thermodynamics and flutter dynamics
- ✓ Thermal management & protection
- ✓ Testing for alternative landing surfaces
- ✓ Ground effects, alternative landing surfaces
- ✓ Flight controls & sensors
- ✓ Flight test instrumentation
- ✓ Payload sensor/windows – ISR, GPS, radar, ...
- ✓ Light weight, hot structures
- ✓ Advanced rocket propulsion
- ✓ High ops tempo – aircraft-like operability: rapid turnaround, small crew, ...
- ✓ Active flow control techniques for reducing heating, boom & drag

External carriage/separation research

- ✓ Dynamic pressures: 1,000+ psf
- ✓ Extreme heat rate: 30 to 500 BTU/ft²/sec
- ✓ Small scale RAM/SCRAM experiments

FY'25 Congressional Add Ask

Hypersonic UAV Prototype - \$3M



①

Qualify Protoflight Engine

Restartable, throttleable,
reliable & safe jet engine-like

④

EDF Jet

Subsonic VTOL
Flight Validation
in Dayton/UD

②

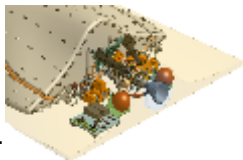
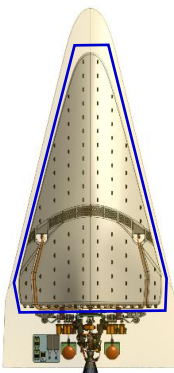


Preliminary design
for 3-Engine
Hypersonic Research UAV



AM Print

Airframe
and ground test at
Springfield Airport

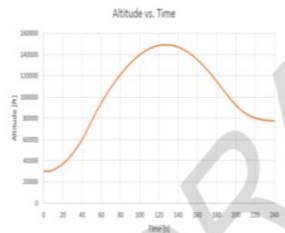


③

High Temperature Structure Optimization - \$2M

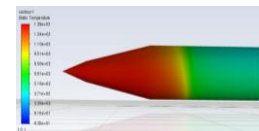
Trajectory Information 1

①

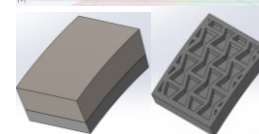


Mission Profile
Mission Requirements

Aerothermal Analysis



+



Ceramic
OML ② Metallic
Frame

=

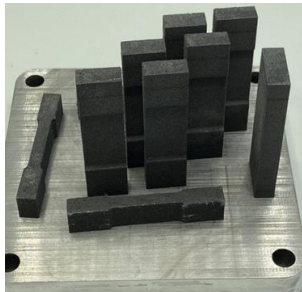


③

Prototype Hot
Structure
Thermal
Protection

Build-on current USAF Phase II SBIR / STTR Efforts

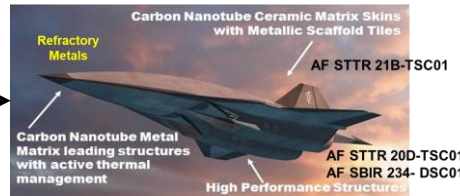
Air Force 20D – TSC01



Haynes 230

6061 Aluminum

Air Force 21B – TSC01



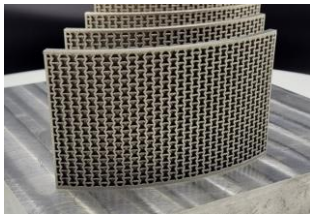
Hypersonic Thermal Protection

Prototype of TPS tile



Develop Materials & Processes

Air Force 23.4 – DSC01



Inconel 718

7075 Aluminum

Applications



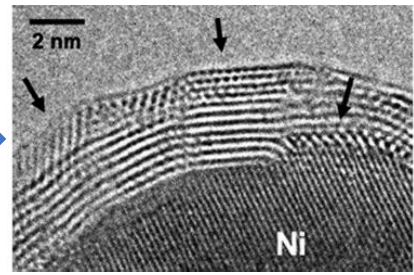
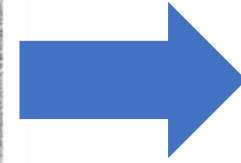
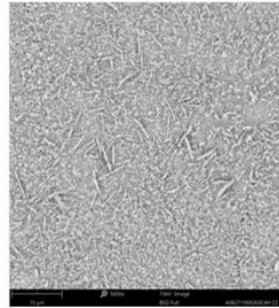
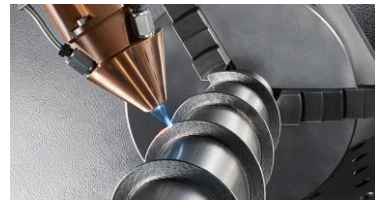
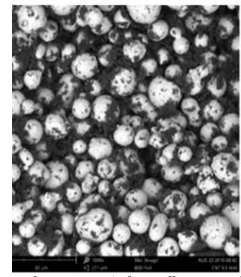
Lightweight Structures



Carbon Nanotube Metal Matrix Composites Address Barriers to Hypersonic Flight

Additive Manufacturing of Carbon Nanotube Metal Matrix Composites

Step to Next Gen low-cost hypersonic transportation and weapons

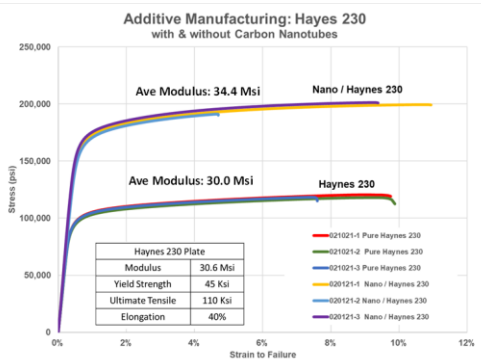


Carbon Nanotubes & Metal Powder

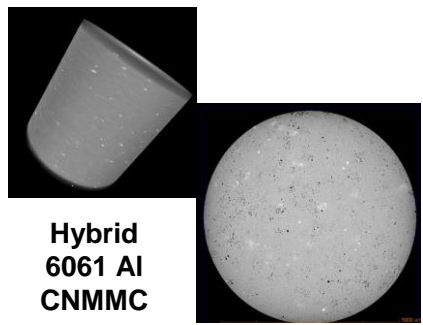
Additive Manufacturing

Two-phase Metal Matrix Composite

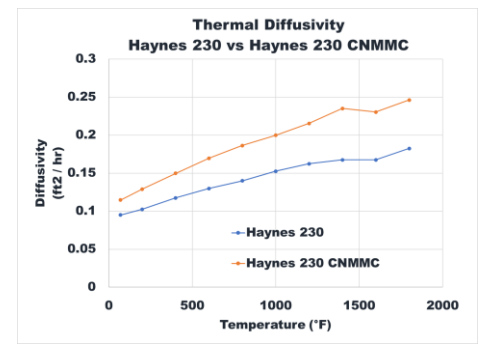
Hybridized electron bonding between carbon nanotubes & metal alloy



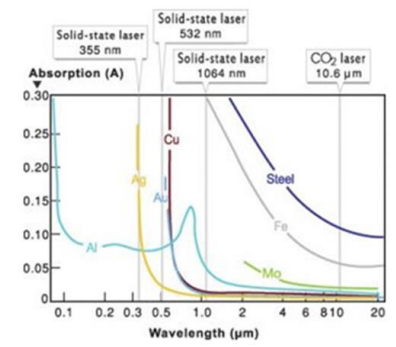
Increased Mechanical Properties



Eliminate Solidification Cracking



Increased Thermal Conductivity



Improved laser processing

Follow-on Vehicles and Applications

✓ R&D/Regional ISR

- **Hypersonic Research UAV**
- **Demo range >2,000 mi**
- **Demo fly out, land & back, no refuel**
- Recce/ISR

✓ Theater Ops

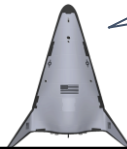
- Range – up to 3,500 mi.
- Fly out, land & return >1,000 mi.
- Special ops/CSAR: V-22 class
 - Personnel Recovery
 - Aeromedical Evacuation
 - Tactical Mobility/Cargo
 - SOF insertion/extraction
- Theater ISR/Strike

✓ Global Reach Ops

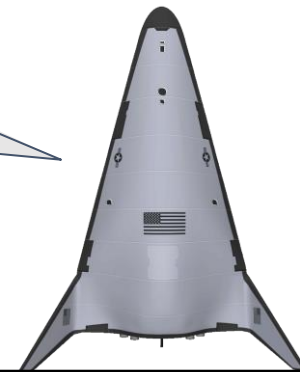
- Range – up to 8,000 mi.
- Theater & Global air mobility
- VIP/Passenger Transport
- Global reach ISR/Strike/...



Hypersonic Research



**Theater Reach
Transcontinental**



**Global Reach
Intercontinental**

Thank you



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