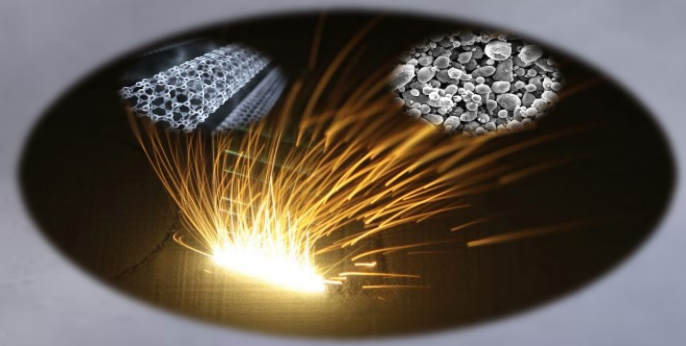
Growing the Greater Dayton Regional Additive Manufacturing Ecosystem



SHEPRA Inc.
Additive Manufacturing R&D
2769 Culver Ave
Kettering, OH 45429

POC: Fred Herman
817-233-1942
Fred.Herman@shepra.com

SHEPRA Company Overview

Founded in 2007, SHEPRA provides Logistical, Engineering and Management Services to the Department of Defense

- *Service-Disabled Veteran Owned Small Business with 20 employees in Florida, Ohio, Virginia, Tennessee and Texas*
- *Certified to review Secret and hold ITAR information*
- *Yearly revenue: ~ $3 million*

Support the Defense Logistics Agency Industrial Supply Chain and Industrial base

- *Perform strategic studies to identify critical gaps in the industrial base and supply chain and develop solutions to resolve the root cause*

Develop new materials for use in metal Additive Manufacturing

Utilize patented approach to incorporate carbon nanotubes into metal powder for Additive Manufacturing with improved mechanical and physical properties

SBIR / STTR Programs

Navy STTR N16A-T007 (17-4 SS, Phase II)

Army SBIR A17-033 (AlSi10Mg, Phase II)

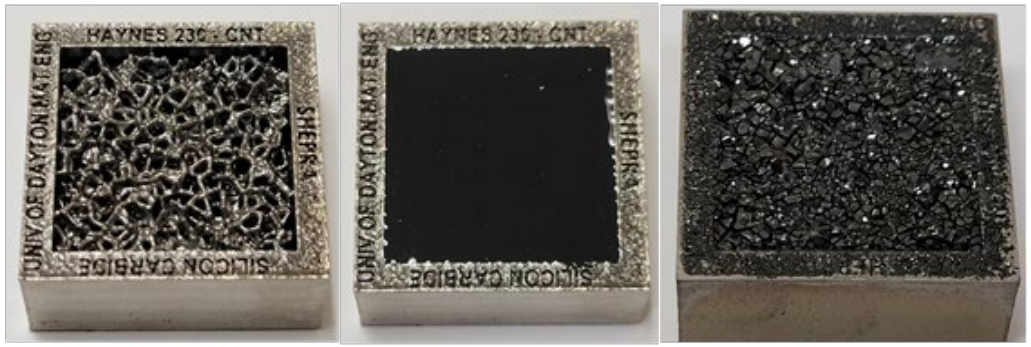
Air Force SBIR 182-005 (6061 Aluminum, Phase I)

Air Force STTR 20D-TSC01 (Hybrid 6061, Phase II)

Air Force STTR 21B (Haynes 230, Phase I)

5 Phase I, 4 Phase II contracts- $4.0 million

Additional $1.25 million selected, but not funded



Processing steps of the Thermal Protection System Tile

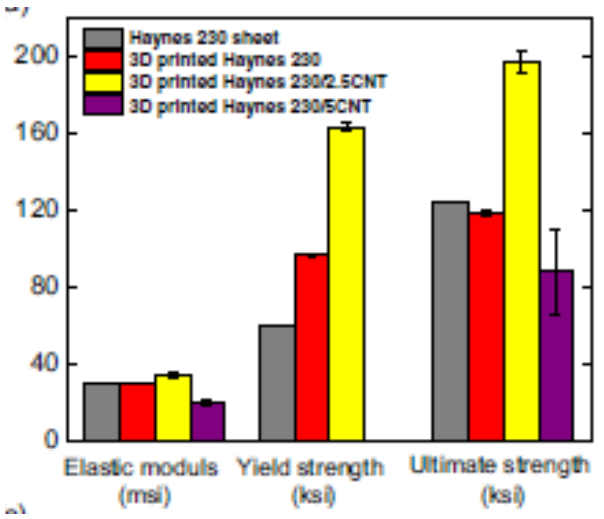
SHEPRA DOD SBIR/ STTR programs

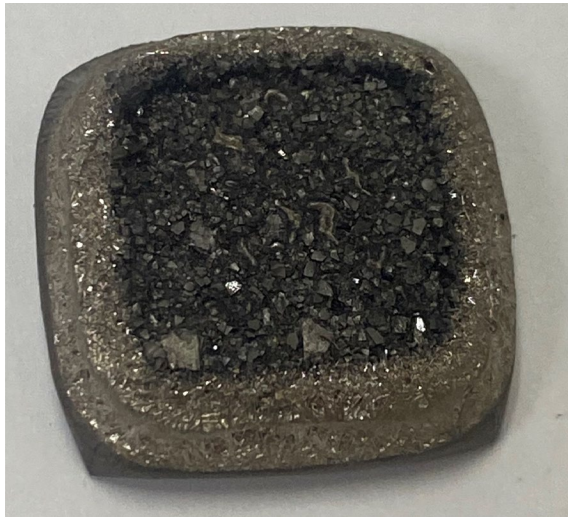
	17-4 Stainless Steel	AlSi10Mg	. Hybrid 6061 Aluminum	Haynes 230	Copper
Program	Navy STTR: N16A-T007	Army SBIR: A17-033	AF SBIR: AF182-005 AF STTR: 20D	AF STTR: 21B-TSC01	IRAD
Status	Phase II	Phase II	Phase I	Active	Inactive
DoD Application	Maintenance & Sustainment, Ground Vehicles	Sabot for Long Rod Penetrator	High Performance Aerospace	Hypersonic systems	Rocket Engines Thermal Applications
Commercial Application	Tooling, Industrial & Construction Equipment	Automotive, Replace castings	High Performance Automotive, Commercial Aerospace	Jet Engines, Turbine Generators	Heat Exchangers
Benefit	AM with ASTM Wrought properties w/o post process heat treat	AM aluminum with wrought properties	AM of high-performance wrought aerospace aluminum	69% increase in Strength 13% increase in Stiffness	Process on standard AM systems

SHEPRA's Value Proposition

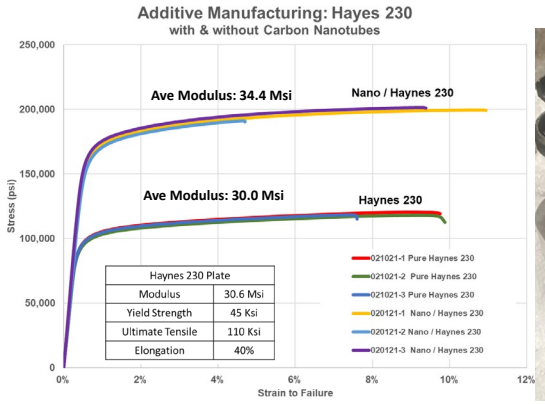
- SHEPRA can combine carbon nanotubes with any metal powder to increase the mechanical strength, stiffness and thermal and electrical conductivity of the composite material
  - The performance characteristics can be tailored based on rule of mixtures
  - Resolve thermal cracking of high-performance aluminum and nickel alloys.

- SHEPRA and the University of Dayton have demonstrated a notional approach to use Additive Manufacturing to combine a carbon nanotube Haynes 230 metal matrix composite with Silicon Carbide to form a hypersonic thermal protection system.





Dayton Region Additive Manufacturing Ecosystem



	Prior DoD Investment	Congressional Add
High quality metal powder production	---	$1,500,000
Carbon Nanotube Metal Matrix Composite Development	$4,000,000	$2,000,000
Laser Additive Manufacturing Process Development	$4,500,000	$1,500,000
Certification / Qualification of Additive Manufacturing processes	---	$2,000,000
Tech Transfer to Ecosystem	---	$250,000
Total Investment:	$9,500,000	$7,250,000

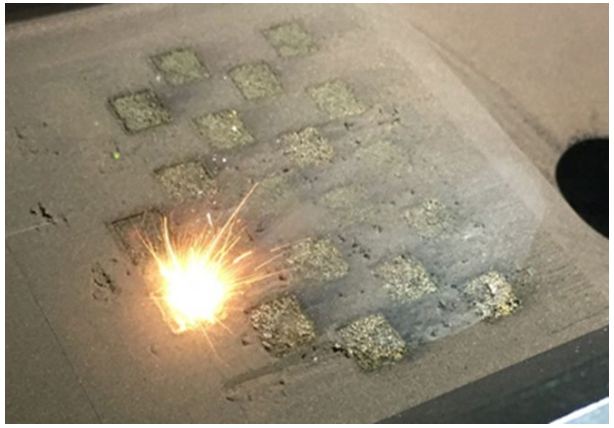
Premise: Ohio and in particular the greater Dayton region is a hub for Additive Manufacturing technology. By maturing key technologies, a competitive advantage can be achieved that will increase market capitalization of commercial and defense markets for local companies

Approach: An Additive Manufacturing value stream currently exists in the greater Dayton region that includes raw materials, value added materials, technical expertise in Additive Manufacturing process, Additive Manufacturing system manufacturing, and Additive Manufacturing fabrication.

Benefits: Developing these key Additive Manufacturing technologies will give greater Dayton Regional companies a competitive advantage in providing Additive Manufacturing goods and services, support other local industries in aerospace, automotive and biomedical manufacturing. Provide a support industrial base to the Air Force Materials Command in developing, maintaining and sustaining Air Force systems

Key Contributors:

Dayton Region Additive Manufacturing Ecosystem



Prior / Current DoD Funding:

- **$4.0 million SBIR / STTR for carbon nanotube metal matrix composite (SHEPRA)**
- **$4.5 million AFRL investment in scale up of Additive Manufacturing production systems (Open Additive)**

Task	Approach	Responsible Party
High quality metal powder production	Develop equipment and approach for production of powder metal to improve mechanical properties and consistency of outcomes	Skyward, Powder Alloy Corp
Carbon Nanotube Metal Matrix Composite Development	Develop a catalog of carbon nanotube metal matrix composite to meet commercial & DoD demands	SHEPRA, OSU, Open Additive, 3D Directions
Laser Additive Manufacturing Process Development	Development of laser beam optics to improve processing efficiencies and increase build rates	Skyward, Open Additive, 3D Directions,
Certification / Qualification of Additive Manufacturing processes	Utilize UD student run businesses to prepare, test and analyze samples to create a mechanical property database for use in material certification and qualification	University of Dayton, SHEPRA, OSU, Open Additive, 3D Directions
Tech Transfer to Ecosystem	Transfer technologies to local Additive Manufacturing Service provides and DoD support contractors	SHEPRA, EWI, Tangible Solutions, BasTech, Kaney

Additive Manufacturing Ecosystem Key Contributors

SHEPRA Inc. — Service-Disabled Veteran Owned Small Business (SDVOSB) with Intellectual Property in Carbon Nanotube Metal Matrix Composites for Additive Manufacturing.

OHIO STATE — The Ohio State University is providing technical expertise in the development of carbon nanotube metal matrix composites

DAYTON — The University of Dayton provided support in the development of carbon nanotube metal matrix composites. Student owned business will be utilized to prepare, test and analyze samples to support certification and qualification

OPEN ADDITIVE — Open Additive is a manufacturer of Additive Manufacturing production equipment capable of rapidly determining optimal Additive Manufacturing processing parameters. Open Additive will provide technical support to develop Additive Manufacturing processing parameters.

EWI — EWI is a world-renowned developer of the technologies to address manufacturing challenges related to thermal-mechanical processing of materials. EWI will be used to support Manufacturing process development and scale up.

3D DIRECTIONS ADDITIVE MANUFACTURING CONSULTING & DESIGN — 3D Directions is an Additive Manufacturing service provider specializing in upgrading existing systems and developing manufacturing strategies to maximize quality of build.

SKYWARD — Skyward is an eVTOL manufacturer that utilizes Additive Manufacturing to build its product. Skyward also has intellectual property in the processing metal powder to ensure quality and laser processing of metals

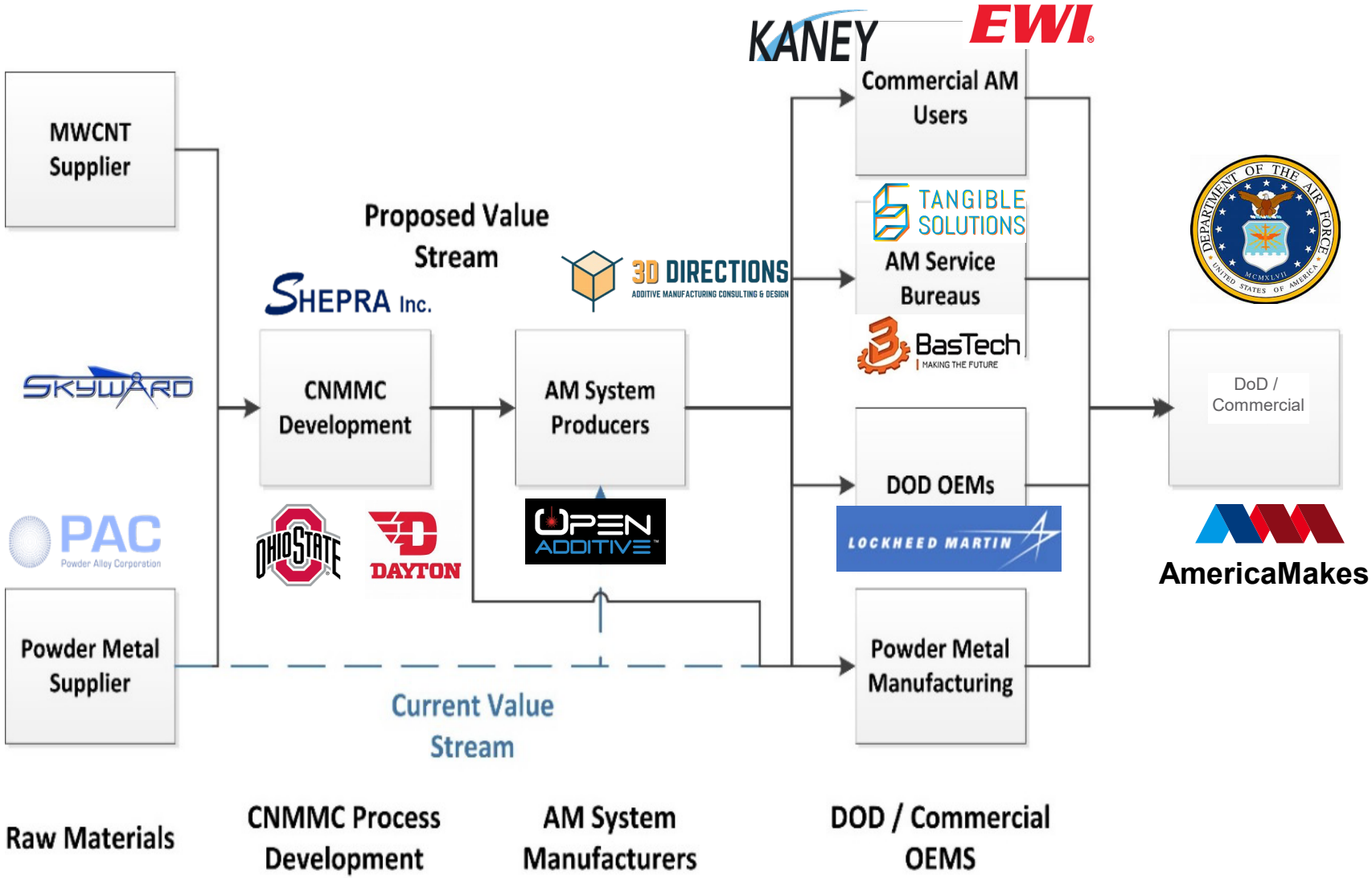
PAC Powder Alloy Corporation — Powder Alloy Corp is aerospace certified producer of metal powder for use in Additive Manufacturing and other processes

KANEY — KANEY specializes in the reverse engineering and fabrication of obsolete DoD components

TANGIBLE SOLUTIONS — Tangible Solutions is an Additive Manufacturing service bureau specializing in biomedical devices

BasTech MAKING THE FUTURE — BasTech is an Additive Manufacturing service bureau specializing in aerospace and commercial products

Additive Manufacturing Ecosystem Value Stream



Value Proposition :

Develop key technologies and applications to provide the greater Dayton region Additive Manufacturing ecosystem with a competitive advantage

Market Growth Strategy:

- Grow AM market by providing new performance capabilities to open AM to additional applications.
- Work with AM system manufacturers, Metal Powder supplies and AM Service Bureaus to provide differentiating solutions to their customers.

DEPARTMENT OF THE AIR FORCE
AIR FORCE RESEARCH LABORATORY (AFMC)
EGLIN AIR FORCE BASE, FLORIDA

13 Jan 2022

MEMORANDUM FOR AFWERX

FROM: AFRL/RWPI
Air Force Research Laboratory, Munitions Directorate
101 West Eglin Boulevard
Eglin AFB FL 32542

SUBJECT: Letter of Support – AFRL/RGV Phase II Solicitation for Carbon Nanotube Metal Matrix Composites

1. As the program manager for the AFRL's High Speed Strike Weapon Technology Maturation (HSSW TM) program, I want to express my interest and support for SHEPRA's Phase II SBIR/STTR efforts to develop carbon nanotube metal matrix composites. There is a definitive need for technologies that enable the design and manufacturing of advanced strike weapons with increases in range and performance capabilities. In addition, I expect additive manufacturing of carbon nanotube metal matrix to find applications elsewhere in the defense mission.

2. After consulting with AFRL/RXM lead for additive manufacturing (Dr. Mark Benedict), I believe the best course of action is for Dr. Benedict to act as the focal point for this effort. I will continue to monitor progress with Dr. Benedict and other members of the HSSW TM manufacturing technical area.

RICHARD J. MCMULLAN, DR-04, DAF
Program Manager, HSSW TM

DEPARTMENT OF THE AIR FORCE

AFRL Materials and Manufacturing Directorate (AFRL/RXM)

07 February 2022

MEMORANDUM FOR AFRL/RGV (AF Ventures)

References: (a) 15 U.S.C. §638
(b) U.S. Small Business Administration SBIR/STTR Policy Directive (May 2019)
(c) 5 C.F.R. §2635.702(c), Exception (1)

FROM: AFRL Materials and Manufacturing Directorate (AFRL/RXM)

SUBJECT: AFRL/RGV Small Business Innovation Research (SBIR) / Small Business Technology Transfer (STTR) Phase II – DAF Organization Defense Need and Participation Interest with SHEPRA Inc. (AF211-DSC01 and AF21B-TSC01)

1. **Purpose:** This memorandum is executed in furtherance of references (a) and (b) and the applicable Air Force SBIR solicitation, which constitute authority to promote products, services, and enterprises within the meaning of reference (c). The purpose of this memorandum is to document interest from a Department of the Air Force organization(s) in working with AFWERX and an open topic SBIR Phase awardee on a proposed Phase II effort.

2. **Defense Mission Need:** AFRL / RXM has several national Defense-related mission needs in the area of Additive Manufacturing specifically AFRL/RXM is the focal lead for all of AFRL with respect to Additive Manufacturing. We believe technology development under this effort could contribute to future mission need fulfillment. The mission impact of this project on the DAF and DoD will be the development of carbon nanotube metal matrix composites for use in advanced munitions related to hypersonic and/ or deep penetration requirements. The main goals of our involvement in this project are:

   (1) Develop a material composition and associated manufacturing processing conditions to create a carbon nanotube metal matrix composite with mechanical and high temperature behavior characteristic suitable for the hypersonic and/ or deep penetration munition requirements.
   (2) Develop a material composition and associated manufacturing process to create carbon nanotube metal matrix composites that can be more broadly used to support the maintenance and sustainment of currently fielded systems.
   (3) Develop a material composition and associated manufacturing process to create carbon nanotube metal matrix composites that can more broadly be used as high-performance structures in future air vehicles.

3. **Project Timeline:** If this SBIR Phase II proposal is selected and awarded, we expect this project to be executed from June 2022 to April 2024

4. **Phase II Funding Commitment from AFRL/RXM:** No funding is committed at this time. Future considerations are based on FY 2022 and FY 2023 resources and established priorities.

5. **Additional agreement:** Prior to and/or following award, if necessary for project success, AFRL/ RXM will consult with Air Force STTR Legal, Contracting, and Program Office personnel toformalize cooperation in the manner protecting the Government's interests.

(1) Prior to award, determine if the proposed effort will require specific clauses or other special features to accommodate the work to be performed. This could include program elements such as Government-Furnished Equipment/Information (GFE/I), use of Government facilities for testing or demonstration, use of Government-provided licenses, environment considerations, etc.
(2) After award, if assistance is necessary, request guidance to award a Phase III contract or other appropriate agreement for transition to an identified Defense mission need.

6. **Phase III Interest:** Further, if the Phase II project is successful but the technology is not able to fully meet the mission need, AFRL/RMX will consider transitioning the resulting innovations to Phase III contracts, subcontracts, or other instruments with other DAF and/or Federal customers. The transition effort will give due regard to the Phase III transition preference for SBIR-funded technologies set forth in references (a) and (b). Phase IIIs are subject to Government organizations' acquisition planning, funds availability, security assessments, and Small Business/Legal/Contracting/other review requirements.

7. **Milestones:** The milestones found in Attachment 1.1, Schedule of Milestones, will provide value as End-Users and/or Customers of the proposed solution.

8. **Stakeholders:** It is understood the successful transition of innovative solutions requires multiple engaged and empowered stakeholders. Responsibilities have been assigned to, and concurrence received from, the following stakeholders relative to the proposed project:

Primary End-User Organization: AFRL/ RXM
POC: Dr. Jonathan Miller, RXM Technical Director, DR-04
Primary Customer Organization: AFRL / RXM
POC: Dr. Jonathan Miller, RXM Technical Advisor, DR-04

See attached letter from Dr. Richard McMullan, Program Manager - High Speed Strike Weapons (HSSW) designating AFRL/RXM as the focal on behalf of the HSSW program.

Phase II Technical Points of Contact (TPOCs):

Primary: Dr. Robyn Vialva, AFRL/RXMD Materials Engineer, Robyn.Vialva.1@us.af.mil
Alternate: Adam Hicks, AFRL/RXM Materials Engineer, adam.hicks,7@us.af.mil

TPOCs will work closely with the company during Phase II performance to achieve project success. This includes but is not limited to receiving and accepting/rejecting deliverables; providing performance and progress feedback to the company; working to overcome tactical execution barriers,e.g., base access, waivers/certifications, etc.; and driving the effort towards Phase III transition if successful. Please see the **TPOC Designation Letter** provided in the attachments, this letter will need to be signed if the proposal is selected for a potential award.

Strategic Stakeholders

Name of MAJCOM or HQ function this proposal most directly impacts: **Air Combat Command, Air Force Global Strike Command**
Name of PEO or Center this proposal most directly impacts: **PEO Armament**

9. **Phase III Transition Strategy**: The Defense Threat Reduction Agency Counter Weapons and Capabilities for WMD (DTRA / CXW) in support of the PEO Armament / Direct Attack Division (AFLCMC/EBD) has already purchased (December 2021) carbon nanotube Haynes 230 and other materials from SHEPRA, Inc. in support of the Energy Dense Warhead Program.
.

10. Installation Access: The SBIR Company will not require access to military installations and/or facilities to perform the proposed work under Phase II.

11. **Cyber Security:** The proposed solution is not considered an Information Technology.

12. **Flight Testing or Utilization of Unmanned Aerial Systems (UAS):** The SBIR company will not require flight testing or UAS utilization to accomplish the proposed Phase II work.

13. **Conclusion and Signatures.** Please contact the individuals below with questions or concerns.

AF End-User Suitability: AFRL /RXM has substantial interests and investments in Additive Manufacturing maturation and transition.
AF Customer Suitability. PEO Armament has multiple programs related to Additive Manufacturing on going (e.g. High Speed Strike Weapons) and has designated AFRL/RXM as stakeholder.

DAF CUSTOMER

Dr. Jonathan Miller, DR-04
Technical Director
AFRL/RXM

Jonathan.Miller.22@us.af.mil

DAF End-User

Dr. Jonathan Miller, DR-04
Technical Director
AFRL/RXM

Jonathan.Miller.22@us.af.mil