White Paper

BAA Number:	**W15QKN-08-R-0241**
BAA Title:	MUNITIONS METAL PARTS MANUFACTURING
Contractor Generated Identification Number	MSI004
Project Title:	Laser-Assisted Manufacturing of Cermets Materials Technologies
Technical Topic and Sub-Topic Areas:	Advance Materials Processing
Prime Contractor: Name; Division, Full Postal Address; and URL (if available); corporation; organization; individual, or other legal entity submitting:	**Mold Shields, Inc.** 4131 Anna Ave. Lyons, IL 60524 Partnership with - **Purdue University**
Technical Point-of-Contact: Full Name; Postal Address; E-Mail Address; Telephone, and FAX Number:	Reginald Phillips 4131 Anna Ave. Lyons, IL 60534 P- (630) 639-3274 F- (708) 443-5871 mr_moldshields@yahoo.com
Principal Investigator (PI) – if different from Technical Point-of-Contact: Full Name; Postal Address; E-Mail Address; Telephone, and FAX Number:	**Dr. Yung Shin** 585 Purdue Mall West lafayette, IN 47907 P - (765) 494-9775 F- (765) 494-0539 shin@purdue.edu
Contracting/Administrative Point-of-Contact: Full Name; Postal Address; E-Mail Address; Telephone, and FAX Number:	Amarzaya Phillips (Mold Shields, Inc.) 4131 Anna Ave. Lyons, IL 60534 (708) 668-8488 zaya8858@sbcglobal.net
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Place of Performance:	Lafayette, Indiana 47907
Period of Performance:	36 Months
ROM Cost:	1st TO: $1.99 MM 2nd TO: $ 2.25MM
ROM Cost for Government Property:	-0-
CAGE Code/ DUNS/ Tax ID	1K6U7/ 061122649/ 36-4215536
Small Business Size Status:	<6
Will Foreign Nationals be Utilized?	No

This White Paper submission will be protected from unauthorized disclosure in accordance with FAR 15.207, applicable law, and DOD regulations.

Signature: Reginald Phillips

Technical Description

The program objective is a three-year effort by Mold Shields, Inc. and Purdue University for research and technical support. The work to be performed is described in the Statement of Work (SOW) by Mold Shields Inc. dated May 25, 2010 (BAA- W15QKN-08-R-0241). Our goal is to assist U.S. Army Business Interface Office and the Research and Development and Engineering Center (RDECOM-ARDEC) with advanced materials manufacturing and corrosion abatement for the prevention of corrosion of weapon components and other Ammunition Materials. Mold Shields, Inc. will develop ceramic components using Laser-Assisted Manufacturing (LAM) technology and **combinations of ceramic and alloy materials** (**Cermets**). This technology greatly reduces the corrosion burden, while reducing the components' weight.

Description of problem(s) being addressed

The approach is *not* to treat the corrosion as an after-the-fact maintenance issue; the goal is to use advance materials to avoid the corrosion abatement. Mold Shields, Inc. plans are to develop products and processes that can reduce the weight of various weapon system components or extend performance either in terms of life, ballistics, or protection of corrosion. Materials that will be used in the research will also be resistant to corrosion and the effects of environmental degradation.

Problems being addressed by technology

Machining of industrial ceramics is presently accomplished by diamond wheel grinding after being formed in a mold to an approximate shape slightly oversized. These custom molds can produce an infinite number of shapes, but cannot achieve the tolerances or surface finish required on any but the crudest parts. Only through diamond wheel grinding can manufacturers reach the close tolerances and smooth finishes necessary for engine parts and most industrial uses. Diamond wheel grinding is slow and expensive.

Work to be performed, milestones and deliverables…… s*ee page 3*

The anticipated results of this program are;

- To gather information on the effectiveness of LAM operating using combinations of ceramic and alloy materials under various conditions.
- Developed a database for LAM utilizing this new process for developing prototype's and production products involving the laser-assisted CNC turning center.

With successful results, Mold Shields, Inc. intent is to produce cermets components for (RDECOM-ARDEC), this program will also reduce cost and increase efficiencies in manufacturing processes for military applications.

Type of Support

Purdue Universities Incubator Facility located in Lafayette Indiana.

Technology's uniqueness – overall and specific areas

The Implementation of silicon nitride components in military application while operating under extreme conditions offers the potential for significant improvements in engine efficiency and performance. For example, engines with silicon nitride cylinder liners, pistons, and valves experience less thermal expansion than its metal counterparts, holds tighter tolerances, can run dry (no oil), is lighter in weight than its metal counterparts and has improved corrosion and wear resistance. Ceramics have a low co-efficient of friction and a high resistance to heat and wear.

Limitations of current technology

Currently the manufacturing of ceramic bushings and cylinder linings has limitations because close tolerances cannot be achieved without diamond polishing. The laser-assisted CNC machining (LAM) process and machining center proposed in this project offer the potential for opening up a sector of the military and automotive market for ceramic components. Current ceramic finishing technology costs prohibit their widespread use in automotive applications. With laser-assisted machining of ceramics, bushings, liners, pistons and valves can be used in extreme-use vehicles such as off road vehicles, tractors, tanks and other applications with an eye to reducing the cost to where ceramics might be used in wider applications.

Commercial applications for this research include:

- Cermets/ceramics components (cylinder liners, bushing and pistons) for internal combustion engines operating under extreme conditions (racing cars, diesel trucks, farm and construction equipment).
- Abusive wear engines tanks, military weapons and vehicle components.
- A new laser-integrated machining system for the machine tool industry.

The Statement of Work (SOW) will be accomplished in three phases:

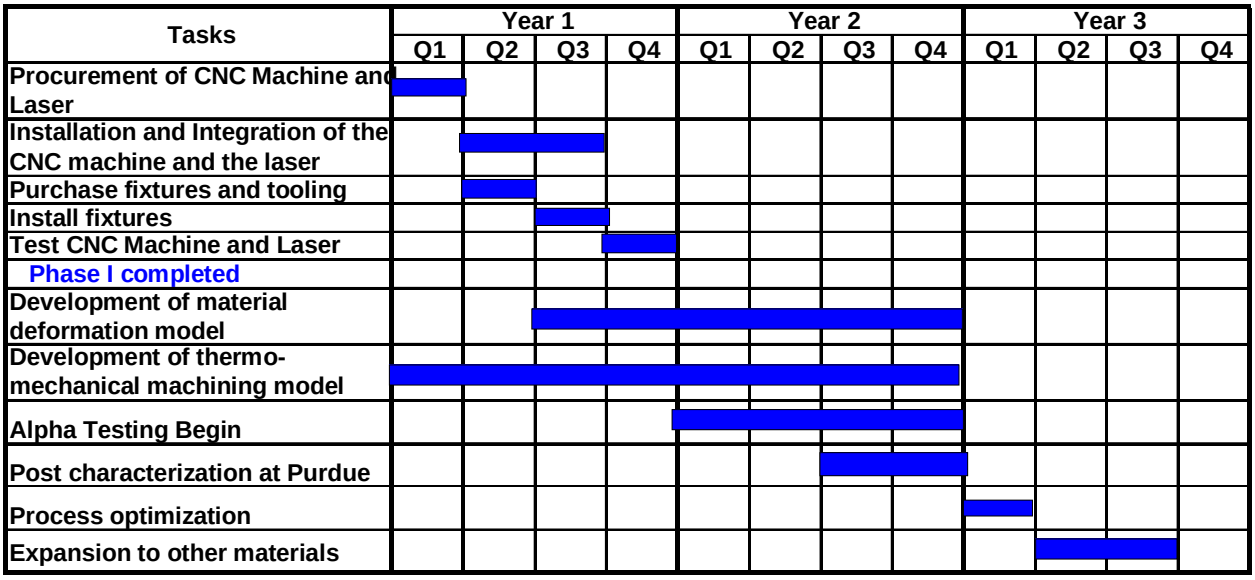
Combination of ceramic and alloy materials and (Cermets)

Phase I – Procure Machining Center Compatible with Ceramic and Laser Aiming Requirements and Laser System Compatible with Ceramic and Machining Center Interface Requirements, including Integration of the System.

Phase II – Begin Predictive Model Development and Evaluation for Laser Assisted Machining of Ceramics.

Phase III – Process Optimization, Benchmarking and Evaluation for Laser Assisted Machining of Other materials for prevention and corrosion of weapons components.

Est. Time Line Schedule



Anticipated technical, performance and economic benefits from the work

Determine the [LAM] machinability of cermets, silicon nitride, and zirconia. The following are the anticipated technology processing to be performed during phase 1.

- Find the operating condition which globally optimize the process, taking into account the desire to:
  - maximize material removal rate
  - minimize sub-surface flaws
  - minimize surface roughness
  - minimize tool wear
- Determine the material removal mechanism for various workpiece materials.
- Determine the tool wear mechanism & tool wear rate for representative LAM conditions
- Develop transient, three-dimensional model of the workpiece undergoing LAM including internal radiation for semi-transparent materials
- Understand the underlying physics of LAM
- Develop guidelines to determine materials for which LAM is best suited.
- Develop an economic analysis to determine conditions for which LAM is a feasible alternative to grinding

Offeror's Capabilities Addendum

Reginald Phillips – Mechanical Design Engineer/ B.A. Economics, former US Navy Data Processing Technician aboard the USS Constellation CV-64 Aircraft Carrier
18 + years engineering experience

Professional History

1997- Present	Owner/President, Mold Shields, Inc. Chicago, IL
2007- 2008	Contract Engineer, Rockwell Metal Products of Chicago, IL
2007- 2008	Gov. Liaison/ Proposal Writing, Reliance Tool & Mfg. Co. Elgin, IL
2001- 2006	Researcher/ Mechanical Engineer, Battelle Memorial Institute (BMI) OH
1999- 2001	Product Design Engineer, Cooper Lighting/ HALO, Elk Grove, IL
1991- 1998	Product Engineer, Littelfuse, Inc, Des Plaines, IL
1987- 1990	Computer Operator, Allstate Corporate Data Center, Northbrook, IL
1981- 1987	US Navy, Data Process Technician, San Diego Ca. Honorably Discharged

Awards: Initiated 2 Space Act Agreements (SAA), one with NASA GRC for a High Speed Data Transfer unit set-top box of the OC-12 (622 Mb/s) and OC-48 (2.5 Gb/s) used in NDE evaluation of turbine fan blades by NASA GRC, SAA with NASA Goddard Space Flight Center, for a small Planetary Gear Bearing

Certificates: Geometric Tolerance & Dimensioning GD&T; ALGOR Finite Element Analysis Steady State Thermal and Stress and Strain Analysis; No Sweat Statistics; Product Development Team Leader; Underwriters Laboratories UL – Specifying Plastics for Electronic Products; FMEA – Failure Mode and Effect Analysis Application; Branson Ultrasonic Assembly; Polymerland Molders Workshop

Owner/ President of Mold Shields, Inc; Minority-owned veteran manufacturing company established in 1997, with a U.S. Patent # 5,310,327 for the "Part Deflector Shield, and Quick Shield," these are vertical shades used in the Plastic Injection Molding Industry to eliminate contamination, improved safety around the plastic injection molding machines while increasing the companies' productivity with every cycle of operation. **MSI,** is also a sole source manufacturer of a Spanner Wrench for the MK-19 "40 MM," Grenade Launcher for Defense Supply Center Columbus and Richmond, Ref. Contract SPM4L1-07-D-5723 currently on call # 07 year 2, of a multi-year contract.

Dr. Yung Shin. – Purdue Mechanical Engineering Department/ LAM

Professor Shin currently is a professor of mechanical engineering at Purdue University. He received his Ph.D. from the University of Wisconsin in 1984. He worked as a senior project engineer at the General Motors Technical Center in Warren, Michigan from 1984 to 1988 and as an assistant professor at the Pennsylvania State University from 1988 to 1990. In 1990, he joined the School of Mechanical Engineering at Purdue University. Since he came to Purdue, he has developed new manufacturing courses and laboratories, which are now equipped with state-of-the-art facilities worth well over $3M. His research areas include laser processing of materials, intelligent and adaptive control, dynamics of machine tools, high speed machining, process modeling and simulation, machining of advanced materials, process monitoring and automation. He has authored over 200 refereed publications in archived journals and refereed conference proceedings, and has authored chapters in several engineering handbooks and co-edited two books. In addition, he has given numerous presentations at various conferences and lectures at different universities, research institutions and industrial companies.

Professional History

1997- Present Professor, School of Mechanical Engineering, Purdue University.
2003- Present Director, Center for Laser-based Manufacturing
1999- Present Chair, Systems, Measurement and Control Area in Mechanical Engineering.
1993- 1997 Associate Professor, School of Mechanical Engineering, Purdue University.
1990- 1993 Assistant Professor, School of Mechanical Engineering, Purdue University.
1988- 1990 Assistant Professor, Pennsylvania State University.
1984- 1988 Senior project engineer, General Motors Technical Center.

Synergetic Activities

1. Associate editor for the ASME Journal of Manufacturing Science and Engineering, 2000-2007.
2. Chair of the ASME International Manufacturing Science and Engineering Conference, 2009.
3. Chair of the 30th North American Manufacturing Research Conference, 2002.
4. Member, SME Machining Systems Technical Committee, 2003-present.
5. Co-PI of the Agile Manufacturing Research Institute, a seven university consortium, 1993-1998.