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Evgeny Shafirovich

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14. ABSTRACT
The objective of this project was to acquire equipment and instrumentation for research and education on energetic materials that would enhance the University's capabilities in materials preparation, materials characterization, and combustion experiments. All requested equipment items have been purchased, received, and installed. They include a glovebox isolator (Terra Universal Series 300), an acoustic mixer (Resodyn LabRAM), a shaker mill (SPEX SamplePrep 8000D), a differential scanning calorimeter (Netzsch DSC 404 F1 Pegasus) coupled with a quadrupole mass spectrometer (Netzsch QMS Aeolos), a laser flash apparatus (Netzsch LFA 457 MicroFlash), an oxygen

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Report Title

Final Report: Energetic Materials Laboratory

ABSTRACT

The objective of this project was to acquire equipment and instrumentation for research and education on energetic materials that would enhance the University's capabilities in materials preparation, materials characterization, and combustion experiments. All requested equipment items have been purchased, received, and installed. They include a glovebox isolator (Terra Universal Series 300), an acoustic mixer (Resodyn LabRAM), a shaker mill (SPEX SamplePrep 8000D), a differential scanning calorimeter (Netzsch DSC 404 F1 Pegasus) coupled with a quadrupole mass-spectrometer (Netzsch QMS Aeolos), a laser flash apparatus (Netzsch LFA 457 MicroFlash), an oxygen bomb calorimeter (Parr 6220), a semimicro calorimeter (Parr 6725), and a high-speed video camera (Vision Research Phantom v1210). This acquisition has resulted in the establishment of a fully equipped laboratory for comprehensive studies of energetic materials, which will be used by the engineering faculty members for their current and future DoD grants. The laboratory provides a research environment that is relevant and comparable to today's government and industrial facilities. The equipment will enhance the academic experience for students and help prepare them for productive work in advanced areas of engineering important for the U.S. Department of Defense.

Enter List of papers submitted or published that acknowledge ARO support from the start of the project to the date of this printing. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

Received		Paper
04/21/2015	3.00	Daniel A. Rodriguez, Edward L. Dreizin, Evgeny Shafirovich. Hydrogen generation from ammonia borane and water through combustion reactions with mechanically alloyed Al·Mg powder, Combustion and Flame, (04 2015): 1498. doi: 10.1016/j.combustflame.2014.11.019
04/21/2015	4.00	Marco A. Machado, Daniel A. Rodriguez, Edward L. Dreizin, Evgeny Shafirovich. Chemical Gas Generators Based on Mechanically Alloyed Al·Mg Powder, MRS Proceedings, (03 2015): 0. doi: 10.1557/opl.2015.287
TOTAL:	**2**	

Number of Papers published in peer-reviewed journals:

(b) Papers published in non-peer-reviewed journals (N/A for none)

Received		Paper
TOTAL:		

Number of Papers published in non peer-reviewed journals:

(c) Presentations

Number of Presentations: 0.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received		Paper
04/21/2015	5.00	Sergio E. Guerrero, Marco A. Machado, Daniel A. Rodriguez, Edward L. Dreizin, Evgeny Shafirovich. Chemical Gas Generators Based on Mechanically Alloyed Reactive Materials, 9th U. S. National Combustion Meeting. 17-MAY-15, . : ,
04/21/2015	6.00	Armando Delgado, Sergio Cordova, Evgeny Shafirovich. Combustion of Martian Regolith Simulants with Magnesium, 9th U. S. National Combustion Meeting. 17-MAY-15, . : ,
04/21/2015	7.00	Sergio E. Guerrero, Edward L. Dreizin, Evgeny Shafirovich. Thermite Mixtures for Rapid Generation of Iodine , 5th Southwest Energy Science and Engineering Symposium. 04-APR-15, . : ,
04/21/2015	8.00	Sergio E. Guerrero, Daniel A. Rodriguez, Edward L. Dreizin, Evgeny Shafirovich. Combustible Mixtures for Hydrogen and Iodine Generation Based on Mechanically Alloyed Reactive Materials, 13th International Symposium on Self-propagating High-temperature Synthesis. 12-OCT-15, . : ,
TOTAL:		**4**

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Received		Paper
TOTAL:		

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts):

(d) Manuscripts

Received		Paper
04/30/2015	9.00	Armando Delgado, Sergio Cordova, Evgeny Shafirovich. Combustion of Martian regolith simulants with magnesium, Combustion and Flame (03 2015)

TOTAL: **1**

Number of Manuscripts:

Books

Received	Book

TOTAL:

Received	Book Chapter

TOTAL:

Patents Submitted

Patents Awarded

Awards

Graduate Students

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Post Doctorates

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Faculty Supported

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

The number of undergraduates funded by this agreement who graduated during this period: 0.00
The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:..... 0.00
The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:..... 0.00
Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):..... 0.00
Number of graduating undergraduates funded by a DoD funded Center of Excellence grant for Education, Research and Engineering:..... 0.00
The number of undergraduates funded by your agreement who graduated during this period and intend to work for the Department of Defense 0.00
The number of undergraduates funded by your agreement who graduated during this period and will receive scholarships or fellowships for further studies in science, mathematics, engineering or technology fields:..... 0.00

Names of Personnel receiving masters degrees

NAME

Total Number:

Names of personnel receiving PHDs

NAME

Total Number:

Names of other research staff

NAME PERCENT_SUPPORTED

FTE Equivalent:
Total Number:

Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

See attachment.

Technology Transfer

Scientific Progress and Accomplishments - Grant # W911NF-14-1-0034

Energetic Materials Laboratory

Evgeny Shafirovich
Department of Mechanical Engineering
The University of Texas at El Paso, El Paso, TX 79968

Objective

The objective of this project was to acquire equipment and instrumentation for research and education on energetic materials that would enhance the University's capabilities in materials preparation, materials characterization, and combustion experiments. This acquisition has resulted in the establishment of a fully equipped laboratory for comprehensive studies of energetic materials, which will be used by the engineering faculty members for their current and future DoD grants. The laboratory provides a research environment that is relevant and comparable to today's government and industrial facilities. The equipment will enhance the academic experience for students and help prepare them for productive work in advanced areas of engineering important for the U.S. Department of Defense.

Approach

The following equipment has been acquired:

- a glovebox isolator (Terra Universal Series 300)
- an acoustic mixer (Resodyn LabRAM)
- a shaker mill (SPEX SamplePrep 8000D)
- a differential scanning calorimeter (Netzsch DSC 404 F1 Pegasus) coupled with a quadrupole mass-spectrometer (Netzsch QMS Aeolos)
- a laser flash apparatus (Netzsch LFA 457 MicroFlash)
- an oxygen bomb calorimeter (Parr 6220)
- a semimicro-calorimeter (Parr 6725)
- a high-speed video camera (Vision Research Phantom v1210)

Relevance to Army

The acquisition provides a new capability of conducting research on the enhancement of reactive materials, propellants, and advanced structural and functional materials.

Accomplishments

- All requested equipment items have been purchased, received, and installed.
- The glovebox isolator, the acoustic mixer, and the high-speed video camera are being used extensively for research under DoD Grant # W911NF-12-1-0056 "Efficient and Safe Chemical Gas Generators with Nanocomposite Reactive Materials." The results were used in the M.S. thesis defended by Daniel Rodriguez. They will also be used in a M.S. thesis of Sergio Guerrero (expected graduation date: Dec. 2015).
- The differential scanning calorimeter has been used for studies on combustion mechanisms of lunar and Martian regolith simulants mixed with magnesium, supported by NASA. It has also been used for studies on combustion synthesis of magnesium

silicide, a promising high-temperature thermoelectric material. Finally, along with the coupled mas-spectrometer, it is being now for kinetic studies of is an ammonium dinitramide based monopropellant.

- The laser flash apparatus has been used for thermal diffusivities measurements for magnesium silicide and for materials fabricated by Dr. C.V. Ramana.
- The following research proposals that involve use of the acquired equipment have been submitted and either awarded or are pending:

  Awarded:

  - A. Choudhuri (PI), J. Chessa (Co-I), N. Love (Co-I), E. Shafirovich (Co-I), R. Wicker (Co-I), "MIRO Center for Space Exploration and Technology Research," NASA, 60 months, $5,000,000, contract pending
  - N. Love (PI), A. Choudhuri (Co-PI), E. Shafirovich (Co-PI), "HAN Based Advanced Hybrid Rocket Motor Technologies," Missile Defense Agency, 36 months, $600,000, contract pending

  Pending:

  - E. Shafirovich (PI), C.V. Ramana (Co-PI), Combustion Synthesis of Boride-Based Electrode Materials for MHD Direct Power Extraction, DOE, 36 months, $250,000
  - D. Nemir (PI), E. Shafirovich (Subcontractor), Bulk Non-equilibrium Materials by Shockwave Consolidation, Air Force SBIR Phase II, 36 months, $750,000 (UTEP part: $147,500)

Collaborations and Technology Transfer

- None

Resulting Journal Publications During Reporting Period

- Rodriguez, D.A., Dreizin, E.L., and Shafirovich, E., "Hydrogen Generation from Ammonia Borane and Water through Combustion Reactions with Mechanically Alloyed Al·Mg Powder," *Combustion and Flame*, Vol. 162, 2015, pp. 1498–1506.
- Delgado, A., Cordova, S., and Shafirovich, E., "Combustion of Martian Regolith Simulants with Magnesium," *Combustion and Flame*, in review.

Graduate Students Involved During Reporting Period

- Daniel A. Rodriguez, graduated M.S. Aug. 2014
- Sergio E. Guerrero, M.S., current
- Armando Delgado, PhD, current

Awards, Honors and Appointments

- The PI received the "First Place for Technical Merit" Award in the Combustion Art Competition from the Combustion Institute, 2014.
- The PI has been appointed to a tenured Associate Professor position at UTEP.

Supplemental Data

Fig. 1. Glovebox (Terra Universal, Series 300).

Fig. 2. Acoustic mixer (Resodyn LabRAM).

Fig. 3. Shaker mill (SPEX SamplePrep 8000D)

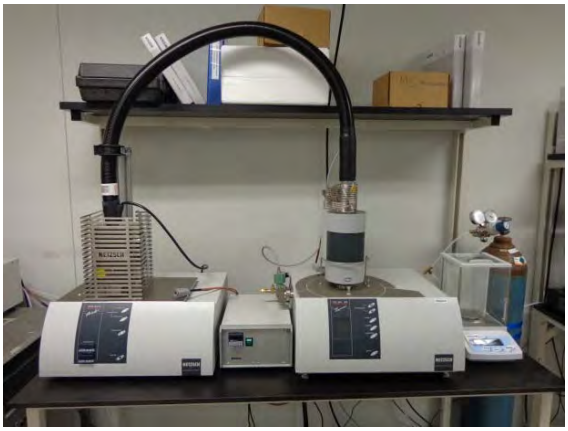

Fig. 4. Left: mass-spectrometer (Netzsch QMS Aeolos); right: differential scanning calorimeter (Netzsch DSC 404 F1 Pegasus).

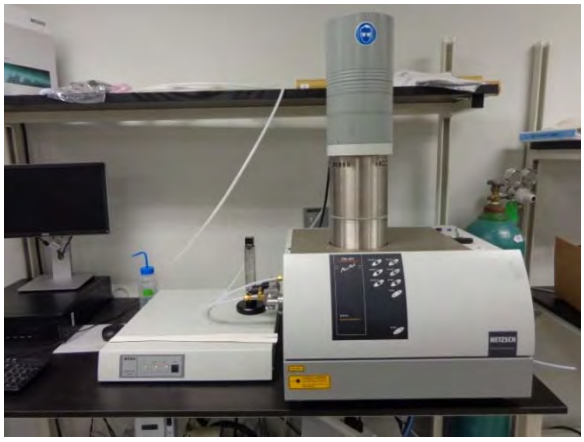

Fig. 5. Laser flash apparatus (Netzsch LFA 457 MicroFlash).

Fig. 6. Oxygen bomb calorimeter (Parr 6220).

Fig. 7. Semimicro-calorimeter (Parr 6725)

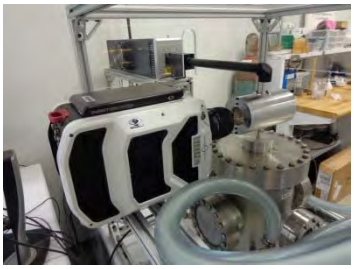

Fig. 8. High-speed video camera (Vision Research Phantom v1210).