Air Force Research Laboratory

Integrity ★ Service ★ Excellence

Dynamic Materials and Interactions Portfolio

Annual Program Review
August 11-13, 2015

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Air Force Research Laboratory

AFRL

Outline

- Portfolio Motivation and Investment Strategy
- Research Thrusts
- Administrivia
- Summary

Motivation

Enabling 6th Generation Aircraft

F-35 and Beyond –
Demands munition innovation

Internal Carriage	High energy density; Multifunctional; Insensitive
Survivable Penetrators	Mechanics of heterogeneous materials; Survivable energetics
Rapid Development Time	Energetic materials by design; predictive multi-scale modeling and simulation
Storage and Delivery	Combined thermal and acoustic loading, thermally stable materials

Dynamic Materials and Interactions

Dynamic Materials and Interactions Portfolio

Description: Fundamental, basic research into the **dynamic** chemistry and physics of **complex materials**, particularly Energetic Materials (EMs).

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Energetic materials by design; predictive multi-scale M&S

Combined thermal and acoustic loading, thermally stable materials

Research Thrusts

- Energetic Materials Science

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Research Thrusts

- Energetic Materials Science
- Dynamics of Heterogeneous Materials

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Research Thrusts

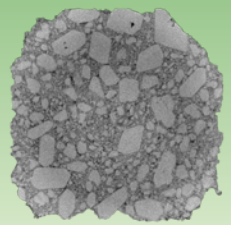
- Energetic Materials Science
- Dynamics of Heterogeneous Materials
- Reactive Materials

Dynamic Materials and Interactions Portfolio

Description: Fundamental, basic research into the **dynamic** chemistry and physics of **complex materials**, particularly Energetic Materials (EMs).

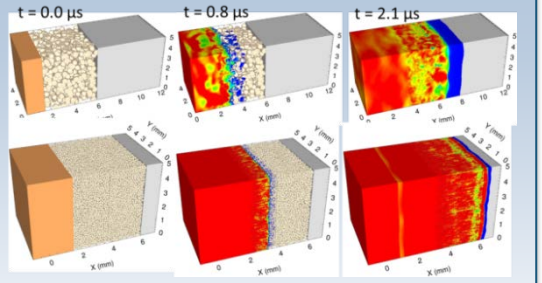
Energetic Materials Science

- **Predictive processing-structure-property relationships**



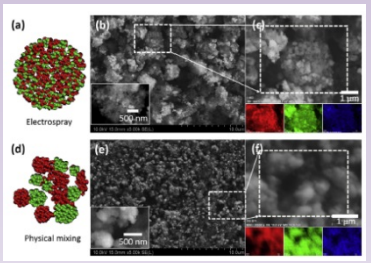
Dynamics of Heterogeneous Matls

- **Material structure – shock wave interactions**
- **Stress wave tailoring**



Reactive Materials

- **Enhanced energy content and improved efficiency**
- **New energetic mat'ls**

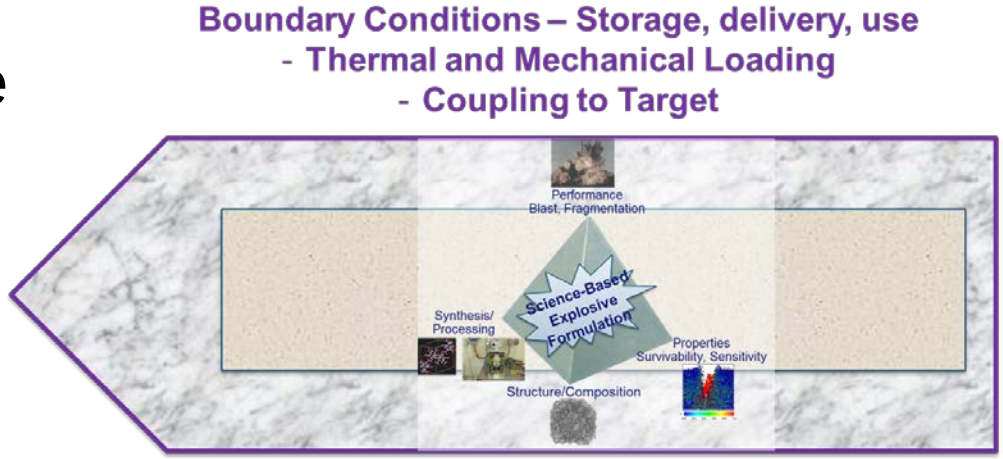


Portfolio Investment Strategy

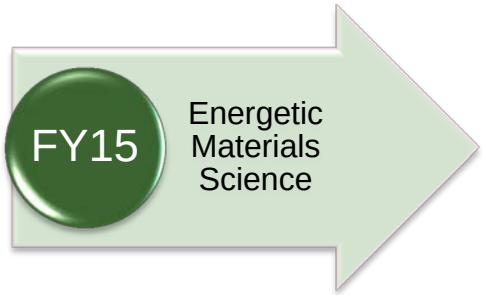
- Discover
  - Increase international collaboration through AOARD and EOARD
  - Cultivate Young Investigators as "bow wave" for key research gaps
- Shape
  - Focus funding on key research gaps – targeted each year
  - Increase Academic – TD interactions
  - Coordinate across DoD basic research (ONR, ARO, DTRA, AFOSR)
- Champion
  - Advocate for research, including MURI, COE, and SBIR/STTR topics

Energetic Materials Science

Challenge: Lack of predictive understanding requires long development times and large resource investment for new explosive formulation



Investment and Way Ahead



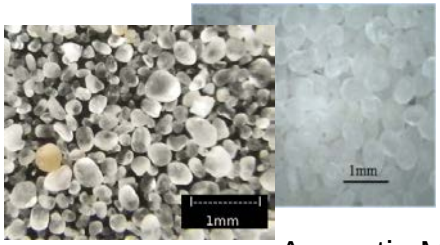
- FY15: Concentrated investment on experimental *in situ* hot spot characterization and associated mesoscale modeling; Phase II STTR on particulate mixing
- Next focus on combined thermal and acoustic load

Coupling M&S with experimentation to transform energetic materials formulation from empiricism to predictive

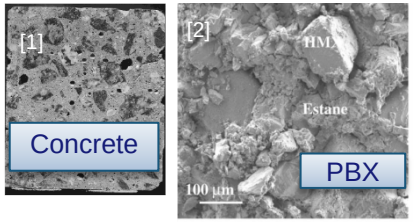
Dynamics of Heterogeneous Materials

Challenge: Dynamic response of heterogeneous materials is complex and continuum response depends on the stochastic mesostructure

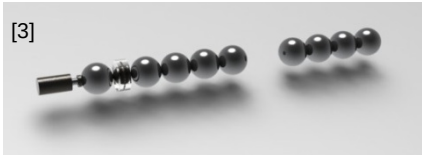
Granular



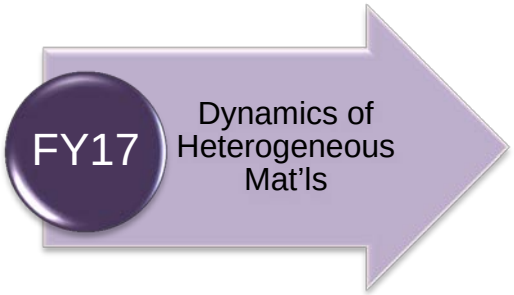
Multi-Constituent



Acoustic Metamaterials



Investment and Way Ahead



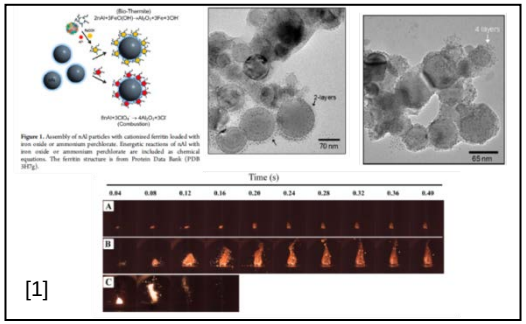
- Center of Excellence through FY17
- Planning investment for FY17+ on manipulating stress wave propagation

Manipulate stress wave propagation through microstructure to achieve a desired output

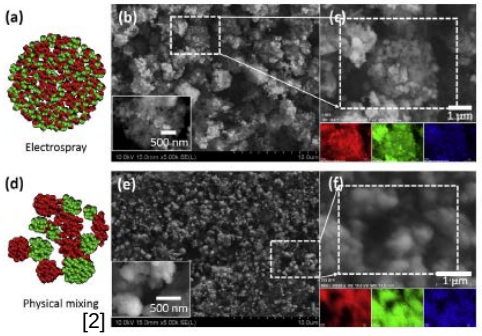
[1] http://www.fhwa.dot.gov
[2] M.R. Baer, *Thermochimica Acta*, 2002
[3] http://www.mechmat.ethz.ch/research.html

Reactive Materials

Challenge: Reactive materials provide promise of increased energy density that has not been realized



[1]



[2]

FY16 Reactive Materials

Investment and Way Ahead

- Focused investment starting in FY16 on understanding heterogeneous reaction mechanisms, reactive multi-phase flow, and bottom-up material design

Understanding reactive materials and manipulation of output power.

[1] J.M. Stock, et al., *Nano Letters,* **13**, p. 2535-2540 (2013)
[2] H. Wang, G. Jian, G.C. Egan, and M.R. Zachariah, *Combustion and Flame*, **161**, 2203-2208 (2014).

Administrivia

Portfolio Annual Cycle

- Core portfolio
  - Request proposals by May for next FY
  - Proposals reviewed over summer
  - Funding plans by Sept – not executed until final budget is announced
- Young Investigator Program (YIP)
  - Call typically released in early summer
  - Proposals typically due in early fall
- Defense University Research Instrucmentation Program (DURIP)
  - Proposals due 9/25/2015

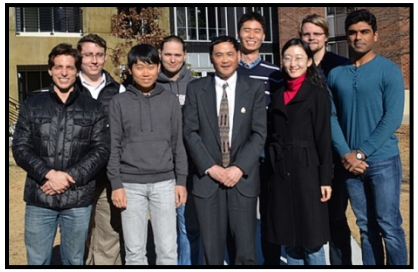
Annual and Final Reports

- AFOSR will be closely tracking annual reports starting in August – final reports already tracked
  - You will receive automated emails
- My expectation for annual reports: ~5 pages (length depends on size of grant) summarizing research progress, including publications

Submit your reports on time!

Highlight Slides

- Requesting highlight slides by Jan 15th
- 1-2 slides highlighting recent research developments
  - Slides will not be used as submitted so format is up to you
  - Include a picture of your research group



  - Include discussion of pictures in the notes section

Spring Review planned for Mar 14-17

Getting the Word Out

- AFOSR communications staff sends daily emails featuring press releases of AFOSR sponsored research
  - If your university sends out a press release, please forward it to me!
- AFOSR is on social media

www.facebook.com/afosr

www.twitter.com/afosr

www.youtube.com/TheAFOSR

Acknowledgments

All publications or public media resulting from AFOSR sponsored research should acknowledge AFOSR as the sponsoring agency

This material is based upon work supported by the Air Force Office of Scientific Research under AFOSR Award No. *insert grant # here*.

(From Federal Research Terms and Conditions, Article 51)

http://www.nsf.gov/pubs/policydocs/rtc/termsidebyside_june11.pdf

Acknowledgements are occasionally tracked by staff from high-level offices with research impact inferred…

Based on Slide courtesy Mike Berman

Contact Information

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APAN: http://tinyurl.com/AFOSR-DMI

2014 Review:
Triservice Energetics Review, Joint with ONR and ARO, September 2014

2015 Review:
August 11-13, 2015, Doolittle Institute, Fort Walton Beach, FL

2016 Review: ??