Airborne Lead Reduction IPR
Qualification of Green Primary Explosive, DBX-1 (ALR-14-01)

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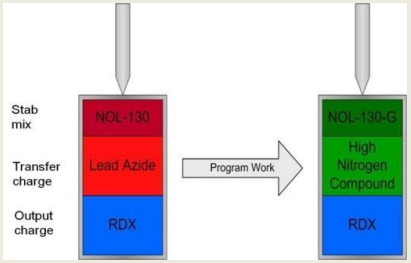
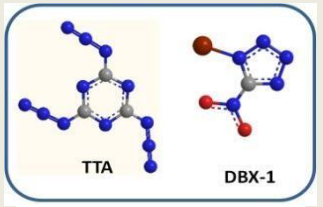
Qualification of Green Primary Explosive, DBX-1 (ALR 14-01)

Project Description

- ARDEC will qualify Copper (I) 5-Nitrotetrazolate (DBX-1) at 500-gms scale to Army performance requirements
- Replace lead azide and lead styphnate in detonators, some primers, blasting caps, etc. (studies already completed at lab scale)
- Produce and qualify green NOL-130 (stab mix) for detonators
- Transition to field through SWO-10





NOL130 = lead azide, lead styphnate, tetrazene, barium nitrate, antimony sulfide

M115 Primer

25mm Round

Requirement/Impact

- Addresses AERTA PP-12-09-02 by qualifying a lead-free primary explosive for Army use
- Until DBX-1 is qualified, there are no Army qualified primary explosive alternatives to lead based compounds in detonators, primers, etc.
- NAS study on lead exposure on firing ranges finds current occupational exposure level in not protective of soldiers/workers on ranges.

Progress Report

- Key dates
  - Endorsement signed by PEO-AMMO: 3Q-FY13
  - TTA signed by PM-CCS: in progress
  - End/transition point: 2Q-FY16
- Recent accomplishments/issues
  - Planning for kick-off meeting end of August/2nd week of September
  - 6 months aging completed on July 26th – August 9th samples will be pulled out from the oven to start testing

Airborne Lead Reduction IPR
Continuous Process to Produce NaNTIDBX-1
(ALR 13-02)

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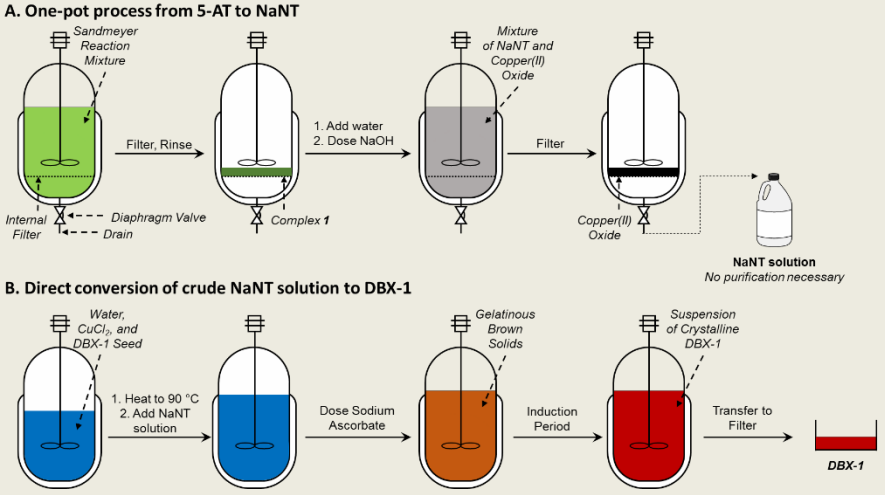
Continuous Process to Produce NaNT/DBX-1 (ALR 13-02)

Project Description

- ARDEC/Nalas Engineering will develop one-pot, high yielding, safe process to produce NaNT (for production of DBX-1)
- Develop kinetic model for the synthesis of NaNT (Nalas Engineering) to understand the reaction kinetics to determine process variables that avoid hazardous conditions and impurities
- From one-pot process directly convert the crude NaNT solution to make DBX-1
- Transition process specification to manufacturer



Lean Process to Produce NaNT/DBX-1

Requirement/Impact

- Addresses AERTA PP-12-09-02 by developing a large-scale production process for a lead-free primary explosive: DBX-1
- Current production processes can not meet Army production requirements. Continuous process will increase throughput and reduce worker exposure to sensitive materials.
- DBX-1 could be used in 1000s of systems

Progress Report

- Key dates
  - Endorsement signed by PEO-AMMO: 3Q-FY13
  - TTA signed by PM-CCS: in progress
  - End/transition point: 1Q-FY16
- Recent accomplishments/issues
  - Nalas Engineering received and installed the 5-L reactor with the sampling system – Dec 2014
  - Completed 3 batches of NaNT for reproducibility

Airborne Lead Reduction IPR
DBX-1 Particle Size Characterization (ALR 15-01)

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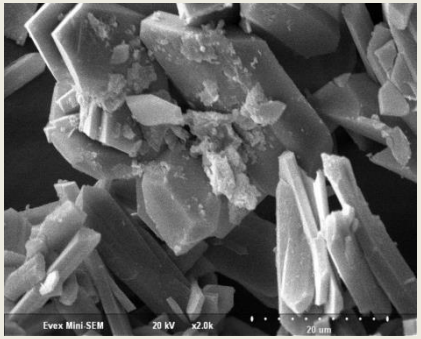
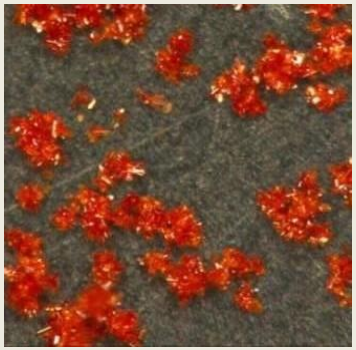
DBX-1 Particle Size Characterization (ALR 15-01)

Project Description

- ARDEC and Nalas Engineering will develop a process to produce different particle size of copper(I) 5-nitrotetrazolate (DBX-1), similar to RDX and HMX, for different applications
- Having different particle size of DBX-1 will benefit all items such as primers, detonators, blasting caps
- Optimize process parameters, categorize particle size distributions and test in different items
- Process specifications transition to manufacturer selected in Title III DPA project





Requirement/Impact

- Addresses AERTA PP-12-09-02 by developing new particle sizes for lead-free primary explosive
- Although a viable candidate for a drop-in replacement has been identified in DBX-1, transition towards commercialization is hindered by particle size distribution and ability to load the material in various units
- Particles sizes increase packing fraction and number of potential applications for DBX-1

Progress Report

- Key dates
  - Endorsement signed by PEO-AMMO: 3Q-FY13
  - TTA signed by PM-CCS: in progress
  - End/transition point: 1Q-FY17
- Recent accomplishments/issues
  - Contract award – August 2015

Airborne Lead Reduction IPR
Green Improved Process to Load Primers
(ALR 14-02)

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Green Improved Process to Load Primers (ALR 14-02)

Project Description

- ARDEC and Innovative Materials and Processes, LLC (IMP) will develop an automated loading process for lead-free primer formulations.
- Develop DBX-1 based formulation for potential use in percussion primer.
- Leverage prior research in primer loading technologies to apply to DBX-1 based formulations.

Current Manual Process

Future Automated Dispensing Process

Requirement/Impact

- Addresses AERTA PP-12-09-02 by developing a process to produce lead-free primers - currently all the primers are based on lead styphnate.
- New, automated loading process will reduce operator error (reducing malfunction) and increase # of primers produced per shift/year.
- Process will reduce worker exposure to hazardous and very sensitive explosives.

Progress Report

- Key Dates:
  - Endorsement signed by PEO-AMMO: FY14
  - TTA signed by PM-CCS: 3QFY13
  - End/transition point: 2Q FY17
- Recent accomplishments/issues
  - Awaiting DOTC contract to approve to send funds to IMP.
  - Working on inert materials to downselect the solvent for DBX-1 formulation.

Airborne Lead Reduction IPR
Detonator Demonstration (ALR 15-02)

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Detonator Demonstration (ALR 15-02)

Project Description

- ARDEC will demonstrate DBX-1 as a replacement for lead azide and lead styphnate in
  - Detonators for projectile/mortar fuzes
  - Detonators for hand grenade fuzes
  - Blasting caps
- Leverage prior formulation efforts in EQT program

Requirement/Impact

- Addresses AERTA PP-12-09-02 by replacing lead based primary explosives with DBX-1 in detonators and blasting caps
- Reduce lead styphnate and lead azide with one material
- Loading process will reduce worker exposure to hazardous and very sensitive explosives

Progress Report

- Key Dates
  - Endorsement signed by PEO-AMMO: FY14
  - End/transition point: 2Q FY18
- Recent accomplishments/issues
  - M100 electric detonator- over 100 spot charged with DBX-1 and transfer charge as DBX-1, all successful fired

Airborne Lead Reduction IPR
M209 Primer for Hand Held Signals
(ALR 13-01)

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M209 Primer for Hand Held Signals (ALR 13-01)

Project Description

- ARDEC will develop an environmentally benign, lead-free primer for hand held signals
- Compare Pb-free M209 primer based on DBX-1 to baseline composition for sensitivity to external stimuli and pressure rise time
- Establish industry partnership and demonstrate Pb-free primer
- Transition for system/safety qualification and implement through an ECP

M42 primer

M209IW209 primer

RequirementIlmpact

- Addresses AERTA PP-12-09-02 by replacing lead, barium nitrate and antimony sulfide in the M209 primer
- Formulation and manufacturing procedure will be based on the current form fit and function that is transparent to the manufacturer and user of the M209 primer in hand-held signals.
- M209 primers use over 500 pounds per year of lead styphnate for military and over 4 tons in commercial applications

Progress Report

- Key dates
  - Endorsement signed by PEO-AMMO: 3Q FY13
  - End/transition point: Q1 FY17
- Recent accomplishments/issues
  - Established relationship with Remington
  - Procured primer cups and cases w/ anvils
  - Blended multi-grams of explosive mixes
  - Measured sensitivity (impact, friction, ESD)
  - Designed test fixtures for primer tester

Airborne Lead Reduction IPR
Lead-free Porous Silicon Primers and First Fire Mixes (CA 12-03)

August 12th, 2015

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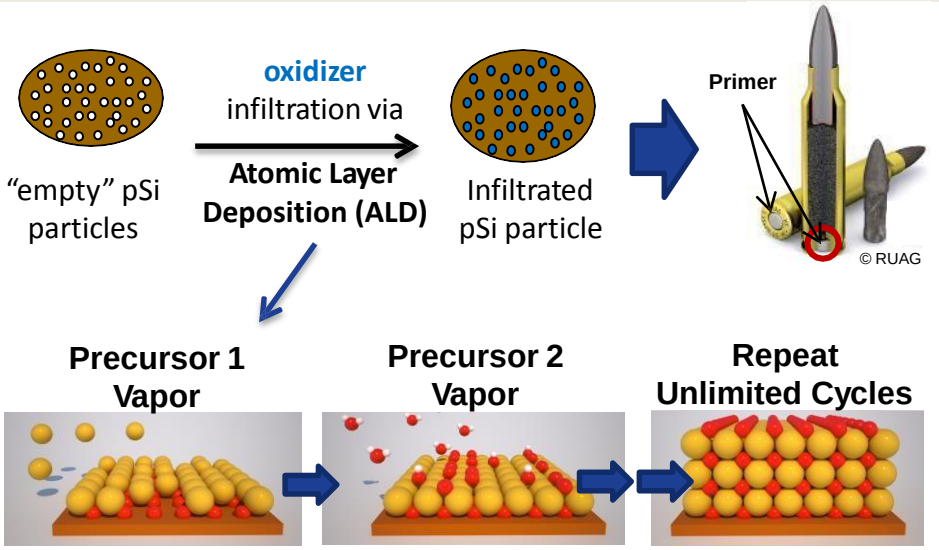
Lead-free Porous Silicon Primers and First Fire Mixes (CA 12-03)

Project Description

- ARDEC will develop highly reactive composites based on oxidizer-infiltrated porous fuel particles prepared via advanced coating technologies such as atomic layer deposition (ALD)
- Provide high performance alternatives to toxic lead-based initiating mixtures
- Applications may include common primers (e.g., M42) as well as MEMS devices



Requirement/Impact

- Directly addresses AERTA PP-12-09-02 by eliminating lead from primer formulations
- Lead-free commercial primers exist, but generally do not meet military requirements and have not been fielded by the DoD
- Toxic lead content of primers has already impacted the DoD by limiting time personnel can spend on firing ranges

Progress Report

- Key dates
  - Endorsement signed by PEO-AMMO: 3Q-FY13
  - TTA signed by PM-CCS/MAS: 3Q-FY17
  - End/transition point: 4Q-FY17
- Recent accomplishments/issues
  - Bi_2O_3/pSi coating achieved on small scale
  - ALD reactor delivered and installed