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22.4/D Specific Topic Showcase

Presented by: Capt Ryan Santa-Pinter (RW) and Dr. Darrel Hopper (711HPW)

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Munitions (RW)

AF224-D008: Continuous Flow Recrystallization of Nitramines

Presented by:

Capt Ryan Santa-Pinter

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Background

- Continuous flow synthesis has been successfully applied to energetic materials and has demonstrated advantages over traditional batch processes

- This SBIR is a complimentary continuous flow process to directly recrystallize the energetic material from a feedstock to control particle size and morphology (without the need for separate grinding steps) and to do so dynamically

Currently Used Continuous Flow Recrystallization Technologies

Recrystallization Processes Examples

- Anti-solvent
- Cooling
- Evaporation
- Precipitation

Reactors Examples

- Plug Flow Reactor (PFR)
- Continuous Multi-stage Mixed-suspension and Mixed Product Removal (MSMPR)
- Continuously Stirred Tank Reactors (CSTRs)
- Continuous oscillatory baffled crystallizer (COBC)

Why Better Particle Size Control is Needed for Explosives

- Research grade explosives require very narrow particle size distributions
  - AFRL requires a much tighter particle size control than most other organizations

- Particle size control is expensive and tedious to maintain throughout the synthesis processes
  - Therefore, a "post-processing" option is valuable to the few organizations that need better control without disrupting the normal synthesis industry

Why Better Particle Size Control is Needed for Explosives

Using Legacy Methods (Grinding)

- Labor and time intensive
- Expensive
- Safety concerns
- Solvent waste
- Requires lots of space

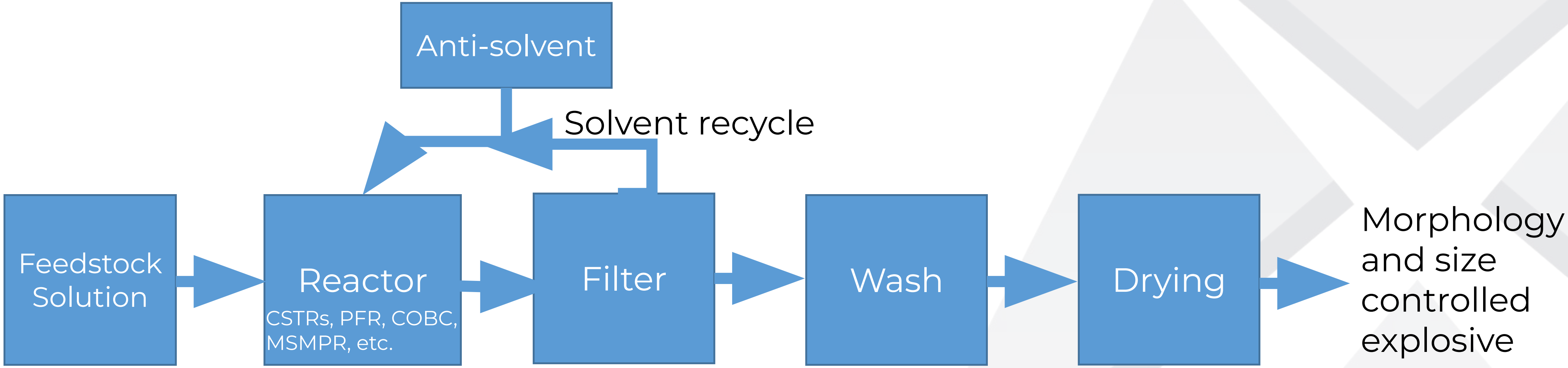
Using Continuous Flow (New)

- Saves time and money
- Reduced operating costs
- Increases overall safety
- Reduced waste
- Smaller footprint
- Highly scalable (parallelization)
- Reproducibility

Objective: Direct-to-Phase II (D2P2)

- Develop and demonstrate one or more pilot scale processes to directly recrystallize crude HMX and CL-20 using continuous flow and show the ability to control particle size (and morphology)
- Show production rate of >1g/min of different class sizes of HMX and CL-20

Generic Process Schema ex. (anti-solvent)



Air Force's Big Picture/End Goal for Topic AF224-D008

- To have this recrystallization process operating at the nitramine production facilities or at the research labs directly to support explosive research
- Relatively cheap and easy to transport around the country as requirements dictate
- Long term – Production capacity to be economical/practical enough to transition technology for the whole energetic industry to use (not just for research grade explosives)

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711 Human Performance Wing (711HPW)

AF224-0008: Digital Multisensory Augmented Reality for Special Warfare (DMARS)

Presented by: Dr. Darrel Hopper

Objective

Develop a low-latency multisensory digital helmet-mounted near-to-eye augmented reality system for use by dismounted special warriors. System must provide multispectral vision in night, day, and all-weather operations.

Description

The Air Force has a mission need for digital visual augmentation systems.

- The Digital Multisensory Augmented Reality for Special Warriors (DMARS) system sought is a dual-band visualization device primarily for night operations.

- Architectures of interest include monocular helmet-mounted with dual imaging sensors: one high-resolution reflective-band scene understanding image (in-line with eye); and one low-resolution emissive-band imager above eye (for overlay or salient extraction). Other architectures (hand-held, split component/off-body mounting, binocular) are also of interest. Both sensor bands must be usable as vision aides during day, night (including overcast starlight), and all-weather operations. Reflective bands require a light source (sun, moon, stars, artificial) and include the visible (400-700 nm, near infrared (625-930 nm) and shortwave infrared (0.9-3.5 um). Emissive (aka thermal) bands include midwave infrared (3-6 um) and longwave infrared (7-15 um). Architecture should enable expansion to include other sensory modalities (audio, tactile).

Description (continued)

- The DMARS device shall be battery powered and be capable of displaying symbology/imagery from an external source, aka end user device (EUD).
- The size, mass, mass distribution, and power consumption should be minimized sufficiently to achieve user acceptance *and avoid neck fatigue or injury.*

DMARS should be comfortable for wearing under combat conditions for days.

- No government furnished materials, equipment, data, or facilities will be provided.
- Must meet or exceed threshold levels sought for all metrics (see next chart).

Performance

Metric	Threshold	Objective	Comments
Image Resolution (px)			
Reflective Band	2,000x2,000	≥ 4,000x4,000	Vis, NIR, SWIR
Thermal Band	640x512	≥ 1280x1024	MWIR, LWIR
Field-of-View (deg. HxV)	40x40	≥ 80x80	AR 1:1 to 20:1
Frame Rate (Hz)	60 Hz	≥ 200	
Latency, objective-to-eyepiece (ms)	< 17	≤ 1	Measured
Head-born Mass Properties			
Weight (kg)	1.0	< 0.5	
Moment Arm (kg-m)	0.1	≤ 0.05	
Power (W)	6	< 2	
Volume (cc)	1000	≤ 500	
Head-Mounted Battery Time (hr)	4	≥ 8	

Phase I

- Design a DMARS system with size, weight, and power (SWaP) consistent with head-worn implementation.
- Estimate all performance metrics via laboratory experiments and analyses.
- Develop a system architecture for DMARS integration into the dismounted special warrior kit, aka Battlefield Air Operations (BAO) kit.
- Develop a System Implementation Plan for evaluating DMARS performance operating in combat environments, including producibility and supportability.

Phase II

- Fabricate and deliver a prototype DMARS at TRL 6. Provide estimated MRL.
- Evaluate prototype in laboratory and representative environments.
- Incorporate mechanical, electrical, and software interfaces required for integration into fielded Battlefield Air Operations (BAO) kits.
- Support operator testing, provide special test equipment, and refine prototype performance based on feedback.
- Deliver prototype optimized for SWaP performance, reliability, and ruggedization consistent with dismounted warfighter operations.
- Provide bill of materials.
- Create roadmap to mature technology to TRL8/MRL8.

Phase III

- Develop, fabricate, and deliver Qty(6) DMARS production-configuration units at TRL8/MRL8 with interfaces to the fielded BAO Kit.
- Establish DMARS performance specification.
- Provide bill of materials.
- By the end of Phase III, the DMARS should be capable of all-weather operation worldwide.
- Evaluate DMARS and its subsystems for other special operations applications.

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Questions?

Please type your questions in the Q&A section.

Let us know how we are doing. Please complete the survey as you leave today's meeting.