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Strategic Environmental Research and Development Program (SERDP)
SERDP Exploratory Development (SEED)

FY 2014 SEED Statement of Need

Weapons Systems and Platforms (WP) Focus Area

ENVIRONMENTALLY SUSTAINABLE BINDER SYSTEMS FOR ENERGETIC MATERIALS

The SEED Solicitation is a means for researchers to develop a proof of concept during an effort of approximately one year.

1. Objective of Proposed Work

The objective of this Statement of Need (SON) is to develop novel binder systems for energetic formulations. Novel binder systems should not include diisocyanates, phthalates, or other chemical compounds that are known or reasonably anticipated to have significant environmental, safety or occupational health (ESOH) issues. These binders should maintain or exceed the performance, mechanical properties, and processability requirements of comparable binders and should decrease sensitivity of the energetic formulation to external stimulus, including impact, friction, shock, and electrostatic discharge. Proposals can target binders commonly used in energetic systems like cast-cured secondary explosives (e.g., PBXN-106, PBXN-109, PBXN-110, AFX-757), composite rocket propellants (e.g., ammonium perchlorate in polybutadiene binder cured with diisocyanate), gun propellants (e.g., phthalates commonly used in propellant formulations to maintain mechanical properties) or pyrotechnics (e.g., polyester resins with plasticizers like Laminac). Additional consideration will be given for binder systems that will encase energetic materials to prevent migration when exposed to the environment or binders that will facilitate reuse, recovery or recycling (R3) of the energetic formulation during demilitarization.

The exploratory research effort should establish the proof-of-principle to support a follow-on multi-year development effort. The proposed work should include an initial evaluation of: (1) relevant mechanical properties, (2) binder compatibility with the current suite of commonly used energetic materials, and (3) small-scale energetic formulation performance and sensitivity testing. In addition, the proposed work should include a preliminary evaluation of the potential environmental properties and toxicity of the binder system. Proposals to reformulate binder systems that have already been tested extensively in energetic formulations such as glycidal azide polymer (GAP), cellulose acetate nitrate (CAN), and bis(dinitropropyl) acetal (BDNPA) will not be considered.

2. Background

The Department of Defense (DoD) continues to rely on decades old binder systems for energetic formulations despite the known ESOH risks associated with these materials. Binder systems are

essential to maintaining energetic, mechanical property, and Insensitive Munition (IM) performance in nearly all energetic formulations. This includes conventional ammunition, rocket and missile propellants, gun propellants, and pyrotechnics. Many cast cure systems rely on diisocyanate as a cure to cross-link polymer systems like polyurethanes or polybutadienes in concentrations up to 8%. In the defense industry, considerable quantities of diisocyanates (e.g., isophorone diisocyanate (IPDI), dimeryl diisocyanate (DDI), hexamethylene diisocyanate (HDI), and toluene diisocyanate (TDI)) are used in the manufacture of all forms of energetics, including cast cured explosives, large solid rocket motors with castable composite propellants, and pyrotechnics. Diisocyanates are widely used across a diverse range of industries for the manufacture of commercial products, even though the ESOH risks are well known. These risks include irritation of the skin, mucous membranes, eyes, and respiratory tract; contact and allergic dermatitis; hypersensitivity pneumonitis; and respiratory sensitization. Some diisocyanates may also exhibit carcinogenic or reproductive effects. Energetic formulations may also use other potentially hazardous materials including plasticizers (e.g., phthalates) or bonding agents to improve mechanical performance in energetic formulations, many of which are potentially toxic and under regulatory scrutiny. Phthalates were found to be reproductive toxins and several are already on the European Union Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) substances Authorization List, including dibutyl phthalate (DBP), a material commonly used in propellant formulations. This regulation, as well as the potential for further regulation in the U.S., may limit or even restrict material availability for use in energetic formulations. Many of the ESOH risks associated with curing agents and other binder ingredients arise during the production and load-assemble-pack of energetic formulations where workers can be exposed throughout the manufacturing process.

Binder interaction in the environment can also impact material release during training and use of energetics. Energetics left on the range through unexploded ordnance or low-order detonations can easily break apart through interaction with water, sunlight or microbial digestion. Binder systems are currently not designed to prevent migration of traditional explosives when they are left on range. Novel binder systems could stabilize or encase energetics in the environment to prevent transport or to the other extreme, even promote biodegradation under certain conditions, reducing the likelihood that these materials can transport to groundwater.

Many of the current irreversibly cured binder systems formulations cannot be recovered at the end of the lifecycle, and as such, must be destroyed in demilitarization. This often leads to increased open burn/open detonation or incineration requirements at DoD facilities. Alternative binder systems could be used to increase R3 of energetic formulations in demilitarization.

3. Cost and Duration of the Proposed Work

To meet the objectives of this SEED SON, proposals should not exceed $150,000 in total cost and approximately one year in duration. Work performed under the SEED SON should investigate innovative approaches that entail high technical risk and/or have minimal supporting data. At the conclusion of the project, sufficient data and analysis should be available to provide risk reduction and/or a proof-of-concept. SEED projects are eligible for follow-on funding if they result in a successful initial project.

4. Point of Contact

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For SEED proposal submission due dates, instructions, and additional solicitation information, visit the SERDP web site at www.serdp-estcp.org/Funding-Opportunities/SERDP-Solicitations.