

CHEMICAL AND BIOLOGICAL DEFENSE PROGRAM SBIR 04.1 Proposal Submission

General Information

In response to Congressional interest in the readiness and effectiveness of U.S. Nuclear, Biological and Chemical (NBC) warfare defenses, Title XVII of the National Defense Authorization Act for Fiscal Year 1994 (Public Law 103-160) required the Department of Defense (DoD) to consolidate management and oversight of the Chemical and Biological Defense (CBD) Program into a single office – the Deputy Assistant Secretary of Defense, Chemical and Biological Defense Programs, DATSD (CBD). The Defense Threat Reduction Agency (DTRA) draws upon the disparate chemical and biological weapons defense expertise in the Department of Defense to direct and manage efforts for proper preparation and response in the event of a chemical or biological weapons attack against U.S. forces or territory, or those of our allies. The executive agent for the Small Business Innovation Research (SBIR) portion of the CBD Program is the Army Research Office-Washington (ARO-W).

The mission of the Chemical and Biological Defense Program is to ensure that the U.S. military has the capability to operate effectively and decisively in the face of biological or chemical warfare threats at home or abroad. Numerous rapidly-changing factors continually influence the program and its management, including planning for war-fighting support to asymmetrical threats, the evolving geopolitical environment, U.S. participation in the Chemical Weapons Convention, the threat of global proliferation of chemical and biological weapons, and DoD resources available. Improved defensive capabilities are essential in order to minimize the impact of such weapons. U.S. forces require aggressive, realistic training and the finest equipment available that allows them to avoid contamination, if possible, and to protect, decontaminate and sustain operations. Further information about the DoD CBD Program (and related programs) is available at the DoD Counterproliferation and Chemical Biological Defense Homepage at Internet address <http://www.acq.osd.mil/cp/>.

The overall objective of the CBD SBIR Program is to improve the transition or transfer of innovative CBD technologies between DoD and the private sector for mutual benefit. The CBD SBIR Program targets those technology efforts that maximize a strong defensive posture in a biological or chemical environment using passive and active means as deterrents. These technologies include chemical and biological detection and identification; modeling and simulation; contamination avoidance & decontamination; protection of both individual warfighters and equipment; and medical pre-treatment, diagnostics, and treatment.

Submitting Your Phase I CBD SBIR Proposal

Your entire proposal (consisting of Proposal Cover Sheets, the full Technical Proposal, Cost Proposal, and Company Commercialization Report) must be submitted electronically through the DoD SBIR/STTR Proposal Submission Website in accordance with the DoD Program Solicitation at www.dodsbir.net/solicitation. **A hardcopy is NOT required for CBD. Hand or electronic signature on the proposal is also NOT required.** The DoD-wide SBIR Proposal Submission system (available directly at <http://www.dodsbir.net/submission>) will lead you through the preparation and submission of your proposal. Refer to section 3.5d at the program solicitation for detailed instructions on the Company Commercialization Report. You must prepare a Company Commercialization Report through the Submission site and it will be included with your electronic submission; however, it does not count against the proposal page limit. Update your commercialization information if you have not done so in the past year. Please note that improper handling of the Commercialization Report may result in the proposal being substantially delayed and that information provided may have a direct impact on the review of the proposal.

Be reminded that section 3.5.a of this solicitation states: “If your proposal is selected for award, the technical abstract and discussion of anticipated benefits will be publicly released on the Internet; therefore, do not include proprietary or classified information in these sections”. Note also that the DoD web site contains timely information on firm, award, and abstract data for all DoD SBIR Phase I and II awards archived for several years. This information can be viewed on the DoD SBIR/STTR website at <http://www.acq.osd.mil/sadbu/sbir/>.

CBD Program Proposal Guidelines

The CBD Program has enhanced its Phase I-Phase II transition process by implementing the use of a Phase I Option that may be exercised to fund interim Phase II activities while a Phase II contract is being negotiated. The maximum dollar amount for a Phase I feasibility study is \$70,000. The Phase I Option, which **must** be proposed as part of the Phase I proposal, covers activities over a period of up to three months and at a cost not to exceed \$30,000. All proposed Phase I Options must be fully costed and should describe appropriate initial Phase II activities, which would lead, in the event of a Phase II award, to the successful demonstration of a product or technology. **The CBD program will not accept Phase I proposals which exceed \$70,000 for the Phase I effort and \$30,000 for the Phase I Option effort.** Only those Phase I efforts selected for Phase II awards through the CBD SBIR Program's competitive process will be eligible to exercise the Phase I Option. To maintain the total cost for SBIR Phase I and Phase II activities at a limit of \$850,000, the total funding amount available for Phase II activities under a resulting Phase II contract will be \$750,000.

Companies submitting a Phase I proposal under this Solicitation must complete the Cost Proposal using the on-line form within a total cost of \$70,000 over a period of up to 6 months (plus up to \$30,000 for the Phase I Option over a period of up to three (3) months). Phase I and Phase I Option costs must be shown separately. In addition, all offerors will prepare a Company Commercialization Report, for each proposal submitted, which does not count toward the 25-page limitation.

Selection of Phase I proposals will be based upon scientific and technical merit, according to the evaluation procedures and criteria discussed in this solicitation document. Due to limited funding, the CBD SBIR Program reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality will be funded.

Proposals not conforming to the terms of this solicitation, and unsolicited proposals, will not be considered. Awards are subject to the availability of funding and successful completion of contract negotiations.

CBD Program Phase II Proposal Guidelines

Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which achieved success in Phase I, as determined by the Army project technical monitor measuring the results achieved against the criteria contained in section 4.3, will be invited to submit a Phase II proposal. During or at the end of the Phase I effort awardees will be invited to submit proposals for evaluation for a Phase II award. The invitation will be issued in writing by the organization responsible for the Phase I effort. Invited proposers are required to develop and submit a commercialization plan describing feasible approaches for marketing the developed technology. Fast Track participants may submit a proposal without being invited, but the application must be received not later than 120 days after the Phase I contract is signed or by the Phase II submission date indicated later, whichever date is earliest. The Fast Track technical proposal is due by the Phase II proposal submission date indicated later. Cost-sharing arrangements in support of Phase II projects and any future commercialization efforts are strongly encouraged, as are matching funds from independent third-party investors, per the SBIR Fast Track program (see section 4.5 at the front of this solicitation).. The Fast Track application form must be completed electronically by firms through the DoD SBIR/STTR Submission Site (www.dodsbir.net/submission). Commercialization plans, cost-sharing provisions, and matching funds from investors will be considered in the evaluation and selection process, and Fast Track proposals will be evaluated under the Fast Track standard discussed in section 4.3 at the front of this solicitation. Proposers are required to submit a budget for the entire 24 month Phase II period. During contract negotiation, the contracting officer may require a cost proposal for a base year and an option year, thus, proposers are advised to be mindful of this possibility. These costs must be submitted using the Cost Proposal format (accessible electronically on the DoD submission site), and may be presented side-by-side on a single Cost Proposal Sheet. The total proposed amount should be indicated on the Proposal Cover Sheet as the Proposed Cost. At the Contracting Officer's discretion, Phase II projects may be evaluated after the base year prior to extending funding for the option year.

The CBD Program is committed to minimizing the funding gap between Phase I and Phase II activities. All CBD Phase II proposals will receive expedited reviews and be eligible for interim funding (refer to top for information on the Phase I Option). Accordingly, all Phase II proposals, including Fast Track submissions, will be evaluated within a single two-tiered evaluation process and schedule. Phase II proposals will thus typically be submitted within 5 months from the scheduled DoD Phase I award date (the scheduled DoD award date for Phase I, subject to the Congressional Budget process, is 4 months from close of the DoD Solicitation). The CBD Program typically funds a cost plus fixed fee Phase II award, but may award a firm fixed price contract at the discretion of the Contracting Officer.

Key Dates

04.1 Solicitation Open	1 December 2003 – 14 January 2004
Phase I Evaluations	January - March 2004
Phase I Selections	March 2004
Phase I Awards	May 2004*

Phase II Invitations	September 2004
Phase II Proposals due	October 2004
Fast Track Applications due	September 2004
Fast Track Proposals due	October 2004

*Subject to the Congressional Budget process.

CBD SBIR PROPOSAL CHECKLIST

This is a Checklist of Requirements for your proposal. Please review the checklist carefully to ensure that your proposal meets the CBD SBIR requirements. **Failure to meet these requirements will result in your proposal not being evaluated or considered for award.**

_____ 1. The Proposal Cover Sheets along with the full Technical Proposal, Cost Proposal and Company Commercialization Report were submitted via the Internet using the DoD's SBIR/STTR Proposal Submission website at <http://www.dodsbir.net/submission>.

_____ 2. The proposal cost adheres to the CBD Program criteria specified.

_____ 3. The proposal is limited to only **ONE** solicitation topic. All required documentation within the proposal references the same topic number.

_____ 4. The Project Summary on the Proposal Cover Sheet contains no proprietary or classified information and is limited to the space provided.

_____ 5. The Technical Content of the proposal, including the Option (if applicable), includes the items identified in Section 3.4 of the solicitation.

_____ 6. The technical proposal, Proposal Cover Sheets and Cost Proposal together is 25 pages or less in length. Pages in excess of this length will not be considered for review or award.

_____ 7. The Company Commercialization Report is submitted online in accordance with Section 3.5.d. This report is required even if the company has not received any SBIR funding. (This report does not count towards the 25-page limit).

_____ 8. The proposal contains no type smaller than 11-point font size (except as legend on reduced drawings, but not tables).

CBD 04.1 Topic List

CBD04-101	Cellular Persistence and Stability (CEPAS)
CBD04-102	Detection of CW Agents at Sub-Chronic Levels
CBD04-103	CW Agents Reporting Materials for Decontamination Operations
CBD04-104	Photonic-Bandgap-Crystal (PBC) Integrated Sensors for Chemical & Biological (CB) Detection
CBD04-105	Automated Rational Design of Antibodies
CBD04-106	Macro to Micro Volume Sample Concentration and Subsequent Processing for Biodetection
CBD04-107	Differentiation of Pathogen at Strain Level
CBD04-108	Universal Sensitivity Enhancement of Foodborne Pathogen Detection Systems
CBD04-109	Decontaminating Protective Skin Cream Effective Against Chemical Warfare Agents
CBD04-110	Novel Hermetic Closure Systems For Chemical/Biological Protective Clothing and Collective Protection Shelters
CBD04-111	Passive Chemical/Biological Protection for Crew Tents
CBD04-112	SCORM-compliant Advanced Distributed Learning Software suite for Medical Response to Weapons of Mass Destruction
CBD04-113	Analysis Tools for Detection and Diagnosis of Biological Threats
CBD04-301	Adsorber or Catalyst to Remove Cyanides from Air Streams
CBD04-302	Low-Temperature Catalyst to Destroy Chemical Warfare Agents from Air Streams
CBD04-303	Capture and Destruction of Organophosphates from Air
CBD04-304	Portable Water Decontamination System
CBD04-305	Digital Opacity Method for Detection of Aerosols
CBD04-306	THz Spectrophotometer for Biological Detection
	CBD04-307 Remote Signaling Point Detector

CBD 04.1 Topic Descriptions

CBD04-101

TITLE: Cellular Persistence and Stability (CEPAS)

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: The objective of this SBIR is to develop an understanding of the persistent, alternative metabolic state of non-spore forming bacteria and to develop a detection system for it and chemical countermeasures against it.

DESCRIPTION: In an intentional release of a microbial biothreat agent, the rapid and efficient detection and identification of the infectious agent is critical in minimizing the number of infections that result. Bacteria, engineered to avoid detection by conventional techniques, would pose unique challenges. While a variety of presumptive tests are available for many organisms, the most reliable and precise test for identification of the agent is culturing the organism. However, some bacteria can enter a "viable but not culturable" state that would frustrate this critical test. Cells in this state have been demonstrated to express toxin genes, however. In established complex microbial communities, while large numbers of the group die during severe adverse conditions, some members persist, developing atypical resistance to conventional antibiotics, standard industrial treatments, and complex medical regimens. These are not spore forming organisms, such as the anthrax organism, *Bacillus anthracis*. This is a different survival phenomenon that has been explained by the presence of a subpopulation of cells, called persisters, that have assumed an alternative dormant metabolic state in which the cells are very resistant to many conventional treatments and can not be cultivated by the usual laboratory techniques. These cells are viable, however, and can, under special circumstances be induced to return to "normal" metabolism. Some researchers have speculated that certain specific compounds, called alarmones, are released by members of the bacterial group into the environment and induce some cohorts into the quiescent state. The nature of this state is not understood, nor is the complex of signals effecting initiation or release from the persistence known. However, it does represent a significant challenge in the identification and control of the microorganisms. If it were possible to frustrate this phenomenon on demand, there would be significant military and civilian implications.

The research to be developed under this SBIR would have military and civilian importance. For example, bioterrorists could engineer biothreat agents to have a sustained persistence in the viable but nonculturable state until the organisms were in the human host. Then, in response to a common cellular signal, such as a cytokine, the agent would become active and initiate the pathogenesis. Of particular concern, the organism in sustained quiescence would not be detected by the usual culturing procedures for identifying such threats. Under this SBIR an understanding of the altered metabolic state would emerge and, it would be possible to develop detection systems for the unique organisms in that condition and initiate appropriate remedial or protective actions. In addition, in easily disseminated diseases, the presence of such persisters could frustrate the usual procedures for control and treatment of the disease. If, however, mechanisms were available to detect and prevent persistence or induce emergence from the resistance form, this could be critical in reducing the spread of the disease.

There are also beneficial applications to the research for the military. For example, organisms can be engineered to degrade a variety of noxious and recalcitrant molecules, such as hazardous energetic and halogenated organic compounds, that are found in contaminated Army sites. It could be possible to engineer organisms with targeted degradative capabilities to be sustained in the persistent state for long periods of time. Then, in response to the particular agent to be degraded, the organism could be triggered to release from its dormant stage and initiate degradation of the targeted substance. It is difficult to maintain large numbers of viable, non-sporulating cells, without suitable storage or containment facilities. Often, organisms that have been engineered for special activities are more sensitive to environmental insults than their usual wild-type parents. Beneficial native or engineered organisms for environmental remediation, industrial or agricultural uses could be induced to enter the quiescent state until they are ready for applications. With the appropriate chemical triggers to be developed under this SBIR, the cells could initiate growth and process development.

PHASE I: The collaboration and integration of specialists in the fields of microbial physiology, molecular biology, and biochemistry would utilize previously identified organisms that display the viable but nonculturable phenotype to establish the reproducible factors for initiation and release from the condition. To understand the altered physiological state research would be initiated to answer questions such as: What is the phenomenon; how is it

initiated; how is it released, and what determines the length of persistence? What are the molecular components of the process?

PHASE II: Physical and nutritional conditions requisite to establishing, maintaining, and release from the altered state would be determined. Gene expression arrays and proteomic analyses would be utilized to ascertain the essential molecular components for initiating and release from the persistent state. In addition, the attendant capacity to express groups of genes under those conditions would be established. Chemical triggers for release from the altered state would be developed. These could include, but not be limited to, usual cellular and environmental components. However, the development of alternative agents for release, such as highly efficient aptamers, could be pursued. Innovative detection measures would be investigated to identify bacteria in the persistent condition. In addition, innovative mechanisms would be studied for incapacitating the persistent cells.

DUAL USE APPLICATIONS: The detection protocol would be tested and developed for field applications. The generality of the persistence phenomenon and the efficacy of the chemical releasing factors would be determined in a variety of environmental organisms, and - in collaboration with the appropriate Army laboratories - on potential biothreat agents or the appropriate surrogates. Formulations of the releasing components would be developed and tested.

REFERENCES:

Edwards C. 2000. Problems posed by natural environments for monitoring microorganisms. *Mol Biotechnol* 15: 211-23.

Fischer-LeSaux M, Hervio-Heath D, Loaec S, Colwell RR, and Pommepuy M. 2002. Detection of cytotoxin-hemolysin mRNA in nonculturable populations of environmental and clinical *Vibrio vulnificus* strains in artificial seawater. *Appl Environ Microbiol* 68:5641-6.

Gilbert P, Maira-Litran T, McBain AJ, Rickard AH, and Whyte FW. 2002. The physiology and collective recalcitrance of microbial biofilm communities. *Adv Microb Physiol* 46:202-56.

Heim S, DelMar Lleo M, Bonato B, Guzman CA, and Canepari P. 2002. The viable but nonculturable state and starvation are different stress responses of *Enterococcus faecalis*, as determined by proteome analysis. *J. Bacteriol* 184:6379-45.

Reissbrodt R, Rienaecker I, Romanova JM, Freestone PP, Haigh RD, Lyte M, Tschape H, and Williams PH. 2002. Resuscitation of *Salmonella enterica* serovar typhimurium and enterohemorrhagic *Escherichia coli* from the viable but nonculturable state by heat-stable enterobacterial autoinducer. *Appl Environ Microbiol* 68:4788-94.

Steinert M, Emody L, Amann R, and Hacker J. 1997. Resuscitation of viable but nonculturable *Legionella pneumonia* Philadelphia JR32 by *Acanthamoeba castellanii*. *Appl Environ Microbiol* 63:2047-53.

KEYWORDS: biotechnology, microbiology, bacteria, growth, culture, persistent, detection, biowarfare countermeasures

CBD04-102

TITLE: Detection of CW Agents at Sub-Chronic Levels

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Develop fluorescence-based CW detectors that have sufficient sensitivity to detect nerve and blister agents at or below the maximum airborne exposure concentration for an 8-hour workday (AEL). AELs for several agents of interest are: 0.0001 mg/m³ for Sarin (GB), 0.00003 mg/m³ for Soman (GD), 0.0001 mg/m³ for Tabun (GA), and 0.003 mg/m³ for Sulfur Mustard (HD) [1]. The detectors should be small (< 30 cubic inches), low power, and low cost. Response time at AEL concentrations should be less than one minute with an ability to provide rapid detection (< 10 sec) at concentrations 10 times the AEL levels. The sensors should only respond to chemicals that have the chemical reactivity of the CW agents that results in their extreme toxicity. They should not respond to species that are not highly toxic, including inactive compounds in the same chemical classes as the CW agents (e.g.,

insensitive to dimethyl methyl phosphonate, a non reactive and much less toxic phosphonate commonly used as a G-class nerve agent simulant).

DESCRIPTION: Fluorescence-based techniques have been demonstrated to provide extreme sensitivity. The extreme sensitivity of these fluorescent detectors will enable their use to determine that areas and facilities are safe for normal operations, to identify areas needing decontamination, and to verify the effectiveness of decontamination operations. They could provide rapid warning of hazardous levels of CW agents during military operations and to protect personnel from terrorist attacks. By requiring sensitivity to the reactivity of the CW agents, these sensors will have low false alarm rates and can be used in areas that may contain other chemical species that are much less toxic but that cause false alarms with current CW detection techniques.

PHASE I: Develop a laboratory prototype detector and demonstrate detection of Sarin, Soman, Tabun, and Sulfur Mustard at concentrations at or below ten times the AEL levels with a response time of less than one minute and at or below 100 times the AEL levels in ten seconds. Demonstrate insensitivity to interferents including nonreactive species of the same chemical class as the CW agents. For this phase, testing with reactive simulants such as diisopropyl fluoro phosphate can be used.

PHASE II: Optimize the chemical detector for improved sensitivity, selectivity, and reliability. Develop a field-ready prototype detector and demonstrate detection of Sarin, Soman, Tabun, GF, Sulfur Mustard, Nitrogen Mustards, and Lewisite at concentrations at or below AEL levels with a response time of less than one minute and at or below 10 times the AEL levels in ten seconds. This testing should be done with actual agents at an appropriate test facility. The system should have high probability of detection with low false alarms even in the presence of high concentrations of potentially interfering chemicals. At end of Phase II, system should be available for testing by DOD personnel.

DUAL-USE APPLICATIONS: Phase III work would involve development of ruggedized sensors for actual deployment. Different sensor configurations may be developed to allow for changing scenarios. Intelligence and homeland defense applications could directly benefit from having a small and ultrasensitive CW detector with high selectivity and low false alarm rates.

REFERENCES:

- 1) Catalytic buffers enable positive-response inhibition-based sensing of nerve agents, Alan J. Russell, Markus Erbelinger, Joseph J. DeFrank, Joel Kaar, Geraldine Drevon, *Biotechnology and Bioengineering*, Volume: 77, Issue: 3, Date: 5 February 2002, Pages: 352-357.
- 2) Fluorescent detection of chemical warfare agents: functional group specific ratiometric chemosensors, Shi-Wei Zhang and Timothy M. Swager, *JACS*, Volume: 125, Number: 12, Date: 2003, Pages: 3420-3421.

KEYWORDS: Chemical warfare agent, nerve agent, blister agent, sensors, fluorescence

CBD04-103

TITLE: CW Agents Reporting Materials for Decontamination Operations

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Develop fluorescence-based materials that could be applied to surfaces to sensitively and selectively identify areas containing minute quantities of chemical warfare agent contamination over large surface areas. These materials should be designed to be selective to the chemical reactivity of the CW agents that results in their extreme toxicity. They should have little or no fluorescence when no contamination is present or when the contamination is due to species that are not highly toxic. Compounds that should not generate fluorescence in these materials include a wide range of compounds that may be seen in military situations including fuels such as gasoline and diesel, solvents such as acetone, cleaning and decontamination materials such as bleach, and inactive compounds in the same chemical classes as the CW agents such as dimethyl methyl phosphonate, a non reactive and much less toxic phosphonate commonly used as a G-class nerve agent simulant.

DESCRIPTION: Fluorescence-based techniques have been demonstrated to provide extreme sensitivity that should enable detection of trace amounts of CW contamination. The extreme sensitivity of fluorescent materials will enable

their use to determine that areas and facilities are safe for normal operations, to identify specific areas needing decontamination, and to verify the effectiveness of decontamination operations. By requiring sensitivity to the reactivity of the CW agents, these sensors will have low false alarm rates in the presence of background compounds. In addition, since decontamination processes often work by converting CW agents to nonreactive species in the same chemical class that are much less toxic, this selectivity will allow these materials to selectively show remaining CW contamination without indicating contamination where an effective decontamination process has occurred.

PHASE I: Demonstrate selective detection of CW contamination on surfaces using materials that selectively form fluorescent species in the presence of CW agents such as Sarin, Soman, Tabun, and Sulfur Mustard and a probe that can detect this fluorescence from a distance of at least one foot. Demonstrate insensitivity to interferents including nonreactive species of the same chemical class as the CW agents. For this phase, testing with reactive simulants such as di-isopropyl fluoro phosphate can be used.

PHASE II: Optimize the fluorescent material and develop a field ready technique for disbursing small amounts of the material over large surface areas. Develop a field-ready detector that can detect the fluorescence at a distance of over 10 feet. Demonstrate detection of Sarin, Soman, Tabun, and Sulfur Mustard on surfaces at an appropriate test facility. The system should have high probability of detection with low false alarms even in the presence of high concentrations of potentially interfering chemicals. At end of Phase II, system should be available for testing by DOD personnel.

DUAL-USE APPLICATIONS: Phase III work would involve development of ruggedized application and detection systems for actual deployment. Intelligence and homeland defense applications could directly benefit from having an ability to remotely detect CW agents on surfaces.

REFERENCES:

- 1) Catalytic buffers enable positive-response inhibition-based sensing of nerve agents, Alan J. Russell, Markus Erbelinger, Joseph J. DeFrank, Joel Kaar, Geraldine Drevon, *Biotechnology and Bioengineering*, Volume: 77, Issue: 3, Date: 5 February 2002, Pages: 352-357.
- 2) Fluorescent detection of chemical warfare agents: functional group specific ratiometric chemosensors, Shi-Wei Zhang and Timothy M. Swager, *JACS*, Volume: 125, Number: 12, Date: 2003, Pages: 3420-3421.

KEYWORDS: Chemical warfare agent, nerve agent, blister agent, fluorescence, decontamination, forensics

CBD04-104

TITLE: Photonic-Bandgap-Crystal (PBC) Integrated Sensors for Chemical & Biological (CB) Detection

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: To design, build and test a new type of chemical and/or biological sensor that utilizes photonic bandgap crystals (PBCs) for integration of state-of-the-art sources and detectors to achieve enhanced sensitivity and performance at terahertz frequencies. The envisioned system should be developed such that it is deployable (e.g., compact, cost effective, room temperature operation, etc.) as a portable gas and/or biosample analyzer for military battlefield applications. The development work should emphasize; sources with higher output power and conversion efficiency, more sensitive detector performance, and the most functionality afforded by PBC integration techniques.

DESCRIPTION: During the last few years, new research programs have emerged within the U.S. Army and the Department of Defense (DoD) that focused on advancing the state-of-the-art in terahertz (THz) frequency electronic technology and on investigating novel applications of THz-frequency sensing [1-3]. These applications include the use of fundamental interactions of THz radiation at the molecular level for sensing and characterizing chemical and biological (CB) agents and to detect weapons and explosives. However, serious technical challenges remain that prevent the realization of a robust THz technology that can be used effectively in battlefield environments to detect and identify threat agents. Major bottlenecks for the successful implementation of THz-frequency sensors include; source output power, detector sensitivity, and component integration for effective and efficient system functionality. These problems presently limit the effectiveness of THz spectroscopic techniques for both the point- and remote-

detection of CB agents. However, recent advances in the areas of electronics and photonics suggest that there may be new solutions for these problems. For example, recent research suggests that parametric processes in new types of nonlinear optical materials (e.g., GaSe, ZnGeP₂ and GaP [4]) may be used to achieve higher source powers. Also, recent investigations suggest that quantum-dot and quantum-barrier devices may be engineered into high-sensitivity THz-frequency detectors at room temperature [5,6]. Finally, photonic bandgap crystals (PBCs) have already shown promise as effective methods for controlling/manipulating wave-propagation within the optical and microwave regimes [7], and extensions to the THz frequencies look very feasible [8]. The proposed effort would seek to combine these state-of-the-art technology components towards an integrated CB sensor demonstration with enhanced levels of sensitivity and functional discrimination. Finally, the system should be developed such that it is amenable to battlefield deployment type scenarios.

PHASE I: Conduct a comprehensive analysis and design phase that assesses the capability of nonlinear parametric sources, quantum-based detectors and photonic-bandgap-crystal (PBC) based integration components. Establish a basic system design that lends itself to CB spectroscopic sensor operation (i.e., for either point and/or remote sensing) within the terahertz (THz) frequency band and it should be capable of operating at enhanced levels of sensitivity and functionality. The system design should be specified such that it will be compact, portable and suitable for battlefield deployment.

PHASE II: Develop and demonstrate a prototype THz-frequency spectrometer for the point- and/or remote-detection of chemical and/or biological agents. The system demonstration should assess available source power, frequency bandwidth, detector sensitivity, and overall reliability. The system should be applied towards the spectroscopic detection and/or analysis of a realistic threat agent, or set of threat agents, and overall performance should be documented in accordance with conventional sensor standards. The prototype system should also be assessed for suitability to realistic battlefield deployment scenarios. It is expected that this phase of the work will include contributions from individuals experienced with conventional methods for testing and characterizing threat agents and that the new prototype system will be assessed within this context.

DUAL USE COMMERCIALIZATION: The technologies developed under this topic will provide a foundation for a new and advanced class of THz-frequency sensor components. These components will enable enhanced spectroscopic systems useful to scenarios for point/remote CB sensing. These systems will also have relevance for application to; airport screening of explosives, detection of chemical laboratories, medical diagnostics, monitoring of bio-contaminants in food processing plants and as a laboratory tool for the microscopic interrogation of biological characteristics and chemical function. This spectroscopic technique also has potential towards the characterization of other materials of interest such as semiconductor materials.

REFERENCES:

1. D. Woolard, "Terahertz Electronics Research for Defense: Novel Technology and Science," in the proceedings to the 2000 Space THz Conference, U. of Michigan (2000).
2. F.C. De Lucia, "THz Spectroscopy – Techniques and Applications," 2002 IEEE MTT-S Symposium Digest, Seattle, WA June 2002.
3. D. Woolard, et. al., "Terahertz Electronics for Chemical and Biological Warfare Agent Detection," in the proceedings to the 1999 IMS, June 13-19, Anaheim, CA, pp. 668-672 (1999).
4. W. Shi, Y. J. Ding et. al., Appl. Phys. Lett. 80 3889 (2002); W. Shi, Y. J. Ding, et. al. Opt. Lett. 27 1454 (2002).
5. S. J. Allen, et. al., "Terahertz Dynamics in Quantum Structures: Towards a Fundamental Terahertz Oscillator," in Terahertz Sources and Systems: Proceedings of the NATO Advanced Research Workshop pp. 3-14 (Kluwer Academic Press, Dordrecht, 2001).
6. P. Boucaud, et. al., Phys. Stat. Solidi B 224 pp. 443-446 (2001); P. Boucaud, et. al., Appl. Phys. Lett. 77 pp. 4356-4358 (2000).
7. S. Noda, et. al., Science 289 604 (2000), A. Blanco, et. al., Nature 405 437 (2000).
8. H. Han, et. al., Appl. Phys. Lett. 80 2634 (2002).

KEYWORDS: chemical and biological sensors, photonic bandgap crystals, nonlinear optical materials, quantum-based detectors, terahertz frequency sensing

TECHNOLOGY AREAS: Chemical/Bio Defense

ACQUISITION PROGRAM: Critical Reagents Program (JPEO-BDS)

OBJECTIVE: A specific goal of this topic is to move antibody development beyond current limitations in diversity creation and antibody construction. The resulting technology will enable a rapid, directed, hypothesis driven method for antibody design.

DESCRIPTION: Antibodies are used as the recognition elements of various biodetection platforms, as well as for medical diagnostics and therapeutics. All of these applications require that the antibody be very specific for the target antigen of interest. In the case of biodetection, for example, one would want an anti-anthrax antibody to be very specific for the pathogenic strain while ignoring other closely related strains. Similarly, medical applications require great specificity, whether this be for diagnosing a disease state or targeting a therapeutic to a cancer cell[1]. In addition to specificity, most applications require a high degree of affinity for the target antigen in order to maximize sensitivity of the detection device.

At present, antibody development begins with system based on natural genetics. Diversity creation is achieved by any of the following approaches: massive, site-directed mutagenesis, which is inefficient, time-consuming and expensive; semi-random mutagenesis (e.g., gene shuffling), which is non-directed and bound by natural genetics; and random mutagenesis, which is non-directed, results in extremely large libraries which are difficult to manipulate and assay, and provides little insight into subsequent antibody design and improvements[2].

PHASE I: The offeror shall propose an approach to explore antibody binding pocket chemistries and to make rational and targeted modifications. The integration of bioinformatics systems into this process is necessary for a hypothesis-driven approach and should be described.

PHASE II: Based on specific hypotheses regarding the effects of making targeted amino acid changes within the complementary determining regions (CDR) of selected antibodies, the offeror should generate structured libraries where directed mutations are readily linked to specific mutation in each CDR and combination of CDRs. Analysis of results should be performed with an interfaced bioinformatics system, and combining these elements should yield an optimized, automated system for high throughput analysis. The technology platform must be demonstrated against several high priority targets. Success will be measured by the optimization of antibody products and the demonstration of the system's utility to rapidly generate critical reagents against a wide range of threat agents.

DUAL USE APPLICATIONS: The ability to rapidly identify and optimize antibodies, as well as to tailor their characteristics in a rationally directed manner will have enormous dual use applications, primarily in medical diagnostics and therapeutics. The use of monoclonal antibodies in cancer therapy, for example, would benefit greatly. It will also facilitate the development of commercial/export variant antibodies for use by Homeland Defense and NATO allies.

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KEYWORDS: Antibody, Critical Reagents, Biodetection, Diagnostics, Rational Design, Bioinformatics

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: The objective of this topic is to design and demonstrate a rapid, microfluidic, chip based, and automated process that takes a sample in a volume of up to 20 milliliters, and concentrates it to a final volume of 100 microliters. The concentrated sample will then be rapidly and automatically prepared for use in immunological or nucleic acid assay systems.

DESCRIPTION:

a. The proposed work seeks to improve the detectability of bioagents at various macro sized sample volumes (up to 20 milliliters) and concentrate the solution down to 100 microliters for analysis by current and developmental immunological and DNA/RNA sensor systems. This is especially true for dilute samples because in such a form, a bioagent may not be able to be detected, whereas in a concentrated form, it can. The low final volumes lend themselves to chip based sample preparation and processing. Example sample volumes range from one to twenty microliters for nucleic acid analysis, and from twenty-five to one hundred microliters for immunoassays.

b. Once concentrated, the proposed work seeks to prepare and process the sample for immunological or nucleic acid analysis. The samples that need concentrated are bacteria, viruses, and protein toxins. Typical collection methods for the bioagents include surface, water, soil, and aerosol sampling, entailing a variety of matrix types. For this topic, the only sample matrix cleanup requirements are to purify genomic DNA and RNA from the bacterial or viral debris for nucleic acid analysis, and to separate and purify target antigens from mixtures containing other bacteria, viruses, or proteins.

c. Because the required end volumes are small, this topic calls for a microfluidic, chip based approach for sample processing and if possible for the concentration as well. Essentially, the work calls for the design and demonstration of a macro to micro interface to provide analysis material in a suitable volume for analysis in a concentrated form. All sample preparation and processing will take place on the chip.

PHASE I: This part of the work effort will concern itself with demonstrating proof-of-principle of the contractor's approach. The primary goal is to demonstrate a rapid (20 minutes or less) method of sample concentration from a 20 milliliter volume down to 100 microliters with starting sample concentrations of 10,000, 1,000, 100, 10, and 1 colony forming unit per milliliter for bacteria; 100,000, 10,000, 1,000, and 100 plaque forming units per milliliter; and 100, 50, 10, 1, and 0.1 nanograms per milliliter for proteins. Biosample concentration and processing will be demonstrated for immunological or nucleic acid analysis using three separate solutions: one bacterial, one viral, and one protein at the starting concentrations above. An automated system is not required for Phase I. Proof-of-principle will also be demonstrated, as well, for chip based sample processing for either immunological and nucleic acid analysis. The various functions do not have to be integrated into a unified process for Phase I but may be demonstrated individually. A few methods of sample concentration and processing that have been extensively studied (but in general, not applied to this application) are: dielectrophoresis, field flow fractionation, acoustic radiation pressure, magnetic beads, ultrasonication, electrophoresis, chromatography, affinity binding, and cavitation. Many others exist as well and are published in the open literature. All are open to incorporation into the topic.

PHASE II: In Phase II, the various sample concentration and processing steps will be further matured and integrated. A final breadboard system will be fabricated for concentration of any type of sample combined with target preparation for either immunological or nucleic acid analysis. Target bacteria, viruses, and proteins will be extracted from mixtures by first using an additional protein followed by a bacteria, both in excess. A successful Phase II will be a demonstration of the breadboard for all three types of bioagents.

DUAL USE APPLICATIONS: Although the topic is oriented towards environmental analysis, it also lends itself to medical applications, such as for the concentration and extraction of rare or mutant cell types and proteins. It could also be useful for food analysis and covert operations. Since the real commercialization potential lies in the non-DoD arenas, a Phase III will focus on development of an advanced prototype for a particular application.

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4. Macounova K., Cabera C., Yager P., "Concentration and Separation of Proteins in Microfluidic Channels on the Basis of Transverse IEF", *Analytical Chemistry*, 73(7), 1627-1633, 2001
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KEYWORDS: microfluidics, microchip, dielectrophoresis, lysis, field flow fractionation, acoustic radiation pressure, sample concentration, sedimentation, magnetic beads, interface, electrophoresis, chromatography, ultrasonication, cavitation

CBD04-107

TITLE: Differentiation of Pathogen at Strain Level

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: To develop novel technologies that will differentiate two different strains of bacillus Anthracis and Vibrio Cholerae strains 0139 vs El Tor at genetic level.

DESCRIPTION: Individual isolates of the pathogens indicated above need to be characterized at the strain level. The anthrax bacteria mailed in the US attacks in fall of 2001 were so closely related to other previously known anthrax isolates that investigators were not able to differentiate them apart based on their DNA fingerprint. Complete sequencing of the entire genome of two isolates revealed four single nucleotide polymorphisms that will serve as new genomic markers to be used to differentiate these two isolates from each other.

The ability to detect and identify a threat agent using its DNA/RNA sequences requires a broad knowledge of the sequences being used for detection. This requirement stems from the fact that there is often heterogeneity in sequence information among individuals in a population, and between populations of a particular species. Therefore, to positively ID a threat agent with a single assay, it is necessary to base the assay upon sequences that are conserved among all members of a species, and that occur in no other species. It is time consuming and expensive to sequence the entire genome of a pathogen and therefore technologies are needed to differentiate pathogen genomes quickly containing only few differences at the sequence level.

PHASE I: Identify and test innovative techniques like temperature gradient gel electrophoresis (TGGE) or single stranded conformational polymorphism (SSCP) to identify and differentiate multiple genomes at the strain level (1,2). Assess the feasibility of employing these techniques to identify the difference at strain level in these genomes. The formulations should be based upon the differences at genetic level.

PHASE II: Improve, develop, and validate these technologies to differentiate multiple genomes. Integration with government or commercial software packages like supergene software, which assists DNA marker analysis via graphical display and databases, is highly recommended to demonstrate and validate the performance of these

technologies. Demonstration must show that these technologies will be robust enough to differentiate differences of up to 3-4 nucleotides and fast enough to achieve the differentiation of genomes within 24 to 48 hours with a lab device.

PHASE III: In addition to military application to protect troops against bio-terrorism attacks abroad, the novel technologies will be used for diagnostics in patients with infections from similar pathogens. These technologies will have potential commercial applications in health and defense industries.

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2. Menezes, J. S., Franklin D. A., Seki, H., Rumjanek, F. D. 2003. Single-strand conformation polymorphism of hyper-variable regions HV1 and HV2 of human mitochondrial DNA: detection by silver staining. *Forensic Sci, Int.*, 133, 242-245.

KEYWORDS: pathogen, toxin, bio-terrorism, novel technologies, sequence

CBD04-108

TITLE: Universal Sensitivity Enhancement of Foodborne Pathogen Detection Systems

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: To develop an automated field portable foodborne viral and bacterial pathogen concentration device that will prepare, in a closed cartridge based system, large volume food samples for subsequent testing with existing PCR and biosensor platforms.

DESCRIPTION: Foodstuffs procured from native populations in theatre may harbor endemic pathogens or covertly introduced biological threat agents. Rapid detection methods based on PCR or biosensors have been effectively developed into fieldable and user-friendly devices (1). However, use of these devices during field inspections of foodstuffs is limited due to the complexity of existing sample preparation procedures. Foodborne pathogen concentration processes that require minimal hands-on interaction and training will best enhance the detection sensitivity of PCR or biosensor systems.

The primary challenge for rapid fieldable and foodborne pathogen testing is the difficulty in quantitatively extracting analyte from macerated samples. Food matrix solubilization and phase separation protocols are complicated by the broad spectrum of carbohydrates, protein, lipid, and nucleic acid comprising the fibrous and sometimes inhibitory samples. An automated, closed cartridge-based system that will concentrate bacteria and viruses from a broad spectrum of foodstuffs should extrude a sample appropriate for insertion into existing biosensor detection systems and nucleic acid extraction devices (2).

PHASE I: Identify a robust, fieldable, battery operated foodborne pathogen concentration system that does not require refrigeration or extensive training. Samples produced by the system will be compatible with existing biosensor detection and nucleic acid extraction devices. The technology should not rely on specific antibody-based capture but instead contribute a broad spectrum pathogen concentration capability.

PHASE II: Test the PCR and biosensor detection sensitivity enhancement of the technology using seeded ground beef (25 g) and vegetable washings (1 L) as sample inputs. The device should achieve a 10³ X concentration of 10 CFU of a gram positive and gram-negative bacterial model and 50 pfu of an enteric virus model seeded into these sample matrices. Comparison to existing gold standard culture based pathogen enrichment methods will be structured based on existing NCCLS specifications for foodborne pathogens.

PHASE III: Validation guidelines for ground beef and vegetable wash testing with PCR and biosensor methods will be developed and conducted according to current NCCLS specifications. The civilian food industry would benefit from validated point of inspection testing and sensitivity enhancement of these detection systems.

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2. Foodborne pathogens, Hazards, risk analysis and control. Editors: Clive de W. Blackburn and Peter J. McClure. CRC Press, Woodland Publishing Ltd., Cambridge, England, 2002.

KEYWORDS: Foodbourne, Pathogen, Detection, PCR, Bio-terrorism

CBD04-109 TITLE: Decontaminating Protective Skin Cream Effective Against Chemical Warfare Agents

TECHNOLOGY AREAS: Chemical/Bio Defense, Biomedical

OBJECTIVE: The development of a pre-exposure decontaminating protective skin cream that that will protect exposed skin from the toxic effects of chemical warfare agents.

DESCRIPTION: Skin Exposure Reduction Paste Against Chemical Warfare Agents (SERPACWA) is a product developed by the Army as a physical barrier against all classes of CWA. It is approved by the FDA with fielding scheduled for 2003. A second generation SERPACWA known as active topical skin protectant is in development. This product increases the efficacy of SERPACWA by adding active moieties that neutralize any chemical warfare agents that penetrate into the base cream. It will not neutralize chemical warfare agents that remain on the surface of the barrier coating. The pre-exposure decontaminating skin cream will be a new product that will neutralize chemical warfare agents on contact. The requirement is to develop a product that when applied to the skin, prior to exposure, will dissolve a CWA challenge and rapidly neutralize the agent into less toxic products before the agent can reach the skin surface. It will replace SERPACWA and active topical skin protectant. The material should have reasonable cost, be safe and nonirritating, chemically stable, and demonstrate rapid kinetics. The contractor will furnish all need materials and develop an innovative solution to the problem of protecting the skin from chemical warfare agents.

PHASE I: Proof-of-concept that formulations can be developed that will meet the objective. Contractors should use their innovation and creativity to develop an effective strategy to formulate a pre-exposure decontaminating protective skin cream that will neutralize chemical warfare agent before it reaches the skin. Success will be preparing at least one formulation that will protect exposed skin from the toxic effects of chemical warfare agent simulants by neutralizing the agent simulant challenge into less toxic products. Reactivity, stability, cost, and skin toxicity must be considered.

PHASE II: Optimization of reactants and formulations. Demonstrate efficacy against simulants and chemical warfare agents. Evaluation of chemical warfare agents will be conducted.

PHASE III DUAL USE APPLICATIONS: This product could be used in a broad range of military and civilian applications. For example, industrial workers exposed to materials similar to CWAs including pesticides, herbicides, and other chemicals that represent health hazards. In addition, this product would greatly improve the protection of civilian first responders to a chemical warfare agent terrorist attack.

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KEYWORDS: Catalysts, Chemical Warfare Agents, decontamination, barrier skin creams

CBD04-110 TITLE: Novel Hermetic Closure Systems For Chemical/Biological Protective Clothing and Collective Protection Shelters

TECHNOLOGY AREAS: Chemical/Bio Defense

ACQUISITION PROGRAM: PM-SEQ CB Protective Shelters and Decontamination

OBJECTIVE: The overall goal is to develop effective closure interfaces and systems for improving the performance of Chemical Biological (CB) protective clothing and Collective Protection (COLPRO) shelters. A successful outcome of this program will result in enhanced protective performance of CB protective clothing for the individual soldier and for COLPRO shelters. Current carbon based and future selectively permeable membrane (SPM) based CB protective clothing and low temperature processible fluoropolymer shelters with improved reliable closures and interfaces will have increased protection factors over the JSLIST overgarment (MIL-DTL-32102, 3 Apr 02), and the CB Protective Shelter (CBPS) [Mil-Spec LP/P DES 1-94a, 20 Jun 1995] respectively.

Comfortable CB protective gloves, booties, self concealing, and softer closure interface will allow the soldier to perform tasks during combat missions and operations in contaminated environment with high level of confidence in regard to CB protection. Flexible CB protective closure interfaces for protective clothing will have dual-use as effective containment interfaces for COLPRO shelter airlocks, interconnection between shelters (complexing), and shelter equipment's connectors such as CB agent filtration/air-conditioning systems. These closures will increase the ease of don and doff gloves, masks, hoods, and protective clothing systems, as well as ease entry and exit into and out of COLPRO shelters and contain air used to overpressure COLPRO shelters. These novel hermetic closures and interface will be designed with consideration taken for the strenuous mechanical demands/requirements of COLPRO shelters. The Warfighter will have CB protective clothing with effective closures and interface such as comfortable CB gloves with improved dexterity and tactility, detachable booties and gloves to account for various size tariffs, and self concealing, softer closure interface, and less-friction closures with increased protection factor to meet a wide range of user needs in different environment. COLPRO shelter entries and equipment hook up to tents will be secured from environmental contamination and contain the leakage of air when overpressuring the COLPRO shelter. These improvements and new developments will provide the soldier a high level of CB protection during their combat missions, emergency medical service for soldiers in COLPRO shelters, and during rest and relief cycles in a CB contaminated environment.

DESCRIPTION: Improvements in closures and interface are needed to provide added aerosol and liquid CB agent protection to the JSLIST overgarment and to the COLPRO shelters. Although CB clothing and COLPRO shelters are different, the closures and interface could be used for both areas with different sizes of the closures/interface. For this reason, NSC/Individual Protection Directorate, Collective Protection Directorate, and the Navy Clothing & Textile Research Facility propose to jointly address the needs for improved closures and interface for clothing as well as shelters. This effort is seeking to develop CB resistant, lightweight, flexible, decontaminable and affordable closures and interface. Affordable closures/interfaces will be investigated which are UV resistant, flame retardant, durable, have a high flex fatigue resistance, and which are not labor intensive to produce.

PHASE I: (1) Investigate commercially available and novel closures investigated^{1,2,3,4,5} for potential use in CB protective clothing and COLPRO shelters which are based on activated carbon containing materials, perm-selective barrier materials^{6,7} and impermeable materials (elastomers and thermoplastics)⁸ (2) Identify materials that have physical properties compatible to the strenuous activities and adverse environmental conditions that the wearer and shelter interface would experience. (3) Perform tests to assess the effectiveness of current closures for their ability to prevent vapor, aerosol, and liquid penetrations. (4) Identify factors that would affect the operations of these CB protective closures and interfaces to better develop effective closures. (5) Design and develop new closure systems

and interfaces. (6) Produce and test prototype closures and interface to assess their effectiveness, users' acceptance, and their durability. (7) Based on tasks 1-6, produce and demonstrate the effectiveness of prototype closures and interfaces for clothing systems and COLPRO shelters.

PHASE II: Best designs of the closures and interfaces down-selected in Phase I for tents and CB protective clothing, will be selected and optimized. Optimized prototype designs will be assembled onto carbon-based and SPM-based fabric systems and CB protective tent material for further system testing such as the use of Man-In-Simulant system vapor testing, Rain-court testing, immersion testing, and human factor testing. These shelter and fabric systems with integrated closures and interfaces will be tested in different environmental conditions to assess ease of clothing integration, durability, ease of use, and wear issues that may not be apparent in Phase I. The effectiveness of these closures and interface will be quantified with special user tests in limited field experiments. The novel closures and interfaces will be produced and expanded to include the requirements for both collective and individual chemical/biological/environmental protection. Novel, low-cost manufacturing techniques to fabricate these closures/interfaces will also be investigated.

PHASE III: Low-cost commercial process to produce these novel closures and interfaces will be set up. Field-testing effort will be conducted. The proposed material will result in low-cost, flexible, user friendly, and effective closures and interfaces for the Joint Service community such as the Joint Service Explosive Ordnance Disposal (EOD), Technical Escort Units (TEU), Chemical Activities, Defense Preparedness, Joint Transportable Collective Protection System (JTCOPS)-Block 2, and Future Medical Shelter Systems, and other individual protective equipment/shelters. This area will also introduce closures and interfaces for use in civilian and military clothing and shelter markets involving civilian emergency responses to chemical incidents (terrorist, or accidental toxic chemical emissions).

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1. Truong, Q. and Heath, C, "Joint Service CB Protective Closures and Interface," NSC-NC&TRF, 98-99. Found at www.natick.army.mil/soldier/JOCOTAS/SBIRreferences.
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3. Fiber Society Fall Technical Meeting Proceedings, www.natick.army.mil/soldier/fiber/index.htm. Specific poster papers include: "Elastomeric Selectively Permeable Membranes for Chemical and Biological Protective Clothing", Quoc Trong, Shantha Sarangapani, US Army Soldier Systems Command, Natick Soldier Center (NSC), Natick Massachusetts, Innovative Chemical and Environmental Technologies, Inc. (ICET), Norwood, Massachusetts
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KEYWORDS: Closures, Interfaces, Seals, Zippers, Collective Protection, Individual Protection

CBD04-111

TITLE: Passive Chemical/Biological Protection for Crew Tents

TECHNOLOGY AREAS: Chemical/Bio Defense

ACQUISITION PROGRAM: 21st Century Fabric Structures Group

OBJECTIVE: Provide chemical/biological (CB) agent protection to small crew tents through the use of a “passive” carbon-based or selectively permeable liner or panel system that does not require overpressure. This system would enable vehicle crews and/or special forces personnel the ability to sleep/rest out of individual protective gear while still being protected in the event of a chemical/biological agent attack.

DESCRIPTION: Current CB protection for tents is obtained by using an impermeable, CB resistant fabric that is over pressured to create a protective, toxic-free “bubble”. To create this overpressure, a carbon filter/blower system is required which of course requires electricity provided by a generator. The logistics burden and cost of an overpressure system in terms of weight, cube and power limits the availability of CB protection to large shelter applications such as medical and command/control. Small lightweight tents used by vehicle crews, far-forward and Special Forces units have no means of providing chemical/biological protection. Individual protection currently uses breathable carbon-based materials and is exploring selectively permeable membranes (SPM) for the future. This project will investigate the feasibility of incorporating existing and/or new selectively permeable materials into small crew tents for 1-5 soldiers that protect the occupants from chemical/biological warfare agents while allowing the exchange of oxygen, carbon dioxide, water vapor, and heat for a habitable, protected interior environment without the use of auxiliary power.

PHASE I: The feasibility of incorporating passive chem/bio protective breathable panels into small crew-size tents will be investigated. Specifications for the materials will be established. Potential existing or new materials will be identified and all of their necessary characteristics for battlefield survivability determined such as carbon dioxide removal and oxygen supply efficiency, toxic chemical/dangerous microorganism filtration efficiency, durability, cost, flame resistance, etc. through laboratory testing. Concepts for incorporation into a crew-size tent will be generated. The outcome of phase I should at least be the downselection of the most promising CB protective material configuration, and tent design(s).

PHASE II: Refine the most promising material(s) and configuration from phase I and fabricate full-scale prototypes for testing. Integrate novel closure systems from other on-going joint service developmental efforts (see references) such as the use of waterproof/CB agent-proof zippers and interface. Conduct all necessary testing to prove out the technical performance of the resulting prototype(s). Identify optimal seam-sealing technologies for SPM based crew tents. Refine any deficiencies identified during testing and optimize for the final design.

DUAL-USE APPLICATIONS: This technology could be incorporated into homeland defense applications for rapidly creating “safe-rooms” in both private and public facilities in the event of terrorist chem/bio attacks against the general public. Joint collaboration with homeland defense agencies and the National Protection Center at Natick is expected for potential civilian uses.

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2. Fiber Society Fall Technical Meeting Proceedings, www.natick.army.mil/soldier/fiber/index.htm. Specific poster papers include: “Elastomeric Selectively Permeable Membranes for Chemical and Biological Protective Clothing”, Quoc Trong, Shantha Sarangapani, US Army Soldier Systems Command, Natick Soldier Center (NSC), Natick Massachusetts, Innovative Chemical and Environmental Technologies, Inc. (ICET), Norwood, Massachusetts

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KEYWORDS: collective protection, chemical biological warfare, selectively-permeable membranes, textiles, fabrics, tents, shelters, closures

CBD04-112 TITLE: SCORM-compliant Advanced Distributed Learning Software suite for Medical Response to Weapons of Mass Destruction

TECHNOLOGY AREAS: Chemical/Bio Defense

ACQUISITION PROGRAM: DOD(HA) PEO IM/IT

OBJECTIVE: Design and demonstrate a SCORM-compliant Advanced Distributed Learning software suite that will allow for the creation of a distance-learning curriculum focused upon training first responders to respond to events involving use of Weapons of Mass Destruction (WMD). This capability will support both forward deployed military forces and civilian personnel engaged in homeland security consequence management.

DESCRIPTION: Emerging weapons technologies have blurred the lines between conventional nation state-directed warfare and asymmetric strategies and tactics that can be employed by individuals and small groups against U.S. interests. Strategies and ordinance once thought to be the domain of the war fighter are now available to anyone intent upon using violence to advance their cause. In order to prepare for and respond to these new threats a modular, scalable network must be developed that can simultaneously provide Just-In-Time (JIT-also referred to as embedded training), customizable WMD training as well as distributed training for diverse populations of health care providers located throughout the country. The target populations will range from first responders such as EMTs and paramedics, to emergency physicians, to nurse practitioners and family practice practitioners in the primary care setting to hospital administrators and local emergency response managers. There is no one-size-fits-all solution to the question of how to train and what to train for. Therefore, the system should employ a "virtual instructor" utilizing artificial intelligence technology that can customize and adapt the system's response to learner input through identifying learner strengths and weaknesses. The Department of Defense has issued a directive that all training be SCORM (Sharable Content Object Reference Model) compliant. This initiative came about as a result of a U.S. Government directive recognizing the need for improved education and training in the 21st century. These needs applied to the community at large, but there was a particular strand addressing the military. In November of 1997, the Department of Defense and the White House Office of Science and Technology Policy launched the Advanced Distributed Learning initiative (<http://www.adlnet.org/>), which resulted in development of the Sharable Content Object Reference Model (SCORM). The SCORM defines a Web-based learning "Content Aggregation Model" and "Run-time Environment" for learning objects. At its simplest, it is a model that references a set of

interrelated technical specifications and guidelines designed to meet the DoD's high-level requirements for Web-based learning content.

In support of this directive, distributed learning management software must be developed that integrates and complies with the SCORM standards. Training courses developed using this standard can be transferred onto any system anytime, anywhere and operate compatibly with few system modifications in order to support distributed learning processes. The courses should be able to integrate with existing or planned simulation/gaming training tools as well as with surveillance and incident command/control solutions such as CATS (Consequences Assessment Tool Set) and HPAC (Hazard Prediction and Assessment Capability) The data collected by this system must be accessible in a way that supports the creation of multiple curricula based upon the unique training requirements of each learner. Chemical, biological, radiological, nuclear and high-explosive weapons (CBRNE) are an increasing threat to the country and its foreign interests, as such, a SCORM compliant advanced distributed learning software suite that supports access to multiple data sources such as the Uniformed Services University of the Health Sciences (USUHS), US Army Medical Research Institute for Chemical Defense (USAMRICD), US Army Medical Research Institute for Infectious Disease (USAMRIID), National Institutes of Health (NIH), Armed Forces Radiobiology Research Institute, Department of Veterans Affairs (DVA), Department of Homeland Security (DHS) and other governmental agencies and private/educational institutions must be developed. The software suite will be employed against a group of geographically distributed data sources comprising text, still images, video, graphs, models and simulations. A distributed learning curriculum will be developed that instructs first responders and military medical personnel on threat identification, appropriate response, and management of casualties and the surrounding environment (including caring for the non-injured, evacuation, infrastructure, security, civil-military cooperation, crime scene management, media, etc) after a CBRNE event. Two to four specific agents will be chosen from biologic and/or chemical threats for the purposes of this curriculum development. The capability currently exists to make SCORM-compliant multimodal e-learning solutions; the "next step" would extend to integrating the existing capabilities with the tools that responders will be using when responding to a CBRNE event such as surveillance and command/control applications and clinical information systems. The systems should also begin to incorporate artificial intelligence in the form of virtual instructors and integrate with modeling and simulation applications that address various salient issues such as patient management and incident command. These elements can then be assembled with data from other sources to create a lesson plan(s). The lesson plan(s) will then be used to train first responders and military medical personnel, and the effectiveness of the training as well as the performance of the software will be measured and continually improved.

PHASE I: Develop basic SCORM-Compliant software design that includes a plan and specifications for the development of the Phase II software package (below). Demonstrate SCORM compliance capability of existing multi-modal e-learning solutions.

PHASE II: Develop and demonstrate a prototype software package that accesses multiple data types utilizing at least one medical simulation application or Artificial Intelligence-based virtual instructor or integration with multiple data sources within the CATS/HPAC or related surveillance/command & control applications (if available) Two to four specific agents will be chosen (in consultation with the government project manager) from biologic and/or chemical threats to create a SCORM-compliant advanced distributed learning curriculum for the selected agents. Conduct testing of the software and the impact of the software on the over-all quality of the curriculum (e.g. validity).

PHASE III: This system could be used in a broad range of military and civilian advanced distributed learning applications where immediate access to scalable medical and technical data allows the timely creation of curriculum that supports training for, and responding to, biological and chemical events. The goal should be a combination distributed/embedded system that can integrate with systems already in use (e.g. laptops in police/fire/rescue vehicles and hospital information systems, public health surveillance systems, command and control systems, etc, without affecting the function of those systems) and allow individual or team training with the ability for learners to use the system under different roles (physician can use the EMS module, etc). The system should eventually be able to provide decision support and threat analysis by allowing incident command and medical intelligence users to model various events and responses to a given event to determine the optimal response and by allowing providers to obtain relevant management information during the event.

REFERENCES:

1. SCORM accessed at www.adl.org

2. Federation of American Scientists, September 2002. Training Technology against Terror: Using Advanced Technology to Prepare America's Emergency Medical Personnel and First Responders for a Weapon of Mass Destruction Attack. Accessed at: http://www.fas.org/terrorism/wmd/docs/wmd_resp.pdf
3. National Research Council. 2002. Making the Nation Safer: The Role of Science and Technology in Countering Terrorism, National Academies Press, Washington, D.C. accessed at: <http://www.nap.edu/books/0309084814/html/>
4. Institute of Medicine. 2001. Biological Threats and Terrorism: Assessing the Science and Response Capabilities, National Academies Press, Washington, D.C. accessed at: <http://www.nap.edu/books/0309082536/html/>
5. Kizakevitch, P., et al 2003. Virtual Simulated Patients for Bioterrorism Preparedness Training in Medicine Meets Virtual Reality 11: NextMed: Health Horizon pp165-67, J.D. Westwood, et al, Eds. IOS Press, Amsterdam. Accessed at: <http://www.rti.org/pubs/VirtualClinic-paper.pdf>
6. Department of Commerce, 2002. Vision 2020: Transforming Education and Training Through Advanced Technologies accessed at: <http://www.technology.gov/reports/TechPolicy/2020Visions.pdf>
7. Grigg, Eliot, et al. 2003 Cybercare: Virtual Reality Technologies for Homeland Defense, by Eliot Grigg, et al, in Medicine Meets Virtual Reality 11: NextMed: Health Horizon, pp96-99, J.D. Westwood, et al, Eds. IOS Press, Amsterdam.
8. Kun, L.G. and Bray, D.A. 2002. Information Infrastructure Tools for Bioterrorism Preparedness. IEEE Engineering in Medicine and Biology Vol. 21, No. 5, pp 69-85.

KEYWORDS: SCORM, Scalable Content Object Reference Model, Advanced Distributed Learning, chem-bio events, homeland security, artificial intelligence

CBD04-113

TITLE: Analysis Tools for Detection and Diagnosis of Biological Threats

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: To develop data management and bioinformatics computational analysis tools for quick detection and identification of biological threats on the basis of host gene expression responses. More specifically, we are interested in the development of databases for storage, management, and query of DNA microarray studies involving host gene expression response and the development of statistical and pattern recognition tools capable of: (1) identifying agent-specific gene profile biomarker signatures that can uniquely discriminate, independent of dose amount and exposure elapsed time, particular biological threats and infectious agents; (2) grouping biological warfare agents and naturally occurring infectious diseases into categorical classes; (3) teasing out exogenous factors (such as stressors, ingested food, etc.) to allow for host gene response characterization of the original stimuli of interest; (4) discriminating naturally occurring infectious diseases from weaponized biological agents; (5) determining the interaction and nonlinear effects of multiple agent exposure and the extent of the masking or overlapping effects on gene response; and (6) linking gene expression responses to physiologic responses to allow for a deeper understanding of infection and disease pathology.

DESCRIPTION: Numerous studies are underway throughout the US Army Medical Research and Materiel Command (USAMRMC) laboratories to catalog and analyze host gene expression responses to exposures to biological threats and infectious agents that exploit the quick response of transcription factors to pathogen exposures and their time evolution reflecting the course of illnesses after exposure. In contrast with more traditional methods based on the direct identification of the pathogen, which, in general, are limited by a strong dependence on agent concentration, the time needed to reach detectable levels, the need for tissue sequestration of the pathogen, and the possibility of mutants (natural or deliberate) to escape detection, the gene profile host-response approach could provide the means for early diagnosis of exposure and the basis for designing stage-appropriate therapeutic intervention strategies.

These USAMRMC studies involve a variety of in vitro experiments with different human and animal cell lines and in vivo experiments ranging from small mammalian models to non-human primates exposed to various bacteria, viruses, toxins, as well as blistering and nerve agents. Overall, the main goal of these studies is to gain insight into the cellular pathways and mechanisms of virulence and toxicity of the host response, leading to the discovery of agent-specific biomarkers for early diagnosis and the development of stage-appropriate prophylactic and therapeutic intervention strategies.

PHASE I: Conceptualize and develop a preliminary prototype database system for storage, management, and querying of DNA microarray studies, including the capability to linking gene profiles to physiologic responses and therapeutic intervention strategies. Determine the existence and characterization of unique gene patterns associated with a given agent or class of agents. Conceptualize and demonstrate feasibility of statistical and pattern recognition algorithms for unique discriminating agents or class of agents, independent of dose amount and exposure elapse time.

PHASE II: Develop a functional prototype software system fully demonstrating the concepts developed during the Phase-I effort.

DUAL USE APPLICATIONS: This set of computational tools will have both military and civilian applications, as the general public defense against chemical and biological warfare agents is now an integral component of homeland defense. There is now significant overlap between the Department of Defense and the National Institutes of Health, National Institute of Allergies and Infections Diseases research and development programs in the detection, characterization, and diagnosis of biological threats.

REFERENCES:

1. DaSilva L, Cote D, Roy C, Martinez M, Duniho S, Pitt MLM, Downey T, and Dertzbaugh M: Pulmonary gene expression profiling of inhaled ricin. Submitted for publication, Oct 2002.
2. Hammamieh R, Mani S, Das R, Neil R, and Jett M: Establishment of bioinformatic analysis and data mining tools for correlating gene discovery and proteomics applications. Proc. 23rd Army Science Conference, Orlando, FL, 2-5 Dec 2002.
3. Draghici S, Chen D, and Reifman J: Review and challenges of DNA microarray technology in military medical research. Submitted for publication, April 2003.

KEYWORDS: pathogen database, gene expression, analysis tools, biological threat, warfare agents, bioinformatics

CBD04-301

TITLE: Adsorber or Catalyst to Remove Cyanides from Air Streams

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Develop an air treatment system able to remove gaseous cyanides from ventilation air.

DESCRIPTION: Removal of cyanides from breathing air is accomplished by filtration through activated carbon filters to which have been added salts of several heavy metals. Although effective, these filters are bulky and expensive, consume quite a bit of either blower or respiratory power, and require disposal as a Hazardous Waste. There is additionally the possibility of exposure to these heavy metals of personnel breathing air so filtered. Whereas fair-to-good methods exist for removing other categories of maliciously delivered air contaminants, none of these is effective against cyanides. This solicitation seeks a cyanide-treatment stage that can be added to an air-purification system to provide comprehensive respiratory protection.

No constraint is placed on the technology to be proposed, other than the usual conventions of safety, practicality, and affordability, and preference will be shown to approaches that incorporate no hazardous materials and that add minimally to net pressure drop.

PHASE I: During phase I, contractor must accomplish an experimental demonstration that the proposed technology can remove 90% of one gaseous cyanide from flowing air at a residence time of 1 second or less.

PHASE II: During phase II, contractor must assemble an engineering prototype model incorporating the candidate technology and use it to demonstrate 1) removal of 99% of one gaseous cyanide in a 1-second residence time; 2) treatment with no more than 2% breakthrough of a mass of one gaseous cyanide equal to 5% of the mass of the active component[s] of the treatment device; 3) removal of at least 90% each of HCN, ClCN, and dicyanogen; and 4) some measure of assurance that human toxicity will not result from use of this material as designed.

PHASE III: During phase III, contractor is expected to proceed with commercialization of the material or, better, development of practical embodiments of the material as CBWA-protective products commercially accessible to DoD. Concurrent pursuit of civilian-market products for homeland defense and protection/security in chemical industry is consistent with the aims of this procurement.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The principal commercial opportunity is in homeland defense [which may also sprout a market in applications to protect private residences and businesses] and in analogous military applications. With slight modification, the same technology may be adaptable to other categories of personal protective equipment, e.g., for HazMat handlers and emergency responders. If the chemistry operates in water, significant opportunities may exist to treat wastewater from precious-metal mining and recovery industries and from electroplating and stripping operations.

REFERENCES:

<http://www.osha-slc.gov/SLTC/healthguidelines/hydrogencyanide/> and links therein provide a detailed introduction into handling and concepts of protection against HCN.

<http://www.sbcom.apgea.army.mil/products/m49.htm> describes a current-generation system for respiratory protection.

KEYWORDS: Cyanide, chlorocyanogen, dicyanogen, HEPA, air filtration, collective protection, individual protection

CBD04-302 TITLE: Low-Temperature Catalyst to Destroy Chemical Warfare Agents from Air Streams

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Develop one or more catalysts that can decontaminate air containing aerosolized or gaseous chemical warfare agents (CWAs) at temperatures that do not generate significant toxic by-products and that can operate for at least 100 hours in a heavily contaminated environment.

DESCRIPTION: High-temperature catalytic oxidation (CATOX) has been shown to be effective as a method of removing and destroying liquid and gaseous CWAs from air, and catalysts have been developed that continue to function for hours during exposure to contaminants containing N, S, and P atoms. Concern about power requirements and combustion by-products could be allayed by lowering the temperature required to accomplish practical rates of destruction of these contaminants.

No constraint is placed on the technology to be proposed, other than the usual conventions of safety, practicality, and affordability, and preference will be shown to approaches that incorporate no hazardous materials and that employ only atmospheric oxygen as the oxidant.

PHASE I: During phase I, contractor must accomplish an experimental demonstration that the proposed catalyst(s) can achieve > 90% destruction of organics containing 3% or more of P and, separately, of S from flowing air at a residence time of 1 second or less for at least 30 minutes.

PHASE II: During phase II, contractor must assemble an engineering prototype model incorporating the candidate technology and use it to demonstrate 1) removal of 90% of a volatile organophosphorus compound, a volatile organosulfur compound, and a volatile amine delivered at a rate of 1% of the mass of catalyst and 100 bed volumes per minute for at least 24 hours; 2) formation of no more than 10 ppm NO_x in the combustion exhaust from treatment of the organophosphorus and organosulfur feeds ; and 3) some measure of assurance that human toxicity will not result from use of this material as designed.

PHASE III: During phase III, contractor is expected to proceed with commercialization of the material or, better, development of practical embodiments of the material as CBWA-protective products commercially accessible to DoD. Concurrent pursuit of civilian-market products is consistent with the aims of this procurement.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The principal commercial opportunity is in homeland defense [which may also sprout a market in applications to protect private residences and businesses] and in analogous military applications. With slight modification, the same technology may be adaptable to other categories of personal protective equipment, e.g., for HazMat handlers and emergency responders.

REFERENCES:

http://www.nap.edu/html/pueblo/letter_report.pdf, page 7, describes typical circumstances of application of high-temperature CATOX to destruction of bulk CWAs.

http://www.johnzink.com/products/thermal_ox/pdfs/tp_catalytic.pdf provides a compact discussion of general considerations relevant to catalytic materials.

Catalysts for Low-Temperature Destruction of VOCs, Abstracts 93rd Air & Waste Management Association Conference and Exhibition, #548, 2000, reprinted as AFRL-ML-TY-TP-2000-4558 [AD-A-383713], provides a brief description of one approach to low-temperature catalyst development.

KEYWORDS: CATOX, catalyst, poisoning, deactivation, decontamination, chemical warfare

CBD04-303

TITLE: Capture and Destruction of Organophosphates from Air

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: This project is intended to produce a fabric/filter material or treatment to remove and destroy mists of VX and related organophosphate chemical warfare agents from moving air streams.

DESCRIPTION: During attacks by chemical and biological weapons, personnel in temporary or permanent shelter[s] are dependent on a constant supply of clean air, so ventilation systems are both a direct and an incidental target for terrorists and saboteurs. Current-generation HEPA filters provide reasonable protection for a practical amount of time, but they are expensive to acquire, they require the use of prefilters to limit their rate of loading, and they dissipate a large amount of power from the ventilation air stream. The alternative approach proposed here is to develop a sequence of selective devices to achieve a satisfactory level of protection, and these devices could be operated constantly if they were catalytic, or in switched pairs if they are capable of regeneration in place. This topic seeks to develop one such component for a multilayer or multistep system.

Any proposed technology should not emit a detectable signature or measurable amounts of hazardous or air toxic materials, it should be capable of extended storage at a range of temperatures, and it should not be irreversibly consumed in the course of acting. No other constraint is placed on the technology to be proposed, other than the usual conventions of safety, practicality, and affordability. Preference will be shown to approaches that operate on a catalytic or other self-regenerating principle.

PHASE I: Contractor must accomplish an experimental demonstration that 50% of a charge of organophosphate ester or thioester, applied directly to 50 times its weight of the material developed during phase I, decomposes in two hours or less at room temperature.

PHASE II: Contractor must accomplish an experimental demonstration a) that 50% of a charge of organophosphate ester or thioester, applied directly to 50 times its weight of the reactive material, decomposes in 10 minutes or less at room temperature, b) that a sample of the reactive material incorporated onto a practical fiber or into a practical coating achieves at least 10% decomposition under the conditions above, and c) that the rate of decomposition after 4 hours of continuous exposure of each sample to the test condition is no less than 90% of the value observed initially

DUAL-USE APPLICATIONS: If the technology is completely specific for one or two chemical warfare agents, dual-use opportunities will be limited to homeland security applications. If specificity is broad, markets will exist in protection of workers manufacturing and applying organophosphorus pesticides and possibly in home and food service processing of agricultural produce.

REFERENCES:

1. <http://www.anachemia.com/defequip/product.html> Constituents in M-8 papers react with several categories of chemical agents.
2. <http://departments.agri.huji.ac.il/soils/dbd/dep/user/benny/pubfile-24.pdf> Natural enzymes decompose organophosphates
3. http://pubs3.acs.org/acs/journals/doi/lookup?in_doi=10.1021/ja029265z Designed molecules react rapidly to decompose reactive electrophiles

KEYWORDS: Chemical warfare agent; nerve gas; organophosphate; VX; sarin; collective protection; individual protection

CBD04-304

TITLE: Portable Water Decontamination System

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: This project is intended to develop a rapid, compact method for removal of a wide spectrum of toxic chemicals and CB agents from liter volumes of water.

DESCRIPTION: Because large-area water distribution systems are difficult to protect from incidental or malicious contamination, some combination of a detection device and local, small-volume, on-demand purification systems is an attractive concept to develop. This topic focuses on exploration and development of a portable unit to decontaminate water in quantities adequate to support deployed forces in potentially contaminated environments, and which can also be activated by a distribution-system contamination monitor to provide safe potable water for an extended period of time at outlets in permanent structures.

No constraint is placed on the technology to be proposed, other than the usual conventions of safety, practicality, and affordability, and preference will be shown to approaches that impose no extreme logistical requirements.

PHASE I: During phase I, contractor must accomplish an experimental demonstration that the proposed technology can remove 90% of any soluble organic and 90% of any simple metal ion in water for an indefinite amount of time.

PHASE II: During phase II, contractor must assemble an engineering prototype model incorporating the candidate technology and demonstrate a) 99% removal of each of the following: a Group Ia metal ion, a transition metal cation, and a transition metal oxyanion; b) 99% removal of ethanolamine, methylphosphonic acid, and toluene; and c) 99.9% removal or killing of E. coli in a water stream for 12 hours of constant operation at a rate to produce 8 gallons of potable water. At least one of the separations must include three of the contaminants specified.

PHASE III: During phase III, contractor is expected to proceed with commercialization of the technology as a CBWA tool commercially accessible to DoD for rapid decontamination of water. Concurrent pursuit of civilian-market products for homeland defense and camping/survivalism is consistent with the aims of this procurement.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The obvious commercial opportunity is in homeland defense [which may also sprout a market in applications to protect public facilities, private residences and businesses] and in

analogous military applications. The same technology should also be applicable to outdoor recreation, small-community water supplies, and possibly wastewater treatment from medical or small manufacturing operations.

REFERENCES:

Hummer, G, et al., "Water conduction through the hydrophobic channel of a carbon nanotube," Nature, 414 (2001) 188–190.

<http://www.llnl.gov/IPandC/tech/aerogels/capacitive.html> briefly describes water purification concepts using aerogels.

<http://wwweng.uwyo.edu/news/010916/> describes an example of capture and subsequent destruction on GAC.

KEYWORDS: water, purification, decontamination, adsorption, filtration

CBD04-305

TITLE: Digital Opacity Method for Detection of Aerosols

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Develop a rapid, digital photographic method for detection and classification of airborne particles.

DESCRIPTION: A technology being considered as an alternative EPA Method for measurement of exhaust stack soot opacity is based on enhancement of the capability of a commercial digital camera to achieve automated collection and analysis of about 2 images/minute under specified conditions of positioning with respect to the sun and source. By manipulation of image information proprietary software in the system measures opacity compared to background in each image. This solicitation seeks a digital photographic technology that can operate autonomously to identify characteristic changes in color, optical density, or other photographically discriminable properties that identify changes in aerosol concentration in free air passing a fixed point.

No constraint is placed on the technology to be proposed, other than the usual conventions of safety, practicality, and affordability, and preference will be shown to approaches that are effective in both daylight and the dark.

PHASE I: During phase I, contractor must accomplish an experimental demonstration that the proposed technology can distinguish between an uncontaminated fog, dry aerosol particles, and dry aerosol particles plus fog in a stream of flowing air.

PHASE II: During phase II, contractor must assemble an engineering prototype model incorporating the candidate technology and use it to demonstrate automated discrimination between an uncontaminated fog, dry aerosol particles, and dry aerosol particles plus fog in an unconfined stream of flowing air.

PHASE III: During phase III, contractor is expected to proceed with commercialization of the technology as a CBWA rapid-detection tool commercially accessible to DoD. Concurrent pursuit of civilian-market products for homeland defense and protection/security in chemical industry is consistent with the aims of this procurement.

PRIVATE SECTOR COMMERCIAL POTENTIAL: The obvious commercial opportunity is in homeland defense [which may also sprout a market in applications to protect private residences and businesses] and in analogous military applications. With slight modification, the same technology may be adaptable to other categories of personal protective equipment, e.g., for HazMat handlers and emergency responders, or for air pollution monitoring applications.

REFERENCES:

<http://www.estcp.org/projects/compliance/200119o.cfm> briefly sketches the validation program for candidate EPA Alternate Method 9.

<http://leo.physics.usyd.edu.au/~andrewn/camera.html> describes an approach to signal handling from a digital camera.

<http://gphoto.sourceforge.net/> is an example of interfacing software for digital cameras.

KEYWORDS: photography, digital image, image processing, aerosol, bioaerosol, detection, particles, opacity

CBD04-306

TITLE: THz Spectrophotometer for Biological Detection

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: To develop a spectrophotometer that operates in the terahertz (THz) frequency region for detecting biological agents.

DESCRIPTION: Absorption spectroscopy in the 0.1 – 10 THz frequency range (i.e., wavelengths of 3000 – 30 micron or wavenumbers of 3 – 300cm⁻¹) has potential for identifying biological materials. A number of studies on DNA and RNA molecules have shown that these materials have characteristic absorption spectra in this spectral range. However, standardized instrumentation for characterizing materials in the terahertz region is not currently available and is needed to determine the viability of biological detection by this approach. Recently, the construction of a spectrophotometer for this application has become practical with nonlinear optical (NLO) processes. By using collinear phase-matched difference frequency generation in a GaSe crystal, Shi, Ding, Fernelius, and Vodopyanov have made a room temperature continuously tunable coherent radiation source in the range of 0.18-5.27 THz (56.8-1618 microns). Advantages of this source are high coherence, simplicity for tuning, simple alignment, and stable output. The peak output power reached 69.4 W at a wavelength of 1.53 THz (196 microns)[pulse width ~5 ns], which corresponds to a photon conversion efficiency of 3.3%. Alternative NLO processes and crystals may provide additional approaches for the THz radiation source. NLO processes could even be the approach for detection since upconversion detection has been used for detecting CO₂ laser radiation with high sensitivity.

PHASE I: The objectives are (1) to breadboard and demonstrate the potential performance of a THz radiation source pumped by a common laser source such as Nd:YAG and tunable over a significant portion of the 0.1 to 10 THz range, (2) to breadboard and demonstrate a detection scheme for sensing the reflected spectra, and (3) to breadboard and demonstrate a working THz spectrophotometer.

PHASE II: The objectives are (1) to further develop and brassboard a THz radiation source pumped by a common laser source such as Nd:YAG and tunable over a significant portion of the 0.1 to 10 THz range, (2) to further develop and brassboard a detection scheme for sensing the reflected spectra, and (3) to brassboard, demonstrate, and package the spectrophotometer.

DUAL USE APPLICATIONS: The spectrophotometer would have a number of commercial applications, especially as related to medical diagnosis, environmental monitoring, and scientific instruments.

REFERENCES:

- D.L. Wollard et. al., "Feasibility of submillimeter-wave technology for the identification of biological warfare agents," pp. 153-166 in Proceedings of the Fourth Joint Workshop on Standoff Detection for Chemical and Biological Defense, 26-30 October 1998, Williamsburg, VA
- W. Shi, Y.J. Ding, N. Fernelius, & K. Vodopyanov, "Efficient, tunable, and coherent 0.18-5.27-THz source based on GaSe crystal," Optics Letters 27(16), 1454 (2002)
- T. Itabe and J.L. Bufton, "Application of upconversion detection to pulsed CO₂ lidar," Applied Optics 21 (13), 2381 (1982).

KEYWORDS: terahertz, THz, spectrophotometer, bio detection, biosensor

TECHNOLOGY AREAS: Chemical/Bio Defense

OBJECTIVE: Develop and demonstrate the operation of an inexpensive, re-usable point detector that can remotely sense chemical and biological agents while sending a remote, real-time signal of detection.

DESCRIPTION: One of the most widely used detection methods today is M8 and M9 paper. Utilization requires visual inspection for contamination. Therefore, an individual must don chemical/biological protective gear, enter a potentially hazardous environment, and physically examine the detector—this is both hazardous and time consuming. Agent concentration and time of contamination are difficult to determine by visual inspection of these detectors. However, new technologies exist that can provide for a quick, accurate and time-warranted device to detect agents that do not expose personnel to hazardous environments. These devices can be produced at minimal size, weight, power, and cost.

Each sensor will be placed in remote areas and provide 24 hour chemical/biological agent monitoring. The devices can be placed on runways, barracks, ventilation shafts and even vehicles or personnel. Once an agent detection occurs, an alarm will be transmitted to a receiver terminal for warning and give location, agent type and concentration. These detectors must provide a real-time alarm of contamination, accurate concentrations of agent(s), constant monitoring capabilities, protection of the warfighter and to-the-second information of installation contamination to the commander for split-Mission Orientated Protective Posture (MOPP) and force protection operations.

Each detection device must be no bigger than 3" x 3" x 3" (including transmission or hardwire component) and operate with an electrical current draw of less than 80milli-amps.

PHASE I: The primary deliverable in Phase I is a conceptual hardware design to detect nerve, blister and nerve agents at the LD50 concentrations. The design must be based on theoretical and experimental results. This design will be provided to a government panel for critical design review to determine continuation into Phase II. The design must be accompanied by projected performance, including sensitivity, power requirements, maintenance requirements, size, weight, lifetime, and system cost. Any algorithms developed to support the detection process will be required to be presented with the prototype design.

PHASE II: The primary deliverable in Phase II will be a prototype system based on the Phase I design. The system must stand alone, meaning that all signal processing, and mechanical interfaces are located within the prototype. The system must detect a minimum of 12 different agents at low monitoring sensitivities. Simultaneous measurement and detection of the agents is required. The system will alarm upon detection and will provide a readable signal indicating which contaminant(s) is (are) present and in what concentrations, assuming the measurement is below saturation.

PHASE III: Chemical and Biological Defense-Contamination Avoidance; Counterproliferation Tactical Intelligence; Battlefield Surveillance; Battle Damage Assessment; Facility Characterization; Domestic Preparedness.

REFERENCES:

<http://www.acq.osd.mil/cp/nbc99/99annexa.pdf>

KEYWORDS: point detector, remote, contamination, chemical, biological