Overview: Chemical Threats Area

DOE - Basic Energy Sciences Workshop on

"Basic Research Needs to Counter Terrorism"

M. E. Sigman

Presented to Advisory Committee, Council on Competitiveness
Washington, D.C., June 5, 2002

Research sponsored by the Division of Chemical Sciences, Geosciences, and Biosciences, Office of Basic Energy Sciences, U.S. Department of Energy, under contract DE-AC05-00OR22725 with Oak Ridge National Laboratory, managed and operated by UT-Battelle, LLC.

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Workshop Dates/Location February 28 – March 1, 2002 at the Gaithersburg Marriott Washingtonian Center.

Workshop Objective Identify critical science issues and opportunities in research areas supported by BES that will be important to our Nation's ability to detect, prevent, protect against, and respond to future terrorist threats.

Workshop Summary A report is available on the web that summarizes presentations and discussions from the workshop and includes recommendations for future basic research investment needs.
http://www.sc.doe.gov/bes/counterterrorism.html

BES Lead Walter Stevens

Workshop Chair Terry Michalske, Sandia National Laboratories

Keynote Speaker Jay Davis, National Security Fellow, LLNL and former Director, Defense Threats Reduction Agency

Chemical Threats

Chair M. Sigman ORNL
Speak M. Sailor, UCSD
Including conventional explosives and toxic chemicals such as choking agents, blood agents, blister agents, nerve agents, and byproducts of their manufacture.

Biological Threats

Chair J. Trewhella, LANL
Speaker D. Franz, Southwest Research Institute
Including bacteria, rickettsiae, viruses, fungi, and toxins. Gram for gram much deadlier than chemical agents. Can be bioengineered.

Radiological and Nuclear Threats

Chair N. Edelstein, LBNL
Speaker M Anastasio, LLNL
Including nuclear explosives and radioactive materials and byproducts of their manufacture.

Chemical Threats:

Chemical Warfare Agents

- Examples: Blister, Nerve, Choking and Blood agents
- Sarin used by Aum Shinrikio terrorist in Tokyo subway, 1995
  - 11 dead; 500 hospitalized; 5,000-6,000 exposed
- Largest threat of high fatality (> 1,000 people) from state-sponsored terrorism (GAO/T-NSIAD-00-50)

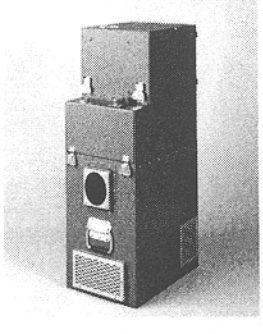
Toxic Industrial Materials (TIMs)

- LCt_{50} < 100,000 mg-min/m^3; Produced in quantities >30 Tons per year at a single facility
- Examples: Methl isocyanate, Chlorine, Hydrogen Fluoride
- 1984 Bhopal accident demonstrates lethality:
  - 8,000 dead; 200,000 exposed.

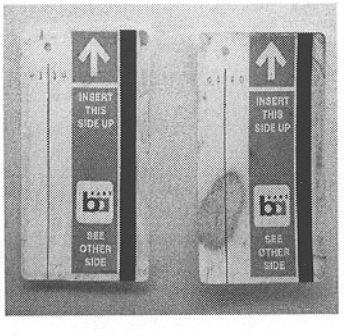
Explosives

- Examples: TNT, RDX, TATP.
- Produced in large quantities and easily accessible
  - Some explosives prepared from readily available ingredients
  - Widespread recipes in published books and on the internet
- Ammonium nitrate/fuel oil (ANFO) used in Oklahoma City, 1995
  - 168 dead (including 19 children)

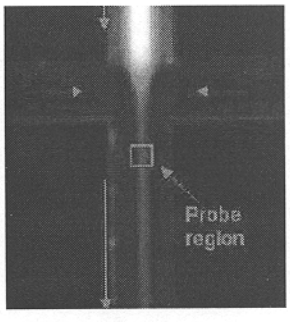
BES Research Contributions to Homeland Security from Chemical Threats



Fundamental processes in mass spectrometry.



Fundamentals of energy transfer leading to novel explosives detection.



Single molecule detection

Contributions in

Detection

Preparedness

Response/Recovery

Prevention

Protection

Example Research Challenges & Opportunities

Detection

- Effects of confined spaces on fluid flow (low surface/volume ratios, electric double layer, etc.) ⇨ Nanofluidic devices
- New sensor concepts utilizing on molecular-based interactions (molecular imprinted polymer receptors, etc.) ⇨ Microelectro-mechanical system sensors
- Improved materials for sample collection and transport ⇨ Selective sampling materials
- New gas phase processes for selectivity, ion trapping size limitations ⇨ Advanced mass spectrometry

Prevention:

- Improved synthetic reactions, milder processing conditions ⇨ Point-of-use synthesis

Protection, Response & Recovery:

- New catalysts and adsorbents to mitigate and protect against chemical threats ⇨ Personal protection equipment (PPE)
- New polymers with designed nanostructures ⇨ Light weight barrier materials for PPE
- New separations and analysis schemes utilizing biomarkers for low level chemical exposure ⇨ Pre-symptomatic diagnosis

Preparedness

- New materials synthesis and fabrication processes for low weight power sources ⇨ Improved batteries
- Improved membrane technology for ion and small molecule transport ⇨ Miniaturized fuel cells

Assets to Insure Success

Infrastructure

- ❖Existing BES Scientific User Facilities and facilities planned and under construction will collectively make a significant contribution to research needs
  - ➢BES synchrotron radiation light sources: radiation from x-rays through the IR
  - ➢High-flux neutron sources: neutron scattering and materials irradiation
  - ➢Electron beam and microcharacterization centers: structural characterization
- ❖The National Nanotechnology Initiative (NNI) and BES Nanocenters will play a valuable role developing technology to counter terrorism
  - ➢Nanocenters will provide the tools for preparation and characterization of the nanoscale devices of the future

Programs

- ❖Multi-Institutional collaborations are needed to insure access to specialized facilities