

# Optical Engineering

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## **Chemical, Biological, Radiological, and Explosive Sensing**

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Although the use of poisons and lethal chemicals in warfare perhaps predates recorded history, this autumn marks the 100th anniversary of the use of industrialized chemical gases in World War I. Shortly following the introduction of xylyl bromide (T-Stoff) in 1914 as a lacrimating agent, the first large-scale attack with chlorine gas occurred 22 April 1915 at Ypres, Belgium. Since the advent of chemical weapons, the world has added biological, radiological, nuclear, and most recently explosive (CBRNE) hazards to the list of threats expected by military forces on the battlefield, as well as to civilians in the homeland.

The current conflict in Syria is not only a claxon call that chemical warfare is not passé, but it is potentially a harbinger of the strategic environment the United States and its allies will face in the future. The rising global trend for civil war and internal conflict, especially in large cities, increases the probability that industrialized chemicals will either intentionally or accidentally become a hazard to military and security forces or the localities' residents. A greater proliferation through the internet of the knowledge necessary to make CBRNE threats, coupled with the trends of rapid innovation and improvisation witnessed in Iraq and Afghanistan with IEDs, will make threat prediction difficult. The nonattribution of strategic CBRNE acts will also make a response difficult without a strong reliance on forensics to narrow down or identify the person(s) or group(s) responsible.

For those of us trying to develop detection capabilities for military, security, and emergency response forces, the current and future strategic environment means that there are literally thousands of lethal materials that can be used as weapons. As a result we cannot only be concerned with detecting the handful of materials prohibited by the Chemical or Biological Weapons Treaties. Optical sensing of CBRNE threats are important to obtain "real-time" answers that allow actionable decisions to be made on-the-spot; to reduce the logistical burden by moving the analysis closer to the source of the sample; to rapidly screen materials to identify samples that need to be sent to a lab for additional analysis and minimize the number of these samples; and to nondestructively analyze large, valuable, or immovable objects for which excising samples is not possible. The trends in recent

conflicts point to threats that are more improvised and "unknown," increasing the need for sensing to be more adaptable and flexible. With the U.S. Department of Defense increasingly interested in offloading forward decision making and analysis from soldiers to software, this will increase the need for algorithms to be more robust and accurate.

In this special section of *Optical Engineering*, eleven papers explore the current state of the art in the optical detection of chemical, biological, radiological, nuclear, and explosive hazards. Many of the papers are updated and expanded versions of proceedings papers from the most recent CBRNE Sensing Conference, part of SPIE's Defense, Security, and Sensing Symposium. While one paper details the development of a new high-energy-resolution gamma ray detector, the remaining papers deal with the challenges of optical detection of either chemical or explosive threats. Glaringly absent are any papers focused on the optical detection of biological threats. This is probably more a reflection on the state of funding for optical strategies by the Department of Defense than the actual state of the art in capabilities. This is an area of needed coverage by SPIE and *Optical Engineering*, and I would welcome submissions in the future.

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