Abstract

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Development of Methodologies for Nuclear Explosion Monitoring

The National Academy of Engineering identifies the prevention of nuclear attacks as one of the 14 Grand Challenges for Engineering in the 21st century. Optical detection techniques can be used towards wide area environmental sampling, enabling standoff, isotopically-resolved detection of nuclear materials with rapid (sub-second) analysis times and no sample preparation. The physical and chemical properties of the plasma produced by the ultrashort laser pulses used in these optical techniques, such as laser-induced breakdown spectroscopy, are representative of high explosives and nuclear fireballs. Therefore, optical sensing provides the additional advantage of a laboratory-scale method towards developing models and techniques to detect, characterize, and respond to nuclear explosion events.

In this oral presentation, we will discuss our current progress towards developing the next generation of robust detectors towards nuclear explosion monitoring. It is well known that interpreting results from optical spectra can be a challenging process due to the complex spatio-temporal conditions of the laser-produced plasma (LPP) plume. Chemical reactions within the plasma lead to the formation of molecular species, which are greatly influenced by the environment, particularly reactive species such as oxygen. As part of our work with the MTV Consortium and in collaboration with Savannah River National Laboratory, we aim to elucidate the effect of environmental conditions on LPP plumes of actinide materials. This exciting collaboration with SRNL is expected to result in the first studies of plutonium laser-ablation plasma plumes under inert and ambient atmospheric conditions, which represents an important knowledge gap in post-detonation nuclear fireball plasma chemistry.