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Waveguide-enhanced Raman Spectroscopy For Field Detection Of Threat Materials

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Detection of threat materials is an important capability for the military and homeland security to protect soldiers and civilians. Waveguide-enhanced Raman spectroscopy (WERS), a photonic integrated circuit sensing methodology, is being developed for field detection of materials related to chemical warfare agents, explosive, and narcotic threats. Low-fluorescence silicon nitride spiral waveguides with long path lengths are used to obtain high signal levels with near-infrared excitation (785 nm and 1064 nm). Compact single-mode-fiber-coupled spectrometers with high sensitivity are being utilized for detection of the Raman scattered light. Thermoelectrically cooled CCD or InGaAs detectors (-15 °C) provide low noise and high quantum efficiency spectral measurement. Performance comparable to that obtained with large benchtop spectrometers is observed. The spiral waveguides are coated with functionalized polymer sorbents suitable for concentrating relevant classes of threat materials in the evanescent field of the waveguide. The sorbents are deposited using piezoelectric microdispensers to allow for controlled deposition of thin films without the need for spin-coating. Raman chemical imaging microscopy is used to characterize the uniformity of the sorbent polymers on the waveguides. Library spectral matching can be used in combination with the selectivity of the sorbent materials to provide discrimination of the materials absorbed by the polymer coatings. The ultimate objective is development of a prototype handheld WERS sensor system suitable for defense and security applications in the field. WERS development and spectral measurements will be presented.

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