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Free-surface microfluidics for detection of airborne explosives

CARL MEINHART, BRIAN PIOREK, University of California - Santa Barbara, SANJOY BANERJEE, City College of New York, SEUNG JOON LEE, MARTIN MOSKOVITS, University of California - Santa Barbara — A novel microfluidic, remote-sensing, chemical detection platform has been developed for real-time sensing of airborne agents. The key enabling technology is a newly developed concept termed Free-Surface Fluidics (FSF), where one or more fluidic surfaces of a microchannel flow are confined by surface tension and exposed to the surrounding atmosphere. The result is a unique open channel flow environment that is driven by pressure through surface tension, and not subject to body forces, such as gravity. Evaporation and flow rates are controlled by microchannel geometry, surface chemistry and precisely-controlled temperature profiles. The free-surface fluidic architecture is combined with Surface-Enhanced Raman Spectroscopy (SERS) to allow for real-time profiling of atmospheric species and detection of airborne agents. The aggregation of SERS nanoparticles is controlled using microfluidics, to obtain dimer nanoparticle clusters at known streamwise positions in the microchannel. These dimers form SERS hot-spots, which amplify the Raman signal by 8 – 10 orders of magnitude. Results indicate that explosive agents such as DNT, TNT, RDX, TATP and picric acid in the surrounding atmosphere can be readily detected by the SERS system. Due to the amplification of the SERS system, explosive molecules with concentrations of parts per trillion can be detected, even in the presence of interferent molecules having six orders of magnitude higher concentration.

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