LOCALIZING CHEMICAL AND BIOLOGICAL THREAT DETECTION

Wearable Chemical Threat And Volatile Organic Compound Detector

Philip Miller Sandia National Laboratories

Wearable devices are emerging as a novel means to collect continuous data from people and their environment. Most of these devices collect physiological vital signs yet largely lack chemical analysis capabilities. Our team at Sandia National Labs has developed a wearable chemical analysis system based on a miniaturized gas chromatography device for using volatile organic compounds (VOC) as diagnostics biomarkers. VOCs continue to be discovered as biomarkers indicative of disease states in humans, can arise prior to symptom onseT , and have begun to be correlated to human behavior and physical performance. These compounds can be easily accessed in breath, skin, or saliva, and present biochemical information from a multitude of organ systems simply by changing the sample collection location. While the appeal of these compounds as a diagnostic source is widely growing due to their accessibility and disease/condition specificity, the challenge of realizing their use in the field stems from the difficulty of creating a portable device capable of analyzing complex chemical mixtures.

Our team approaches the portable VOC detection problem using a ‘system’ approach that mimics the process of a benchtop analytical unit, but employs miniaturized components to reduce SWAP (size, weight, and power). This system approach utilizes a three-step process which includes pre-concentration (PC), separation, and detection. Silicon micromachining is used to make the PC and separation stage (2D micro gas chromatography) and a co-fired ceramic for the drift-tube based ion mobility spectrometer. Coupling the VOC peak capacity of the micro GCxGC with the resolving power of the miniature IMS produces a theoretical VOC detection limit into the hundreds to thousands, which may greatly improve algorithm development given the data density input. Due to the size of these components, our system only weight 1.1lbs with sensor component dimensions of ~4” x 2” x 3”, which is reasonable for both portable and wearable deployment. Additionally, our team is supported by DHS to make a version of the device for environmental detection of chemical threat agents.

In addition to our instrumentation development, our team has efforts studying new biogenic VOC biomarkers, performing initial metabolomic profiling of these VOC biomarkers, and maturing the wearable VOC collection interface. Our recent results on an epileptic seizure detection project have shown that the biomarkers of interest have documented metabolic pathway connections to several sensory systems and metabotropic receptors thus illustrating potential pathways for non-invasive collection of biomarkers indicative of neurological processes.