MicroChemLab

Detection - Stage Three

The third stage of the MicroChemLab system is the detection unit. This baseline detector consists of an array of surface acoustic wave (SAW) sensors.

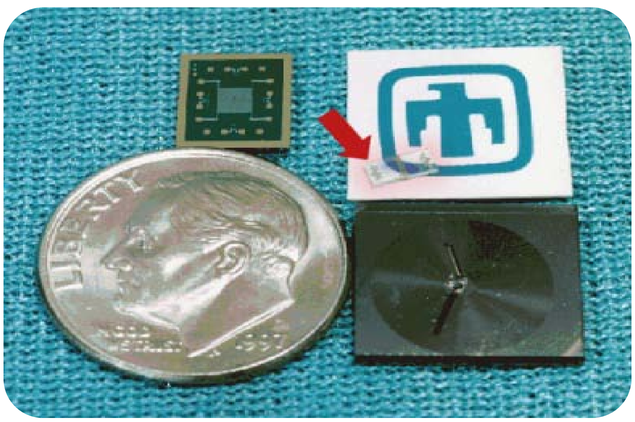

Figure 1. The SAW device is the smallest of the three-microfabricated stages. The SAW detector uses quartz as its piezoelectric substrate. This SAW device is a four-element array.

Each SAW device consists of an input and output interdigital transducer patterned on a piezoelectric substrate. When the input transducer is excited at its synchronous frequency (typically 100MHz to 1 GHz) the input transducer generates a surface acoustic wave that propagates across the crystal and regenerates an electrical signal on the output transducer. The surface wave has acoustic energy confined to within roughly one wavelength of the surface, making the wave extremely sensitive to accumulated surface mass.

To make the SAW device a chemical sensor, a sorbent film is deposited onto the SAW propagation path. This film is typically a polymer that has been dissolved in a solvent and dispensed using a programmable pipette. As each analyte exits the GC column and passes across the SAW sensor, the coating momentarily absorbs the analyte. The resulting minute increase in surface mass causes a decrease in the SAW propagation velocity. This gravimetric response is registered by incorporating the SAW device as the frequency control element of an oscillator circuit or by comparing the phase shift across coated and uncoated (reference) devices.

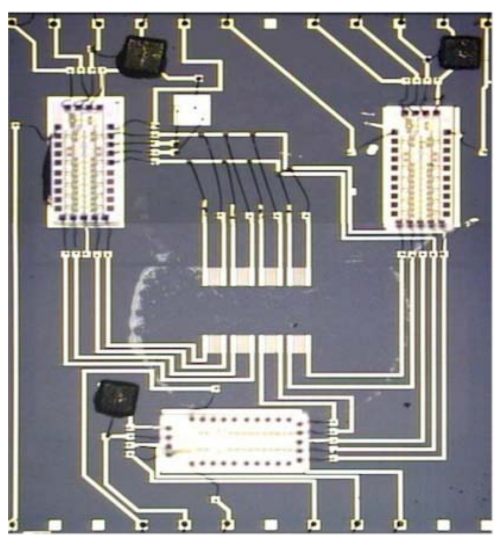

Figure 2. SAW Array with integrated electronics for DC-in; DC-out operation.

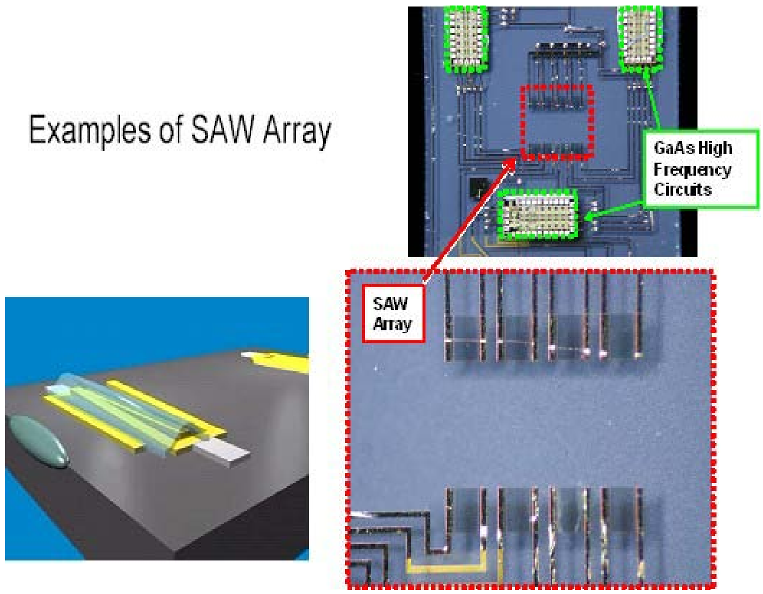

Figure 3. The SAW sensor array typically consist of three sensors with different sorptive coatings and an uncoated reference device. The array thus provides several responses that can be used to differentiate analytes that co-elute from the GC column, providing an extra degree of discrimination over the temporal separation provided by the separation stage.

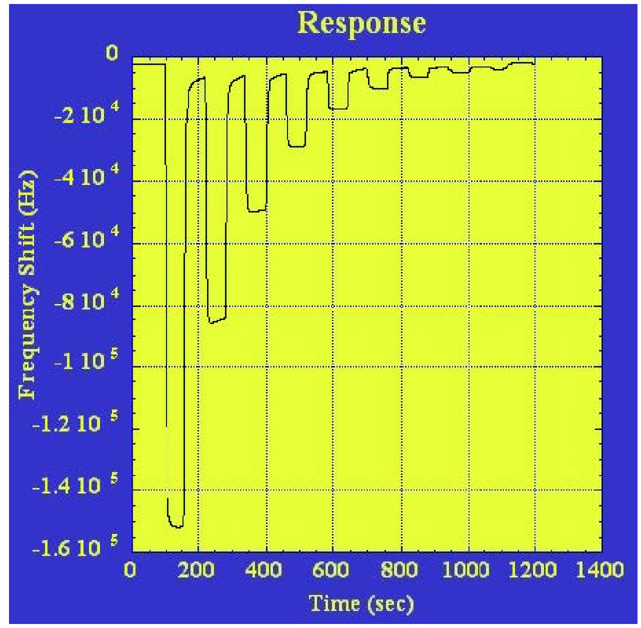

Figure 4. This figure illustrates several key features of a good SAW coating.
1. Rapid response to the introduction and removal of analytes.
2. Linear dose response to increasing concentrations of the test analyte.

FID/NPD Discussions:

The Nitrogen Phosphorus Detector (NPD) is selective for only nitrogen, phosphorous, and sulfur containing compounds. It is capable of detecting nitrogen and phosphorous at a ratio of 10,000:1 over carbon with picogram sensitivity. While detecting phosphorous requires H2, a fully miniaturized NPD should minimize the usage of H2. However, compounds containing nitro groups like explosives can be detected without H2. The NPD is ideal for handheld fielded Microsystems and uses low work function metal.

The Micro Flame Ionization Detector (microFID) uses catalytically-supported combustion on a microhotplate to ionize and detect hydrocarbon analytes. It uses catalytic combustion to permit further miniaturization and expand the limits of flammability. The microFID has been coupled with gas chromatography (GC) columns, including microGCs, to isolate the influence of injection pressure pulses on detector response and to separate complex gas mixtures such as natural gas.

Other Detectors:

- Magnetic FPW
- Pivot Plate Resonators
- Nanoparticles
- Ion Traps

For additional information or questions, please email us at MGA@sandia.gov.