MicroChemLab

Separation - Stage Two

The second stage in the MicroChemLab is the GC separation stage, as shown below. This stage is a high aspect ratio (depth - to - width) GC column that is fabricated using deep reactive ion etching into a silicon wafer. The column is typically about 1 m in length, but formed in a spiral so as to occupy only 1 cm2 of chip area. The column cross-section is typically 50 - 100 mm wide by 400 mm deep. Typically air is used as the carrier gas (5 psi across the column) providing separations in 30 - 60 seconds. The high aspect ratio provides a large flow cross-section, while maintaining effective separation due to the small width.

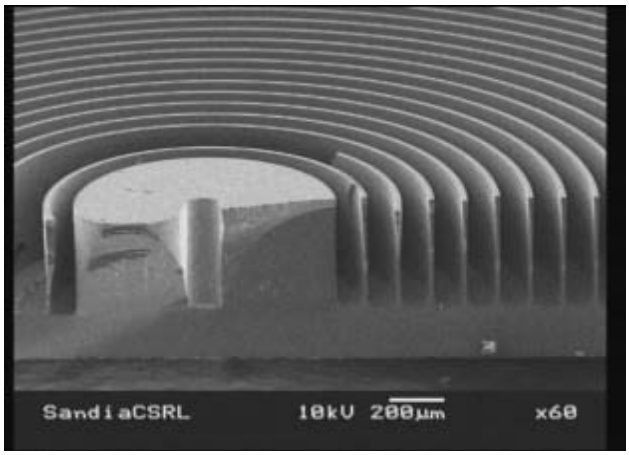

Figure 1. A one-meter long column etched in silicon takes up a footprint of 1 cm^2. The column grooves are about 50 mm wide and 400 mm deep.

The walls of the GC column can be coated with a stationary phase to provide differential analyte retention for identification. Stationary phases range from the very nonpolar polydimethylsiloxane to the highly polar polyethylene glycol. Polar phases typically interact strongly with polar analytes, causing longer elution times and better separations; likewise, non-polar phases are best suited for non-polar analytes. The interactions of the analyte and the stationary phase mean that the analytes are repeatedly sorbed and desorbed as the sample flows through the column. Ideally, the analyte mixture is injected in a narrow pulse, causing the eluted species to come through in distinct, narrow pulses based on the analyte's interaction with the column, giving a chromatogram that allows for the identification of each constituent.

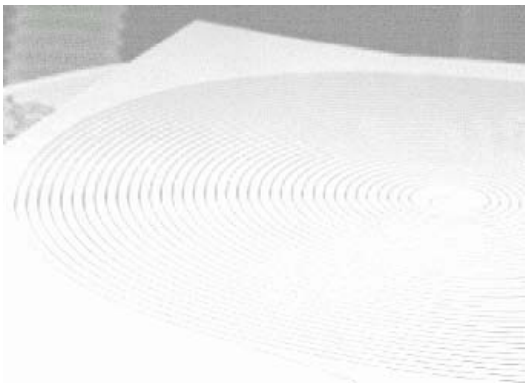

Figure 2.

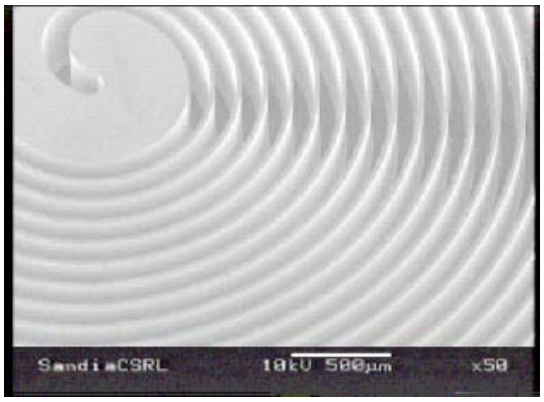

Figure 3.

Chromatographic separations can be performed either isothermally or with temperature ramping. The latter provides some advantages in separating mixtures of analytes with widely varying boiling points. A heater and temperature probe are affixed to the back of the GC column and are used to control the temperature.

The open channel GC's are effective for separating high boiling point chemicals (vapors of chemicals normally liquid at room temperature). For separating low boiling point analytes (normally gases at room temperature), columns packed with beads that are coated with a stationary phase are typically used.

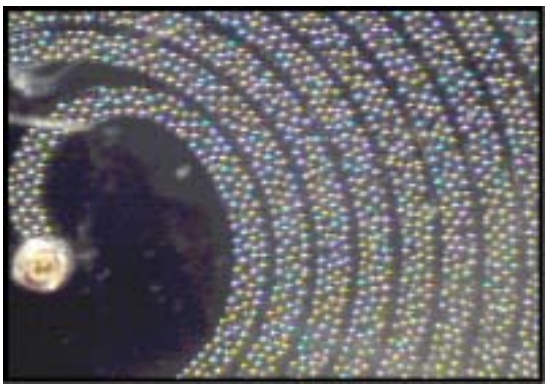

Figure 4.

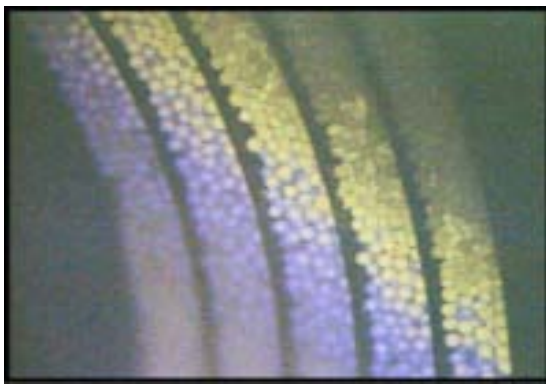

Figure 5.

The wall of the GC column can be coated with a stationary phase to aid in analyte separation. The stationary phase can be polar or non-polar depending on the analyte set to be separated. For separation of low boiling point gas analytes a packed GC column is best. The GC column can be packed with beads that are coated with a stationary phase as shown above.

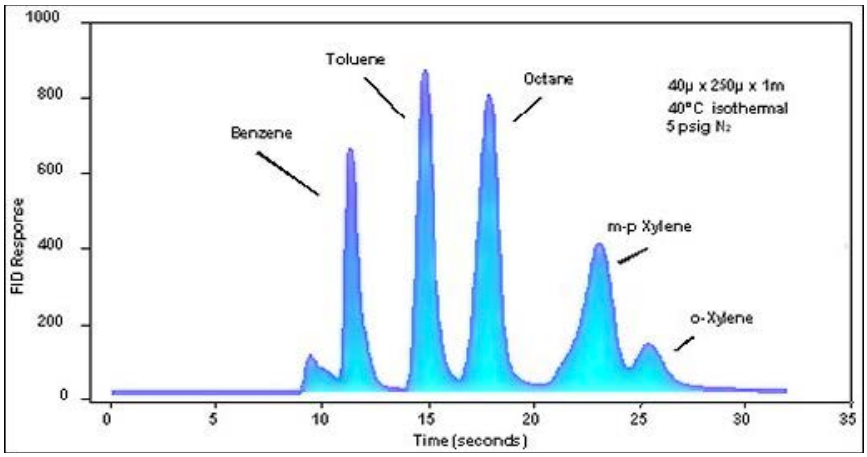

Figure 6.

This is a chromatogram showing the separation of benzene, toluene, the three xylene isomers, and octane. The separation is performed in only 30 seconds. All analytes can be resolved except for the meta and para isomers of xylene. These two isomers are very similar chemically and require a longer column for resolution.

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

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