# Micro-concentrator Interface for Real-Time VOCs sensors

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Air monitoring involves qualitative and quantitative analysis of a wide range of volatile organic compounds (VOCs). The detection and quantitative measurement of volatile organic compounds (VOCs) at trace levels in air emissions is of considerable importance in view of the hazard they pose development of sensitive sensors of the fast measurement of these compounds at trace (parts per million to parts per trillion levels) is necessary. Since VOC normally exist at trace level, sub-parts per million, preconcentration techniques are necessary for their analysis.

Over the last few years, we have developed and patented techniques for real-time monitoring of VOCs using traditional instruments such as gas chromatography mass spectrometry and non-methane organic carbon (NMOC) analyzer. Triangle Saintific Instruments of Research Triangle Park, NC, are currently commercializing the NMOC analyzer. The key component of these instruments is a micro-concentrator referred to as the microtrap. It consists of a narrow diameter (0.5-mm ID) metallic tube packed with an adsorbent. The VOCs pass along with a stream of air, and the organic compounds are adsorbed by the microtrap. Rapid electrical heating of the microtrap releases the adsorbed gases as a "concentration pulse", which serves as an injection for the detection system. The relatively small size of the microtrap allows it to be heated and cooled within a few seconds and results in fast response time. The microtrap serves dual purpose of sample concentration and injection. On the whole, the use of microtrap enhances the sensitivity by two to three order of magnitude, and makes feasible analysis of very low concentrations.

The aim of this project is take this proven, successful concept, and develop a micro-machined microtrap that can be coupled to any chemical sensor. The micro-concentrators were fabricated on <100> oriented 6-inch silicon wafer, which precedes in a series of oxidation, photolithography, chemical etching, and metal deposition steps similar to a regular IC device processing. The microtrap and the sensor will be fabricated on a chip using microelectronics technologies. Specifically, micro-electro-mechanical-system (MEMS) devices offer the advantage of ease miniaturization, the capability to include multiple sensors on a single chip, integration of different devices on the same substrate to fabricate an integrated sensor, and once the design has been validated, cost reduction through mass fabrication. It is envisaged to fabricate a micro-concentrator with micromachined channels etched into silicon wafer and then coated with thin-film stationary-phase adsorbent to act as the microtrap. By heating the microtrap, they are desorbed as a pulse of high concentration that will be detected by the sensor.

This paper presents a simplified process for the fabrication of micro-concentrator on the microchip substrate using standard photolithographic techniques and chemical wet etching followed by polymer coating [2]. We have evaluated the performance of the micro-concentrator with portable GC and analyzed the VOCs.

Channels of different dimensions were fabricated on 6-inch, p-type silicon wafers by etching them in the oxide, followed by deposition of nitride and metal layers, which were also patterned to form the conduction layer. The channels are lined with a conducting layer through which an electric current is passed to heat the microtrap.

A stationary phase, or a sorbent layer needs to be coated on the surface of this conducting layer. This layer would trap and concentrate the VOCs. However, polymeric phases such as OV-17, or polydimethyl siloxane, which are good candidate for the sorbent phase, these organic polymers have a low adhesivity for silicon or metal cannot be chemically bound on the metal surface. So, a coat of glass was specially applied on the channels by spinning them over the surface of the wafer, and this was coated with the polymer. The temperature characteristics of before and after spin-on-glass coating are presented.

**Reference:**

[1] S. Mitra, L. Zhang, N. Zhu, Xuemei Guo, "Characteristics of On-Line Membrane Extraction Microtrap G.C. System as Applied to Air and Water Monitoring", *Journal of Microcolumn Separations, 8, 1 (1996).*

[2] B. He et all, *Anal. Chem., Vol. 70, No. 18, Sept. 1998.*