*Exceptional service in the national interest*

Sandia National Laboratories

# MicroChemLab

## *Preconcentrator - Stage One*

The first stage of the MicroChemLab system is the preconcentrator unit. The preconcentrator unit is a sample collection/concentration stage that samples and collects analytes from an inlet gas sample stream and ejects them on command into the separation stage. Typical sample collection times from the inlet gas stream are 30 to 60 seconds. This stage consists of a thin silicon nitride membrane supporting a patterned metal film heating element.

The membrane is coated with a templated porous sol-gel to selectively and reversibly absorb analytes of interest. By tailoring this preconcentrator film, analytes of interest can be captured, while allowing interferents to pass by.

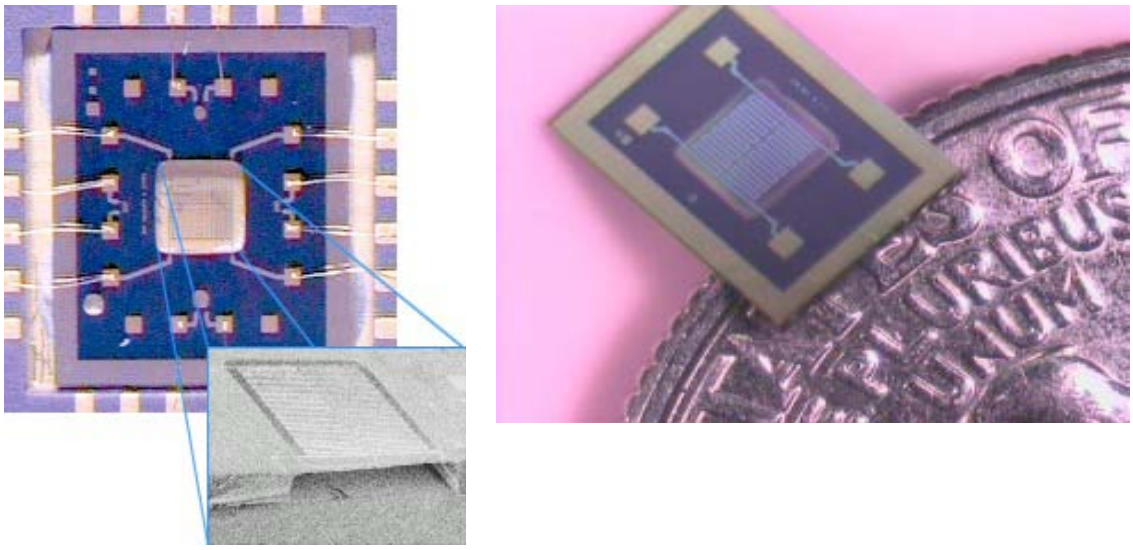

**Figure 1.** The preconcentrator is seen here resting on a dime. The size of the PC is 4.5mm X 6.5mm with a heated area of 2.5mm in the center.

The suspended membrane structure of the preconcentrator gives it an extremely low heat capacity, which allows for very rapid heating. The application of a current pulse to the heater causes the film layer to heat rapidly and uniformly; this thermally desorbs the collected analytes in a narrow concentrated chemical pulse. Using a sample collection time of 30 to 60 seconds causes a 100-fold concentration enhancement in the desorbed pulse over the inlet stream. This desorbed pulse occurs over approximately 0.2 seconds.

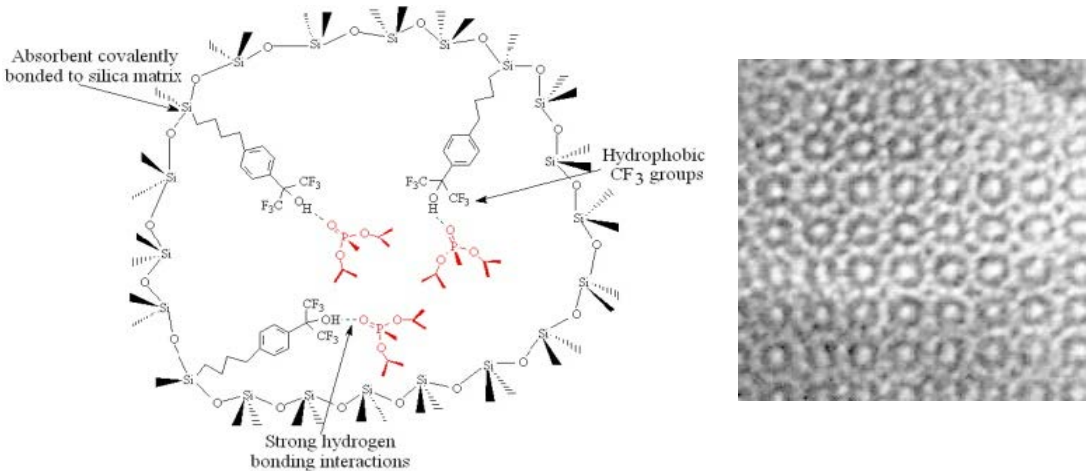


**Figure 3.** The preconcentrator has a membrane that can only be coated with a film to selectively adsorb analytes. This can be accomplished using tailored surface chemistry, tailored porosity or a combination of the two.

To increase collection area, while minimizing power consumption, Sandia has independently implemented the three-dimensional preconcentrator 3D-PC) designs. The available surface area for depositing or packing in coatings has increased in our 3D-PC via the use of wafer thickness silicon structures as adsorbent supports. The planar device loads more rapidly at first, but saturates at 2 minutes of collection time. In contrast, the 3D-PC takes more than 20 minutes to saturate. This allows lower concentrations of analyte to be collected, and/or allows expansion of the analyte set to compounds not easily collected with the planar PC. Comparing the power consumption of the two devices, the parallel-flow 3D-PC displayed improved performance while consuming only 0.6 W of power, compared to 3 W of power for the thermal desorption tube.

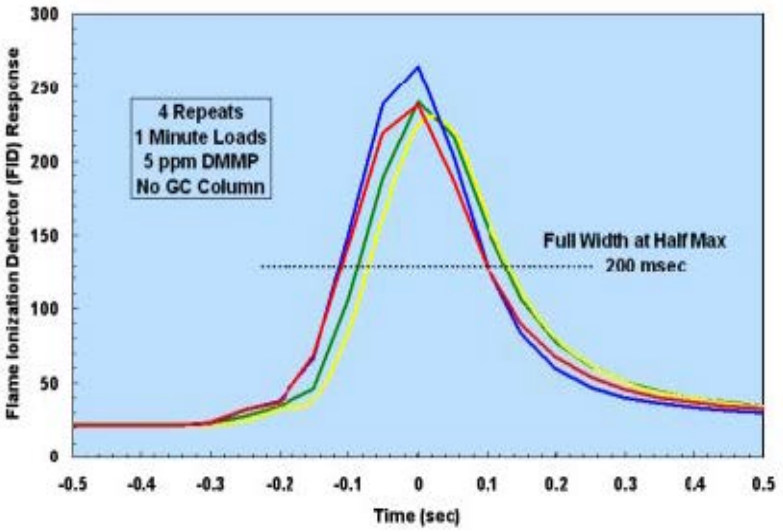


**Figure 4.** This graph illustrates how quickly analytes can be flash desorbed from the membrane.

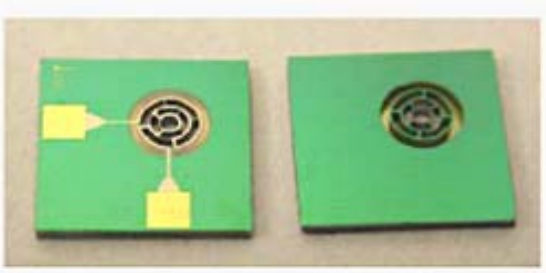

**Figure 5.** 3D-PC with flow perpendicular to the substrate surface. Front and rear sides of the die show an adsorbent support of cylindrical cylinders of Si, all suspended by a SiN membrane. The central part of the SiN membrane is etched open to allow flow through the device

**Figure 6.** (Left) 3D-PC with flow parallel to the substrate surface. A fin-like Si adsorbent support is suspended by a SiN membrane.

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

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