FABRICATION OF CHEMICAL GAS SENSING SYSTEM WITH STEREOLITHOGRAPHY

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Stereolithography offers the capability to fabricate microstructures with aspect ratios greater than 100 at lower cost and with shorter fabrication times than a micromachining process. The fabrication cost is much lower than micromachining for small volume manufacturing[1]. The benefit of integrating the stereolithography with a micro-fabrication process is that it can improve the 2.5 dimensional structures obtained from a micro-machining process to real 3 dimensional structures in stereolithography. Stereolithography also allows the integration of all the fluidics components into the microfluidics system in the presence of leak free packaging[2].

The gas chromatography column has been fabricated on silicon while the first miniaturized GC was reported almost 20 years ago[3]. By comparison, the aim of our present work is to demonstrate the capability of the stereolithography technology combined with micro-fabrication processes for designing and fabricating of a miniaturized chemical gas sensing system.

A miniaturized gas chromatographic column (0.5 and 1mm ID) with a length of 100 cm has been fabricated with a stereolithography machine (SLA 3500, 3D Systems, Valencia, CA). The digital image of the micro-column under the microscope is shown in Figure 1. The material for stereolithography was liquid photopolymer SL 7510 (3D Systems, Valencia, CA). Since the dimensions of a column fabricated with SLA can be changed easily in a CAD design, the length and dimensions of the column can be designed differently for different applications. Fabrication of a gas chromatographic column in 3 dimensions is a good illustration of the use of stereolithography. In other words, instead of fabricating the entire length of the column on the same plane, it can be fabricated on multiple planes, stacking all the layers together to minimize the overall size of the device.

To apply the micro-column to an application in chemical detection, a silicon micromachined chemical sensor can be integrated into the micro GC column for chemical gas sensing (Figure 2). Since the micro-columns are made of transparent polymer, the gas can be detected using an optical method[4]. An optical sensor can also be introduced into the sensing system as in Figure 3.

The miniaturized gas chromatographic column system can correspond to the integration of polymer micro-columns with a chemical sensor, valves, and pump, as shown in Figure 4. This represents a good demonstration of a functional device that can be constructed with stereolithography technology.

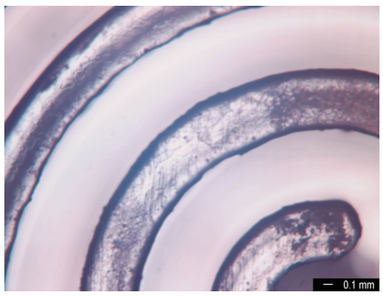

Figure 1: The digital image of the gas chromatographic spiral channel with 500 um wall thickness and 1 mm spacing.

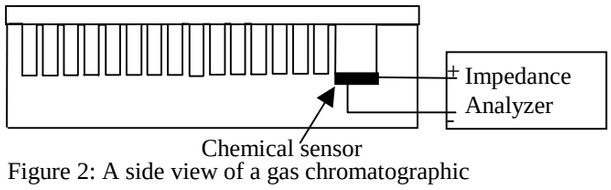

Figure 2: A side view of a gas chromatographic column with a chemical sensor integrated at the exit of the column

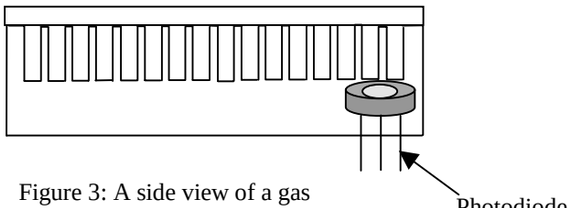

Figure 3: A side view of a gas chromatographic column with an optical sensor for chemical detection.

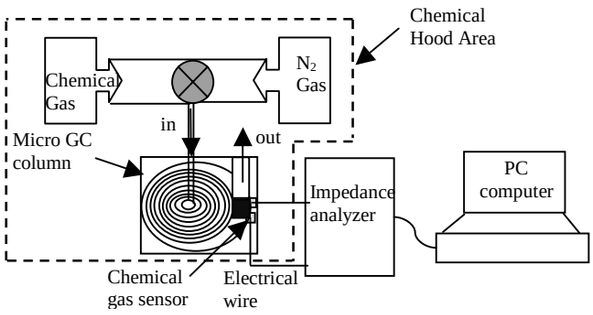

Figure 4: Setup for chemical gas sensor detection with a micro GC column

References

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