

A Micromachining Pre-concentrator Focuser for Improving the Efficiency of Fruit Transportation Supply Chains

Outline and Aims

A micromachining preconcentrator focuser is very important component in gas detection systems to analyse the contamination of air. In fruit transportation logistics systems, it is very important to attain good maturity and ripening levels; this can be controlled by the freight's emission of ethylene gas (Table. 1). In order to achieve this it is necessary to measure the levels of ethylene gas in fruit transportation containers to maintain high maturity and ripening so the fruit can reach the customers in very good condition. The intelligent container (figure.1) can be used for fruit transportation in logistics supply chain, since it provides full and updated informations about the fruits. The master controller of the supply chains

will be updated by the fruits' status, and based on this data the decision will be made "which container has to be delivered to which customer along the supply chain", with the result that a high quality of ripened fruit will be delivered to customers. Traditionally, analyzes of contaminated air is performed by a large bench gas measurement system in the laboratory. However, these systems suffered from the large size, large power supplies, long analysis time and large sampling volumes. Many research work has been made to develop a high performance portable gas detection system. Therefore, there is considerable interest in a fast, reliable, and small system that can provide real time monitoring for gas analysis. A micromachining

preconcentrator-focuser (PCF) is very necessary to enhance the sensitivity of the ethylene sensor which is limited by the low parts per million (ppm) concentrations. The working principle of PCF is that, the low-concentration compounds flow through the PCF for certain time to allow the adsorption material to adsorb as much as possible then these compounds will be desorped again after heating the adsorption material. Hence, the high concentration released compounds from the PCF will be detected very easily by the sensors. Monitoring of ethylene gas in fruit container will enhance the performance of fruit supply chain logistic system by reducing the cost, required delivery time and quality of the fruits.

Fruit Type	Ethylene Production Rate [µl/(Kg.h)]	Ethylene Concentration in the container [ppb/h]
Orange	0.01 ~ 0.1	15 ~ 150
Water melon	0.1 ~ 1.0	150 ~ 1500
Banana	1.0 ~ 10.0	1500 ~ 15000
Apricot	10.0 ~ 100.0	15000 ~ 150000
Apples	> 100.0	> 150000

Table 1: Emission of ethylene from some types of fruit



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 Finished in September 2009

Problem to be solved

Conventional pre-concentrators devices are large in size and consume high driving power. They also suffer from high complexity and limited heating efficiency due to their large size

A micromachining preconcentrator focuser can overcome these limitations by significantly reducing the device size, thermal mass and required driving power. A micro fabricated pre-concentrator has to be designed to enhance the detection of ethylene gas. However, the devices will be designed to concentrate ethylene to make it more easily detectable by the sensor system. The device design, including the selection of suitable adsorbent material, fast and efficient micro heater, the fabrication technology, the thermal measurements and the desorption performances will be studied.

Motivation and Research Method

In order to obtain an optimum performance from the preconcentrator focuser, it is important to collect the maximum amount of the target gas sample from the injected air sample and then release with high concentration.

Many factors have to be considered in the design and fabrication of a micropreconcentrator-focuser for ethylene gas sensing applications. One of these factors entails the checking and characterization of suitable adsorption materials: The microheater design should combine both a large volume for the adsorption material, fast and uniform heating of the adsorbents.

In the designing of a preconcentrator focuser as a component in gas analysis microsystem, many factors such

as size, driving power, pressure drop and fabrication technology need to be studied and highlighted because it can magnify the small analyte concentration to a much higher level of concentration which can be detected easily by the sensors.

However, The preconcentrator focuser consists of micro channels in which the adsorption material is filled, two ports for passing and collecting of the sample and heater beams used to heat up the adsorption material.

An air sample contains the ethylene is passed through the preconcentrator focuser so ethylene will be adsorbed by adsorption material which will be heated resulting a desorption of ethylene but in high concentration level which finally can be easily detected by gas sensor.



Figure 1: The Intelligent Container