Characterization of Novel Microreactors for Breath Analysis

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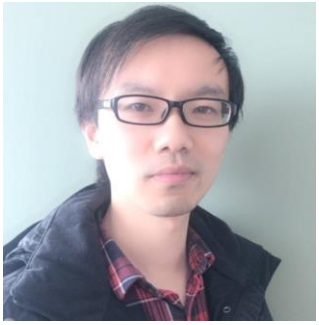
Abstract

Breath analysis is promising as a noninvasive diagnostic tool for early detection of lung cancer and other diseases. Development of a new approach for analysis of volatile organic compounds (VOCs) in exhaled breath is critical for fulfillment of the promise. Quantitative analysis of trace VOCs is a key for identification of disease metabolic markers in exhaled breath. We report the development of new microreactors with thousands of micropillars in a microfluidic channel that have been engineered to selectively preconcentrate trace volatile aldehydes in exhaled breath. The microreactor chips are fabricated using MEMS fabrication technologies. The micropillar surfaces are functionalized with a reactive quaternary ammonium aminooxy salt for trapping trace carbonyl compounds in exhaled breath by means of oximation reactions. The microreactors are used for directly preconcentrating carbonyl compounds in exhaled breath. One challenge of the microreactor approach was that the capture efficiencies of carbonyl compounds were significantly affected by the gas flow rate. This work investigated the effects of the gaps between the micropillars and the microreactor length on capture efficiencies of carbonyl compounds at different flow rates. A reaction engineering model was developed to understand the effects of microreactor length on the capture efficiencies of carbonyl compounds at different air flow rate. Deuterated carbonyl compounds were spiked into breath samples for characterizing the capture efficiencies of the microreactors. The new microreactor can be operated at much higher sample flow rate with the same capture efficiencies of VOCs.

Biography of Presenter

Qi Li is a fifth year PhD student in the department of Chemical Engineering at the University of Louisville. His research interest focuses on breath analysis, microfabrication of micro-devices and different analytical chromatography methods. His PhD project is to develop the microdevice for breath analysis and using mass spectrometry to detect as many as volatile organic compounds for statistical analysis, and furthermore to find the potential biomarkers of lung cancer disease. He has demonstrated the quantitative analysis of carbonyl volatile organic compounds (VOCs) and identification of lung cancer VOC markers in exhaled breath using unique silicon microreactor technology.