THz sensor in microfluidic devices for on line determination and control of ethanol concentration

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The paper presents a sub-THz sensor for on line detection of label-free ethanol concentration in water-ethanol mixtures in microfluidic devices.

Techniques to characterize liquids are of fundamental importance for chemistry and life sciences [1][2].The sub-terahertz (frequency 10 to 500 GHz) sensor allows for such interrogation in a label-free environment through electromagnetic measurements of small permittivity changes. We have developed a chemical sensing methodology that integrates sub-terahertz reflection in time-domain sweep (THz-TDS) combining into microfluidic devices fabricated on silicon, glass and polydimethylsiloxane (PDMS) outlets coupled into the sensor.

In the experimental procedure we first prepared solutions with known concentrations to calibrate the system and obtain the response for ethanol density varying from 0 to 100%, as shown in fig. 1. With the calibrated sub-THz sensor in a reflection mode at 60 GHz frequency and room temperature, we reached amplitude signal responses from 0 dB to 2.79 dB. Then we attached the micromixer with microchannels width from 100 to 300 µm and depth from 20 to 64 µm, to the system (fig. 2a), and by sweeping liquid injection by syringe pump with flow rate between 7.5 and 125 µl/min, we established a relationship between the flow rate and ethanol concentration in the system.

Relative variation of ethanol concentration detected was in the range from 0.19 to 0.32 and percentual error between the required and measured ethanol concentration was from 0.38% to 1.65%, with R-squared 0.9997, as shown in fig. 2b. In summary, this paper presents aplication of THz-sensor for micromixer devices characterization and linear control with label-free samples with non-invasive and non-destructive on line measurements.

References:

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[2] Whitesides, G. M. The origins and future of microfluidic.Nature.Vol. 447. n.27.368 – 373, 2006.

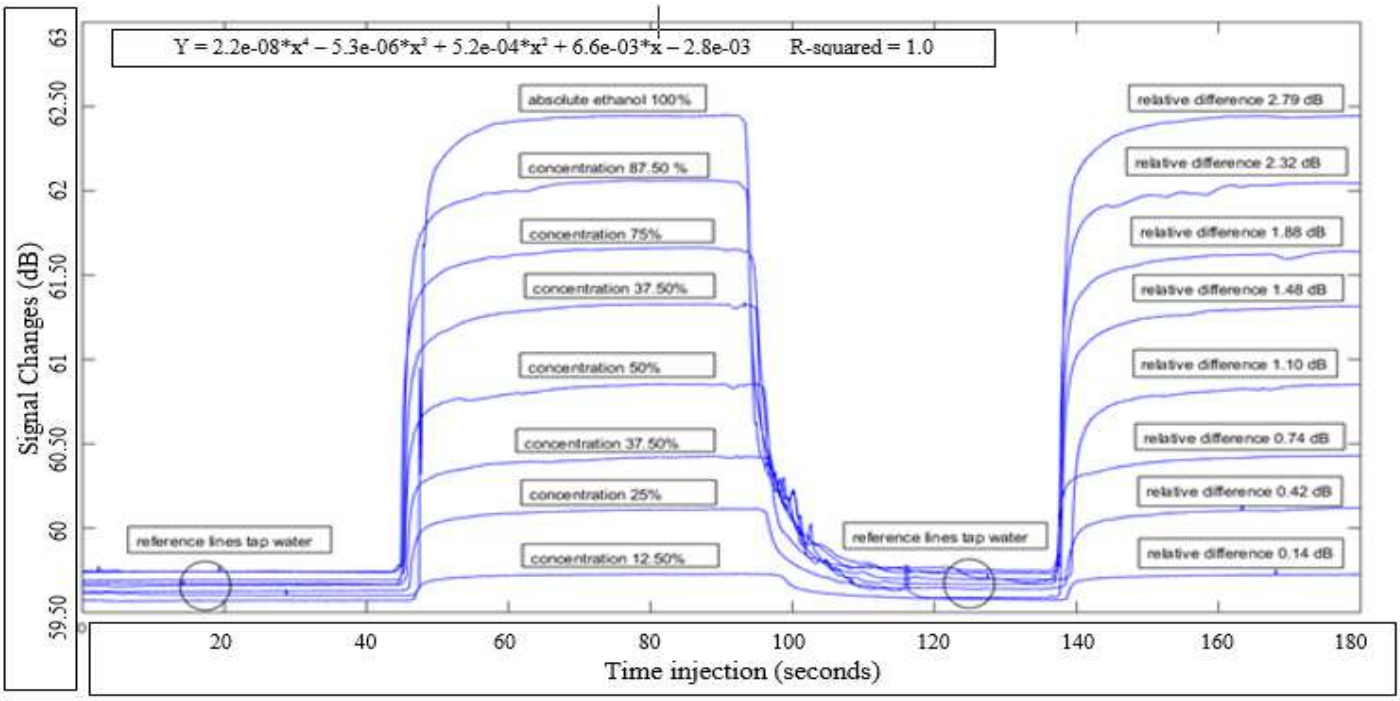

Figure 1: Sensor response in dB to ethanol concentrations in mixtures with water varying from 12.5% to 100%.

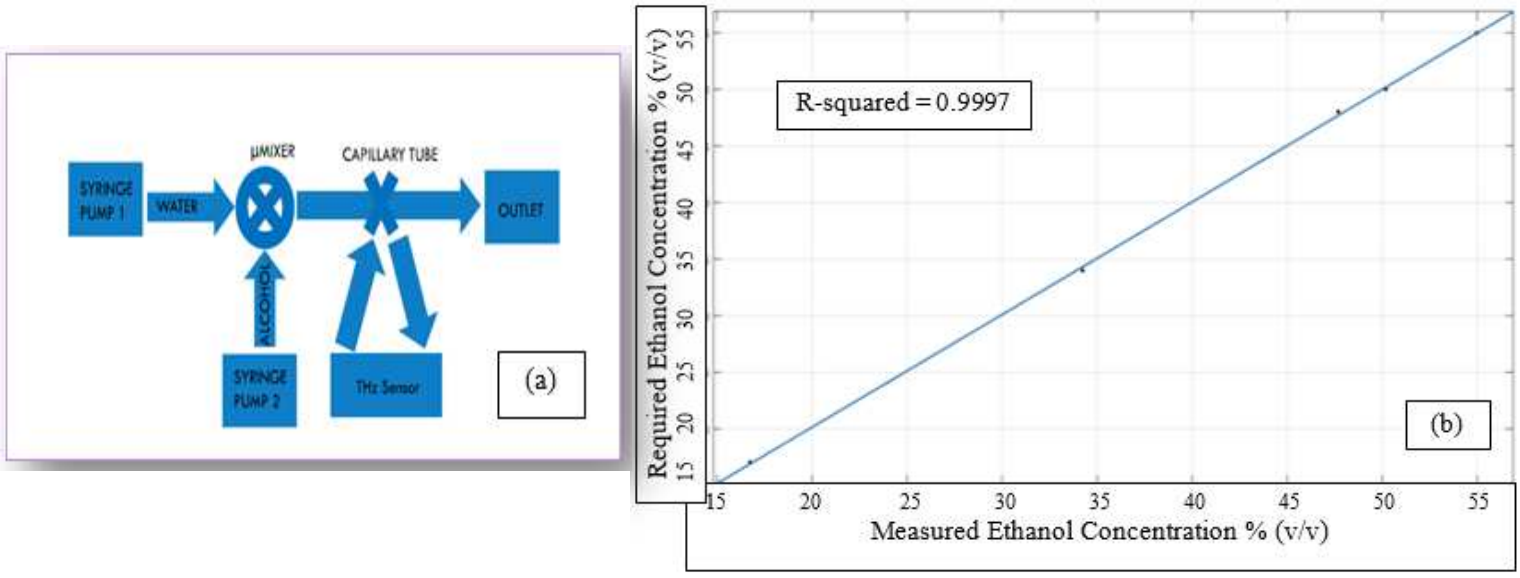

Figure 2: Setup of THz sensor, injection system and micromixer (a). Measured versus required ethanol concentration (b).