Coupling of a sub-THz liquid sensor for online microfluidic sensing

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This paper reports on the performance of a sub-THz liquid sensor tool coupled to a microfluidic system. Non-invasive, non-destructive and online measurements are demonstrated for the determination of methanol, ethanol and biomolecule concentrations and for controlling microfluidic devices. Techniques to characterize liquids are of fundamental importance for chemistry and life sciences [1][2]. The frequency $10^{10}$ to $10^{13}$ Hz range allows sensors for such interrogation in a label-free manner through electromagnetic measurements of small permittivity changes. We have developed a chemical sensing methodology that integrates sub-terahertz sensor technology into microfluidic devices fabricated on silicon, glass and polydimethylsiloxane.

The proof-of-concept sensor in micromixer applications operating at 60 GHz was demonstrated for known ethanol concentration ranging from 0 to 100%, with a corresponding signal change of 2.79 dB. For microchannels dimensions of 100 µm width and 20 µm depth. The sensor allowed to establish the relationship between the flow rate controlled by a syring pump and ethanol concentration in the microfluidic system, the sensor allowed to control the ethanol concentration with a precision of <1.65%. Similar setup was used at room-temperature for water-to-methanol ratio determination with high dynamic range [3]. The same technology was applied for biomolecule studies (determination of concentrations, conformational changes, concentration and molecular binding), using a very small sample volume and high sensitivity [4].

The technology could be applied for the characterization of micromixers, the analysis of biomolecules (e.g. proteins, DNA), including concentration measurements, and hydration shell studies.