Methods and Systems for On-chip Spectrometry
Technology #18021

Applications

- Biological and chemical sensing
- Portable sensing and lab-on-a-chip functionality

Problem Addressed

Advances in on-chip spectroscopy are resulting in improved chemical and biological sensing applications. Fourier Transform Infrared (FTIR) technology, a leading spectroscopy system, exhibits an enhanced signal-to-noise ratio over other spectroscopy designs by utilizing Fellgett's advantage. To achieve this, FTIR spectrometers have a variable arm path length and use modulation of the index of refraction to enable spectral decomposition of light from the interferogram. However, this approach often requires discrete optical elements resulting in a costly and bulky design. In addition, it results in increased system complexity from mechanical moving parts and reduced system robustness. Many on-chip spectrometers use spectrum splitting, a much less effective spectrometry system, due to size and power constraints. These designs have a reduced signal-to-noise ratio because they lack the Fellgett advantage present in FTIR spectrometers.

Technology

The invention is a FTIR interferometer that extracts spectral density information through direct modification of the waveguide path. This results in an inexpensive and robust design that is compatible with on-chip integration. Direct optical path modulation via switching has also proved to be a far more effective method for spectral decomposition than modulating the index of refraction. Using solid-state on-chip switches eliminates reliability problems, as there are not mechanical moving parts, and also features reduced complexity and increased system robustness. The invention is both highly tolerant of fabrication errors and extremely generic. It can be constructed on a wide variety of waveguiding platforms including silicon-on insulator, III-V semiconductors and polymers.

Advantages

- Superior spectral resolution compared to prior on-chip FTIR devices
- Compatible with compact on-chip integration
- Highly tolerant of fabrication errors
- Inexpensive and simple FTIR sensor design without bulkiness
- Generic design excellent on a wide array of on-chip waveguiding platforms

Categories For This Invention:

Electronics & Circuits
Electronic Components
Photonics
Sensors (Photonics)
Spectroscopy (Sensors)

**Intellectual Property:**

Methods and systems for on-chip spectrometry
PCT 2017-139560
Apparatus, systems, and methods for on-chip spectroscopy using optical switches
Issued US Patent
Apparatus, systems, and methods for on-chip spectroscopy using optical switches
Issued US Patent

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**Publications:**

*Miniature Spectrometer and Beam Splitter for an Optical Coherence Tomography on a Silicon Chip*
Optical Express
July 15, 2013

*On-chip Infrared Spectroscopic Sensing: Redefining the Benefits of Scaling*
IEEE J. Sel. Top. Quantum Electron
2017

**External Links:**

Juejun Hu Research Group
http://web.mit.edu/hujuejun/www/

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