1 Introduction

Gas sensors are key elements in many applications that affect the quality of our natural life as well as the efficiency of industrial production. In many of these applications, multiple gases must be monitored simultaneously over a long period of time with minimal maintenance and in different locations. For such features to exist, optical techniques are the best candidates. For these reasons, spectroscopic gas sensors have gained both academic and industrial interest in the last few years. Optical spectroscopic sensors are not in direct contact with the measured gases, and they are usually able to detect and quantify a wide range of gases simultaneously, depending on their spectral range. A Fourier transform infrared (FTIR) spectrometer is a good example of a device that can satisfy most of these required features. However, a FTIR spectrometer is usually a desktop instrument with high cost and weight; it also needs calibration and readjustment. The recent development in this domain using new technologies, such as the microelectromechanical systems (MEMS) technology, can overcome such obstacles as demonstrated in the literature in the last two decades. This technology provides the necessary compactness and low production cost.

This Spotlight is focused on using a MEMS FTIR spectrometer as a core building block in optical gas sensing. The micro-optical bench technology used for this development is discussed, followed by presenting the basics of the sensing technique. Then an overview of the system components and their state of the art is given including the light source, the miniaturized interferometer and gas cell, the optical connectivity, and the detection for both the near-infrared (NIR) and the mid-infrared (MIR) spectral ranges. A comparison is carried out showing the pros and cons of each range accounting for the absorption cross sections of the gases and the noise performance of the system components. Next, the impact of the limitation in the signal-to-noise ratio (SNR) and spectral resolution due to miniaturization on the gas sensor performance is discussed. Then, an experimental setup to evaluate the sensor performance and extract its sensitivity is explained and the experimental results for detecting acetylene (C_2H_2) and carbon dioxide (CO_2) gases are presented as examples. Finally, this Spotlight is concluded by a discussion on the foreseen challenges and a summary of the work done in this direction.

2 Gas Sensing

There are various applications for gas sensors: industrial, medical, automotive, petrochemical, and environmental. They are primarily used for indoor and outdoor air-quality monitoring and maintenance, detection of combustible and toxic gases, exhaust emission control in automobiles, etc. Thus, there is a need to study their major market sectors and technologies. Because spectroscopy-based gas sensing—which is the main subject of this Spotlight—is usually carried