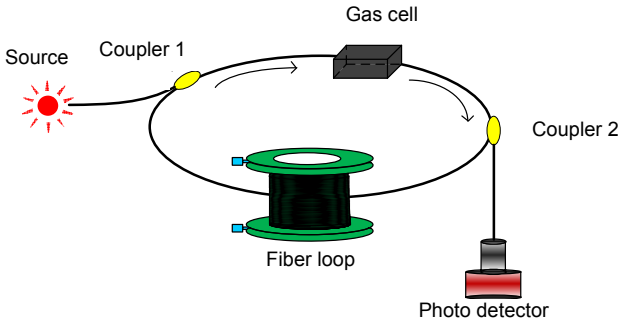
DOI: 10.3969/j.issn.1003-501X.2017.09.002

Applications of optical technology in gas concentration detection

Shutao Wang, Changbing Wang, Zhao Pan*,

Deming Kong, Qi Cheng, Zhifang Wang

Institute of Electrical Engineering, Yanshan University, Qinhuangdao 066004, China



Schematic diagram of FLRDS (*Sensors and Actuators B*: *Chemical*, 2016, **228**: 665–672.).

Abstract: With the problem of air pollution and the improvement of life quality, people are increasingly anxious about the surrounding air quality in recent years, which also promotes the development of gas concentration detection technologies. At present, these technologies have focused on electrochemical method, catalytic combustion, gas chromatography and optical methods. Among them, the optical method of gas concentration detection has its unique advantages, such as high sensitivity and high accuracy. Through the combination of optical fiber sensing technology, this method can realize the detection of gas concentration in extreme environment, with the advantages of anti-electromagnetic interference, flame retardant, intrinsically safe, and so on. In contrast, the non-optical detection methods make some bad performance, such as poor sensitivity, bad accuracy and low reproducibility, which are unable to be applied to the industrial site.

And seven common optical methods for gas concentration detection are described, which contains 3 conventional gas concentration detection technologies and 4 novel methods. The former is composed of optical interferential method, photoacoustic detection (PAS), and correlation spectroscopy. The latter consists of tunable diode laser absorption spectroscopy(TDLAS), evanescent wave field sensing technology, hollow core photonic bandgap fiber(HC-PBF) sensing technology and fiber loop ring-down spectroscopy(FLRDS). The basic principles, advantages and disadvantages of each method are given and compared in detail. The improvement work and some novel ideas are presented. The applications of combined methods are also discussed. The prospect of optical gas sensing is listed, which mainly refers to miniaturization, intelligence, portability, low power consumption, high accuracy, fast response and distributed multi-component telemetry technology.

At last, some new ideas and technologies have been pointed out for gas concentration sensing, such as seeking sensitive films that can interact with the measured gas, adopting special fibers, or using the cladding doped rare earth elements. In addition, on the basis of evanescent field sensing, researchers combine physics with optics to form surface plasmon resonance fiber gas sensing. And the use of hollow core photonic bandgap fiber for the gas chamber, sharing the way with the optical path, increases the utilization of optical power and can achieve distributed sensing, but the gas diffusion cycle time should be considered. The emergence of laser technology makes the optical detection method more excellent, and with the development of wireless communication technology and the awareness of people's health, harmful gas detection devices will be more and more popular with the family. Simultaneously, the telemetry distributed sensing technology for gas concentration will also become increasingly common in factories.

Keywords: optical sensing; gas concentration; detection method; fiber optics sensing

Citation: Wang Shutao, Wang Changbing, Pan Zhao, *et al*. Applications of optical technology in gas concentration detection[J]. *Opto-Electronic Engineering*, 2017, **44**(9): 862–871.

See page 862 for full paper.