Label-free detection of dissolved carbon dioxide utilizing multimode tapered optical fiber coated zinc oxide nanorice

ABSTRACT

A label-free detection for dissolved carbon dioxide (dCO 2) is developed using a tapered optical fiber sensor. The tapered region of the optical fiber is coated with the zinc oxide (ZnO) nanorice and used as a probe for dCO 2 sensing. The sensor probe was exposed to different concentrations of dCO 2 solution ranging from 10 to 100 ppm. ZnO nanorice can adsorb dCO 2 via strong hydrogen bonding due to the presence of plenty of oxygen atoms on its surface layer. The interaction between ZnO nanorice and dCO 2 changes the optical properties of the ZnO nanorice layer, resulting in the change in reflectance. From the experiment, the result shows that there is an improvement in the sensitivity of the sensor when higher concentration was used. A broad linear trend ranging from 0 to 60 ppm (R2=0.972) is observed for the sensor probe that is coated with 1.0 M of ZnO nanorice compared with the 0.1 M and 0.5 M ZnO nanorice concentrations. The sensor sensitivity obtained is 0.008 mW/ppm. The sensor demonstrates a response and recovery time of 0.47 and 1.70 min, respectively. Good repeatability is obtained with the standard deviation in the range of 0.008–0.027. The average resolution calculated for this sensor is 4.595 ppm.

Keyword: Optical fiber sensor; Tapered optical fiber; Zinc oxide; Dissolved carbon dioxide