A Highly Sensitive Sensor of Methane and Hydrogen in Tellurite Photonic Crystal Fiber based on Four-Wave Mixing

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Abstract

A tellurite photonic crystal fiber (PCF) sensor structure is proposed for simultaneous measurements of the methane and hydrogen. The structure is a simple hexagonal three-cladding structure, and six air holes in the inner cladding are coated with methane-sensitive film and hydrogen-sensitive film respectively. Based on the degenerate four-wave mixing (DFWM) theory, the direct relationship between the wavelength shifts of Stokes spectrum or anti-Stokes spectrum and the variations of gas concentration can be established to realize the accurate detection of gas concentration. The influences of pump wavelength and gas-sensitive film thickness on the gas sensitivity are investigated, and the maximum sensitivity of methane and hydrogen after parameter optimization are -2.052nm/% and -0.236nm/%, respectively. The linearity of the fitting can reach up to 99.95%, and the low detection limit of methane is 450ppm and hydrogen is 2500ppm. The sensing method based on four-wave mixing in non-silica photonic crystal fiber also can be extended to other detections of gas-mixture in the mid-infrared field.

Full Text

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