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Abstract

Hollow-Core Photonic Crystal Fibres (HC-PCFs) have emerged as an area of interest for fibre-optic based distributed gas sensing. In order to allow the gas to enter the hollow core of the fibre, various techniques such as lateral drilled side holes have been investigated in the literature. However, it is essential to understand the mechanisms of gas flow in HC-PCFs with drilled side holes in order to determine the optimum design parameters of the sensor such as the size and spacing of drilled side holes. This study aims to analyse the gas flow behaviour and determine the response time of HC-PCFs with drilled side holes by developing and applying a numerical model based on gas diffusion in a microchannel. The model is validated against the results of two different experimental studies. The model is then applied to determine the response time is a function of the length, the number and spacing of side holes and the gas type (methane and acetylene). It is found that an inverse relationship exists between the effects of number and spacing of side holes on the response time and the optical loss, suggesting that an optimum design point exists.

Keywords: Hollow-Core Photonic Crystal Fibre; Gas sensor; Gas dynamics; Diffusion; Response time.