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High sensitivity photonic crystal waveguide sensors

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Abstract A theoretical investigation of the sensitivity of an optical liquid sensor, based on photonic crystal waveguide, is carried out. The sensing principle is based on the variation of the effective index of the waveguide induced by analyte refractive index change. The sensor modelling is carried out by using the 3D finite element method. The influence of geometrical parameters on the sensor sensitivity has been investigated. The results show that the sensitivity can be optimized by an appropriate choice of the geometrical parameters and a sensitivity superior to 20 has been achieved, near the cut-off in the slow light region, which is several times higher than that can be achieved with conventional waveguides.

Keywords Optical sensors · Photonic crystal waveguides · Finite element method

1 Introduction

In recent years considerable research effort has been developed to employ optical micro and nano-sensors in a great number of application fields. Photonic sensors have attracted great attention because of their immunity to electromagnetic interference, good compactness and robustness, high sensitivity and compatibility with fibre networks. Using integrated photonic technologies, it is possible to fabricate very compact, high performing and low-cost chemical and biochemical sensors. Different kinds of integrated optical chemical sensors have been proposed over the years, like those based on directional couplers (Nacer and Aissat 2012; Passaro et al. 2009), Mach-Zehnder interferometers (Luff et al. 1998; Qui et al. 2002), ARROW waveguides (Prieto et al. 2000; Benaissa and Nathan 1998), hollow waveguides (Campopiano et al. 2004), surface plasmon resonance (Dostalek et al. 2001), Bragg gratings Veldhuis et al. (1998); Hopman et al. (2005), micro-ring resonators (Dell'Olio and Passaro 2006; Chao et al. 2006), slot waveguides (Dell'Olio and Passaro 2007; Bettotti et al. 2011) and photonic crystal (Di Falco et al. 2009; Scullion et al. 2011).

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