Background: Gas-filled microstructured optical fibres [1-4], in particular photonic band-gap fibres (PBGFs), have been suggested as a replacement for bulk-optic cells in optical gas sensors. However, the extended filling time required (~ hours) limits their usefulness in most real-world applications. Recently, sealed gas-filled fibres have been employed as fixed wavelength references for telecommunications [3], where filling time is no longer important. We now demonstrate the use of a sealed gas-filled PBGF as reference cell in a high-selectivity correlation spectroscopy gas sensor. The advantages of using PBGFs in this application are:- their suitability to sensing hazardous gases (only ~1 µl.m⁻¹ of gas is required); their capability for providing long effective path lengths (because of high overlap between the guided mode and enclosed gas, and very low fibre loss: ~0.05 dB.m⁻¹); and the ability to produce compact gas cells by simply coiling the fibre.

Method: As illustrated in Figure 1, a path-switched complementary source modulation (CoSM) correlation spectroscopy sensor [5] was constructed with a reference cell consisting of a 722.5 mm length of PBGF (SEM image shown in Figure 2). We designed the PBGF to have a transmission window overlapping the P- and R-branch absorption bands of acetylene (ethyne, C₂H₂) at 6579 cm⁻¹, or 1.5 µm. This gas cell was filled with 100% C₂H₂. Gas samples containing various acetylene concentrations (obtained by volumetric mixing) were introduced at three-minute intervals into a standard 100 mm free-path, reflective measurement cell.

Experimental results: Figure 3 shows the resulting change in modulation index measured for different acetylene concentrations in the measurement cell. Favourable return-to-zero behaviour and noise levels were obtained. A noise-limited sensitivity of 0.17% acetylene was achieved with a four-second integration time.

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