Fiber Bragg gratings with micro-engineered temperature coefficients: supplement

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1. Introduction

In this work, we originally used glycerol as the liquid within the optical fibers in order to change the thermal sensitivity of fiber Bragg gratings (FBGs). However, these devices had a relatively high loss and a large variation in reflectivity with temperature at 1550 nm, so proprietary refractive index oils from Cargille Labs were used instead. We have included the earlier work with glycerol here as it may have value for applications at other wavelengths or for applications where these oils are not suitable.

2. Glycerol-filled devices

An alternative liquid that has been used in the devices was glycerol solution. Glycerol is non-toxic and non-flammable with a much larger thermo-optic coefficient of $\frac{dn_{gly}}{dT} = -225 \times 10^{-6}{}^{\circ}\mathrm{C}^{-1}$ [1] than that of fused silica. Furthermore, pure glycerol has a refractive index of 1.4473 at 1550 nm at room temperature [2].

An advantage is that glycerol can be easily tuned to a lower refractive index by dilution with water to match the refractive index of fused silica, making it easier for designing different devices that meet different requirements. Here we present the high sensitivity and low sensitivity devices filled with glycerol solution in Fig. 1 and Fig. 2. In these two devices, the microchannel fabrication methods are the same but filled with glycerol instead. Glycerol solution of 90% glycerol concentration was chosen for the high sensitivity device and 85% of that was chosen for the low sensitivity device. It is well understood that the temperature sensitivity at a given temperature is determined by the refractive indices of liquid.

A key disadvantage of glycerol solution, however, is the high absorption ratio at 1550 nm [1]. As a result, the loss of the device was as high as 5 dB at room temperature. Even worse, the loss is dependent on the temperature in both devices which is unwanted. Therefore, glycerol was selected as a testing material rather than be used in the final device.

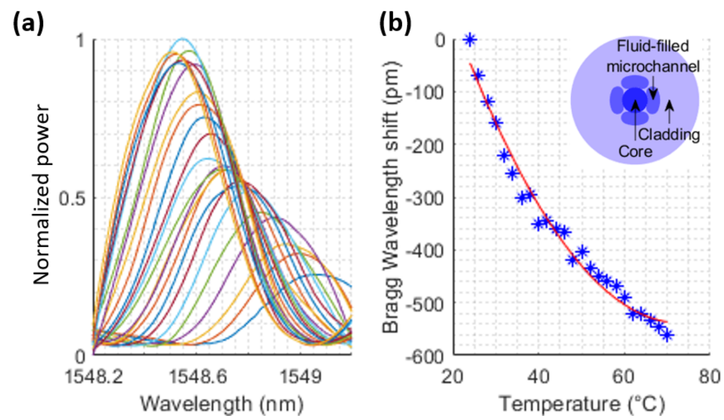

Fig. 1. A high temperature sensitivity FBG device with (a) the spectrum of reflection at temperatures from 22 °C to 70 °C, and (b) a plot of the Bragg wavelengths against temperature. Inset: the cross-section profile

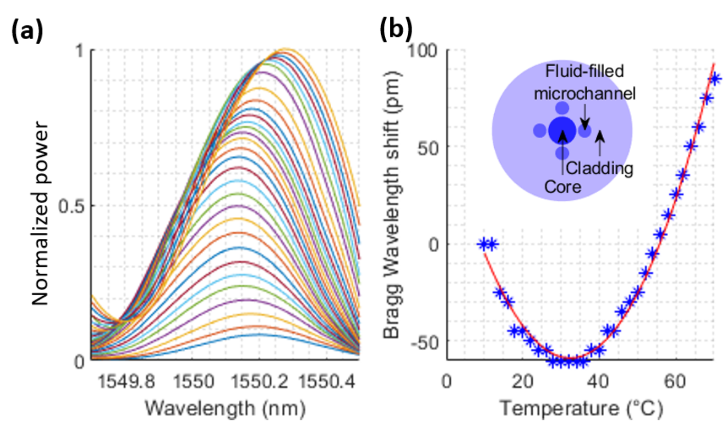

Fig. 2. A compensated temperature sensitivity FBG device with (a) the spectrum of reflection at different temperatures from 10 °C to 70 °C and (b) plot of the Bragg wavelengths against temperature. Inset: the cross-section profile

References

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2. L. F. Hoyt, “New table of the refractive index of pure glycerol at 20 C,” Ind. & Eng. Chem. **26**, 329–332 (1934).