FIBER-OPTIC FABRY-PEROT INTERFEROMETERS FOR HIGH-SENSITIVITY MEASUREMENTS

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FUNDAMENTALS OF THE FIBER OPTIC FABRY-PEROT INTERFEROMETERS (FFPI)

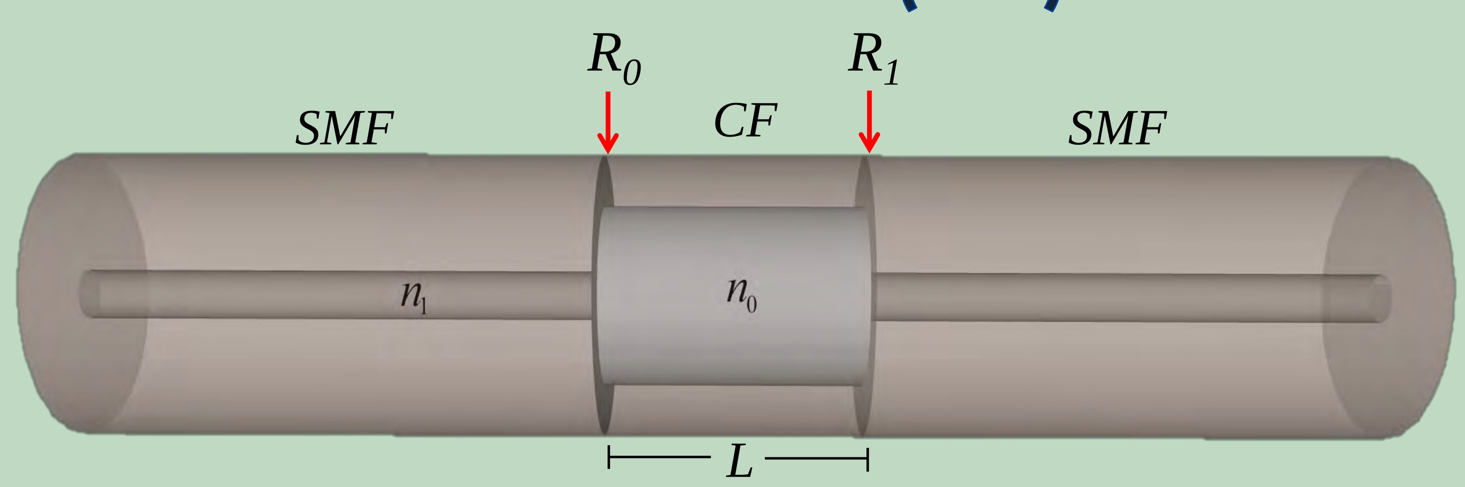

Fig. 1. Basic scheme of a FFPI, consisting in a capillary fiber spliced between two SMFs.

$$R = R_0 + (1-R_0)^2 R_1 + 2(1-R_0)\sqrt{R_0 R_1}\cos(2kn_0L_1+\varphi) \qquad (1)$$

FFPI FABRICATION

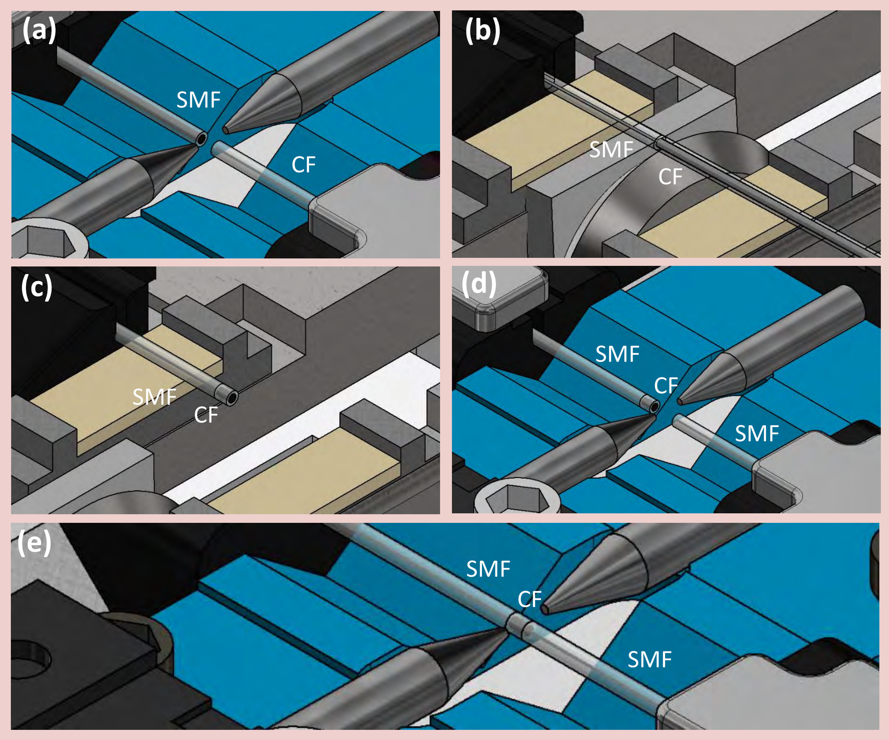

Fig 2. Illustration of the fabrication process of the FP cavities.

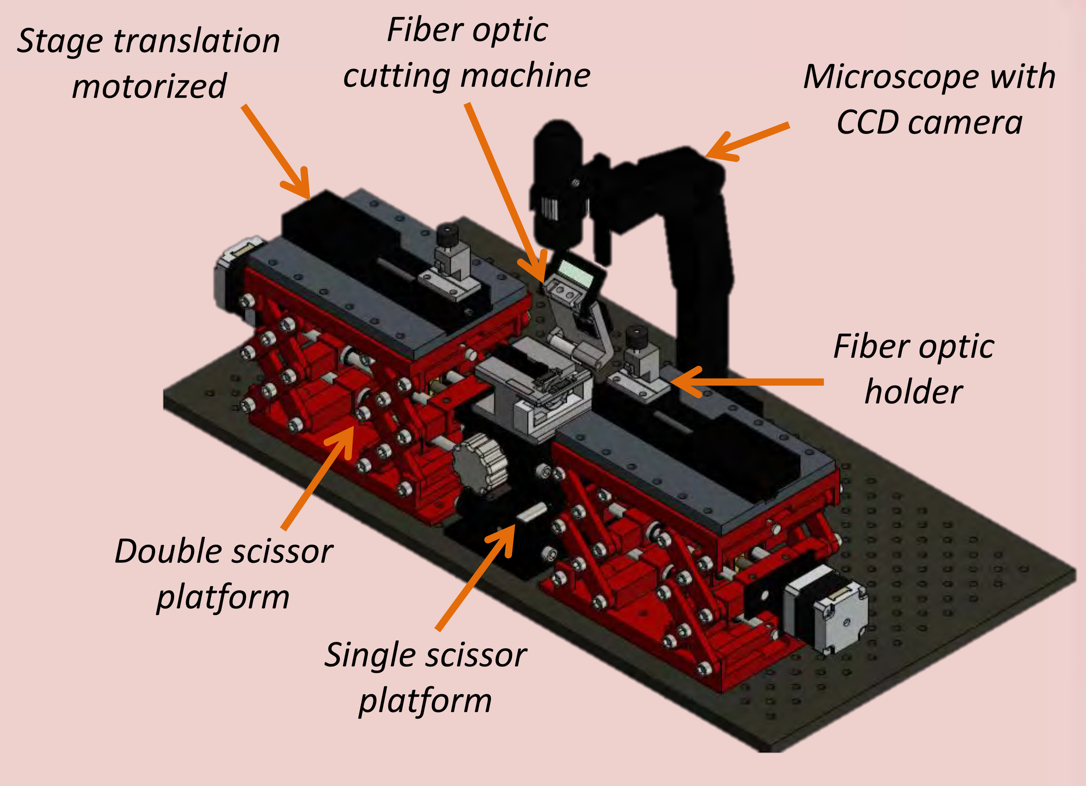

Fig 3. Scheme of the semiautomatic platform designed and constructed.

FFPI CHARACTERIZATION

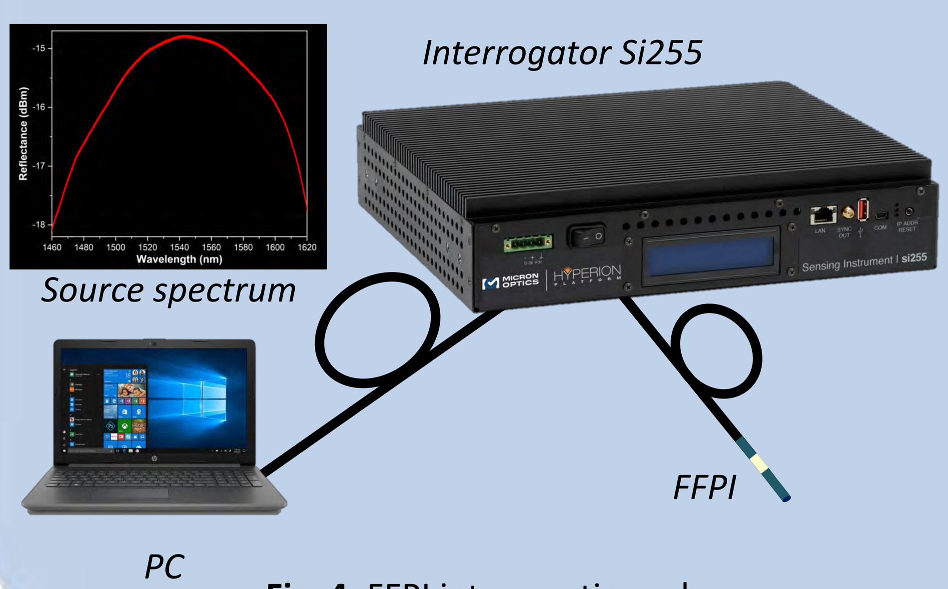

Fig. 4. FFPI interrogation scheme.

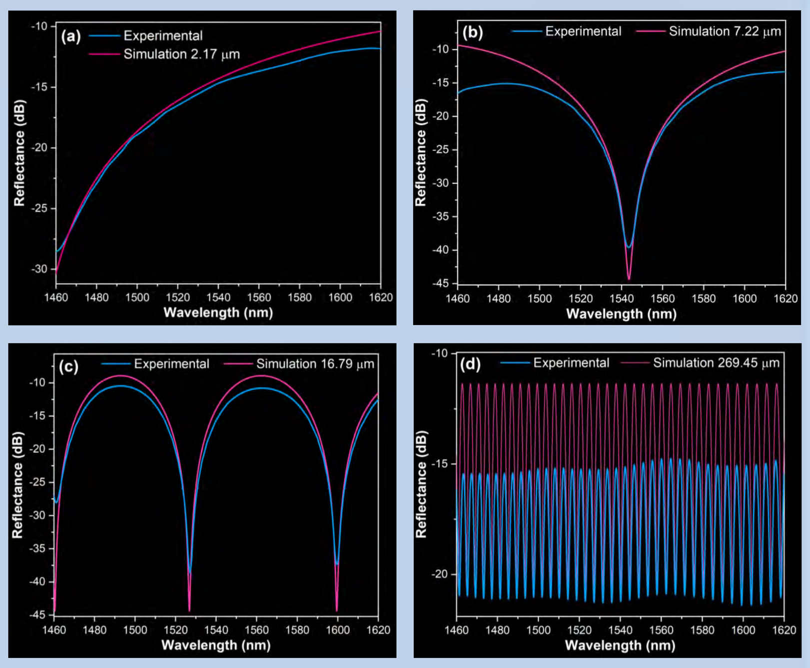

Fig. 5. FFPI's reflectance spectra.

STRAIN SENSOR

Strain is defined as the relative deformation:

$$\varepsilon = \frac{\Delta L}{L} \qquad (2)$$

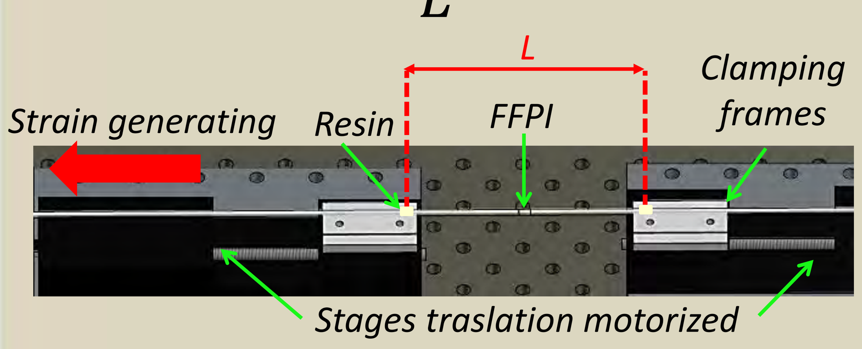

Fig. 6. Image of the strain test experimental setup.

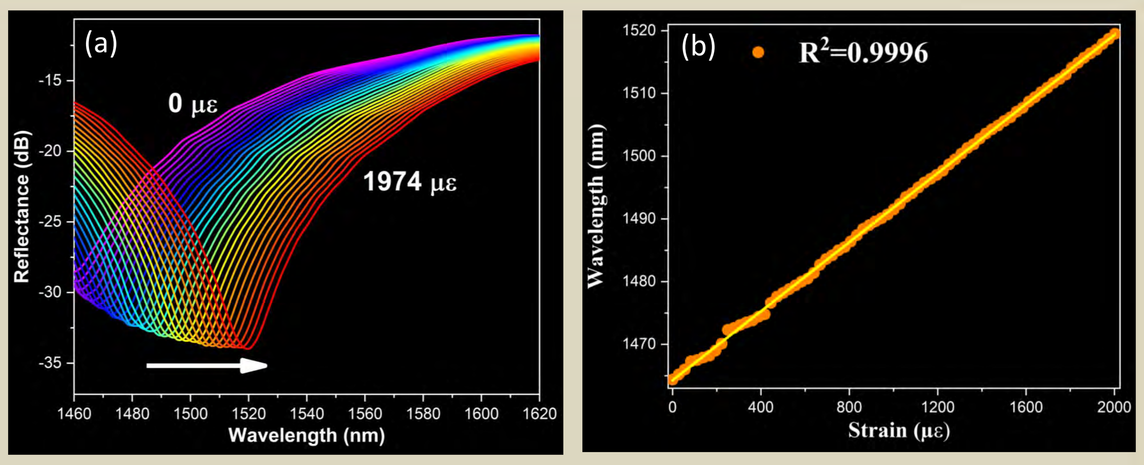

Fig. 7. Strain response of a FFPI with a cavity length of 2.17 µm (a) wavelength displacement of the spectrum (b) linear fitting of the wavelength dip.

Wavelength-strain sensitivity: **27.53 pm/με**

TEMPERATURE SENSOR

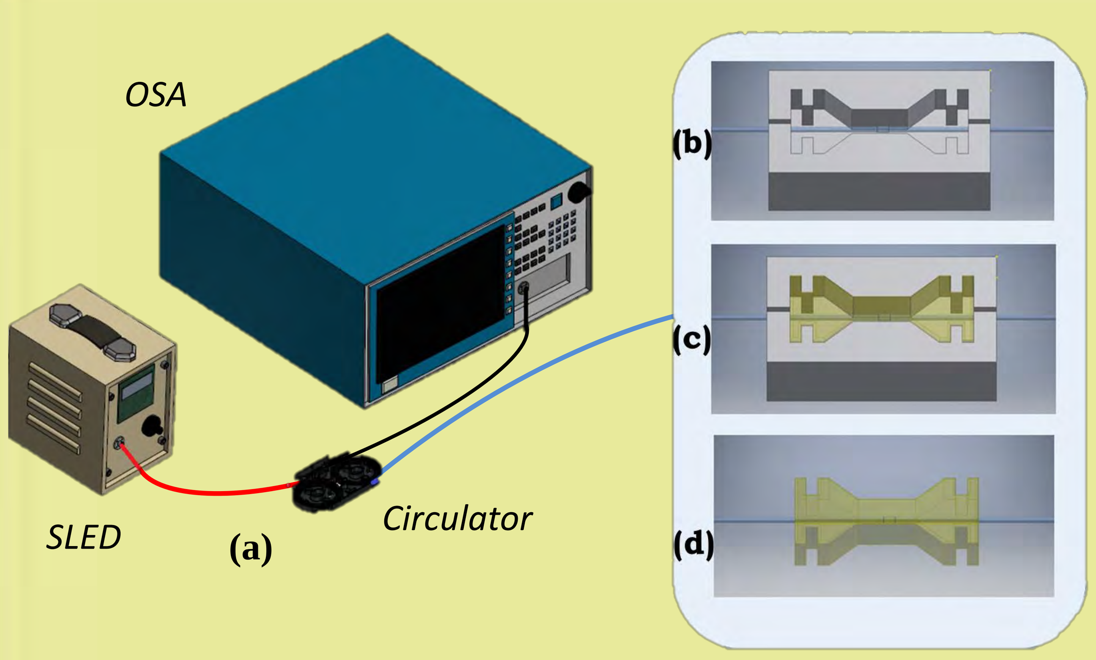

Fig. 8. (a) Experimental setup, (b) FFPI fixed into the Teflon mold, then (c) polymer is poured into the mold and finally, (d) sensor head is demolded.

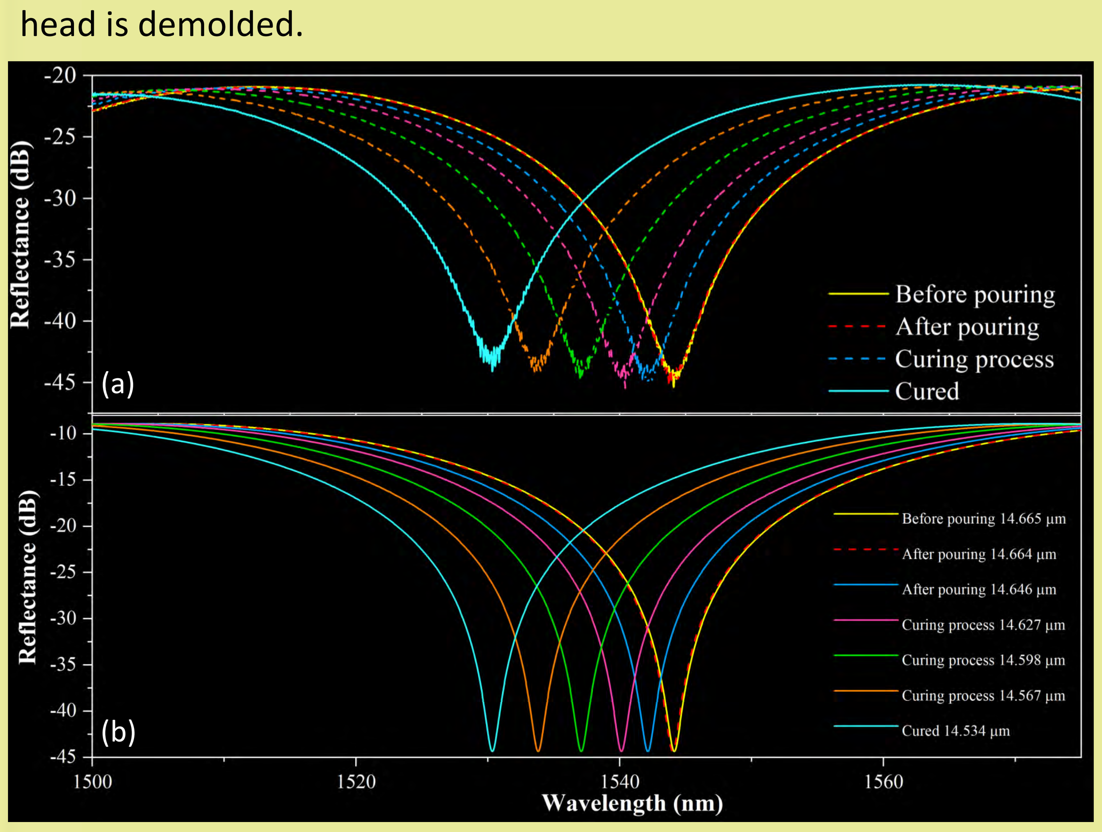

Fig. 9. (a) Experimental spectra during the curing process. (b) Calculated spectra for the curing process.

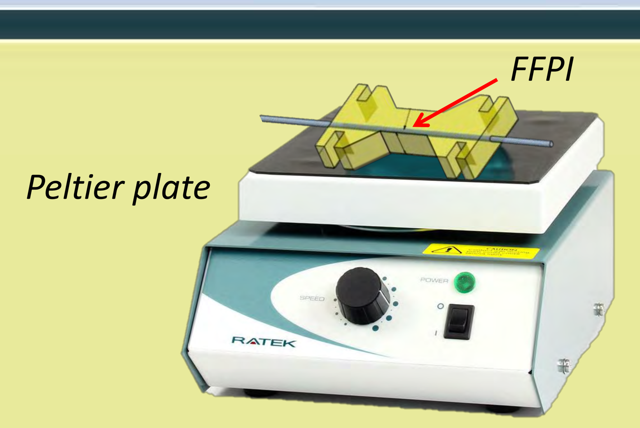

Fig. 10. Embedded sensor was placed over a Peltier plate.

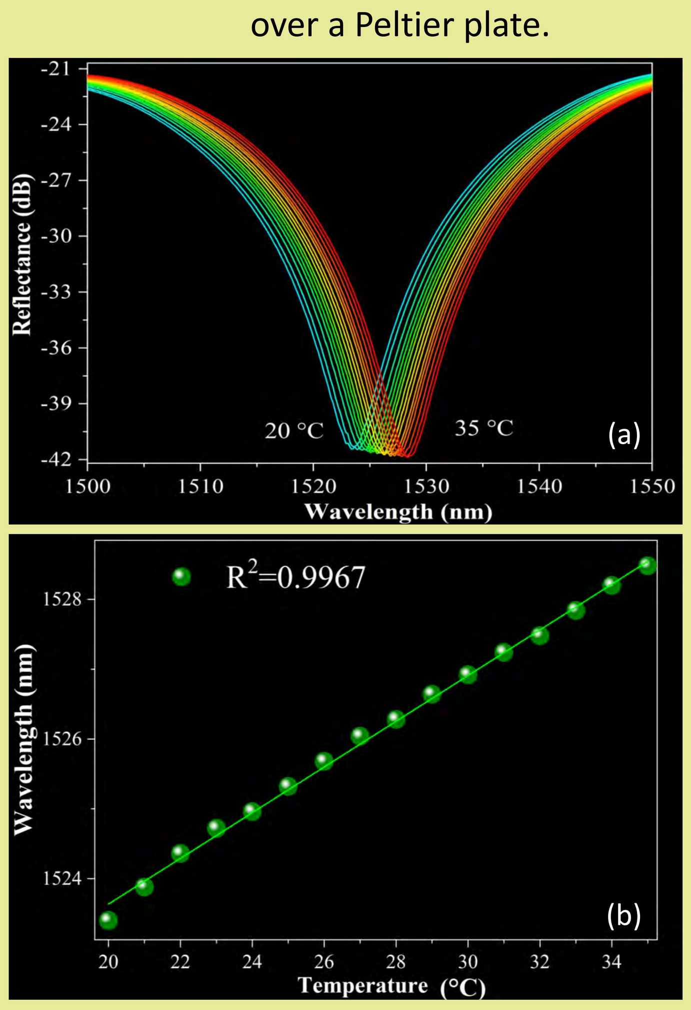

Fig. 11. (a) Experimental spectra of the sensor reflectance for different temperatures. (b) Wavelength dip changes as a function of temperature.

Wavelength-temperature sensitivity: **327.3 pm/°C**

OPTICAL-POWER INTERROGATION

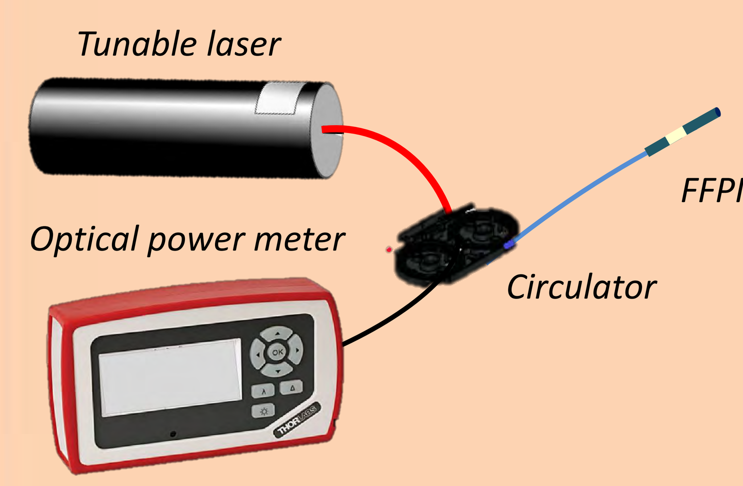

Fig. 12. Optical-power interrogation scheme.

- **STRAIN:**

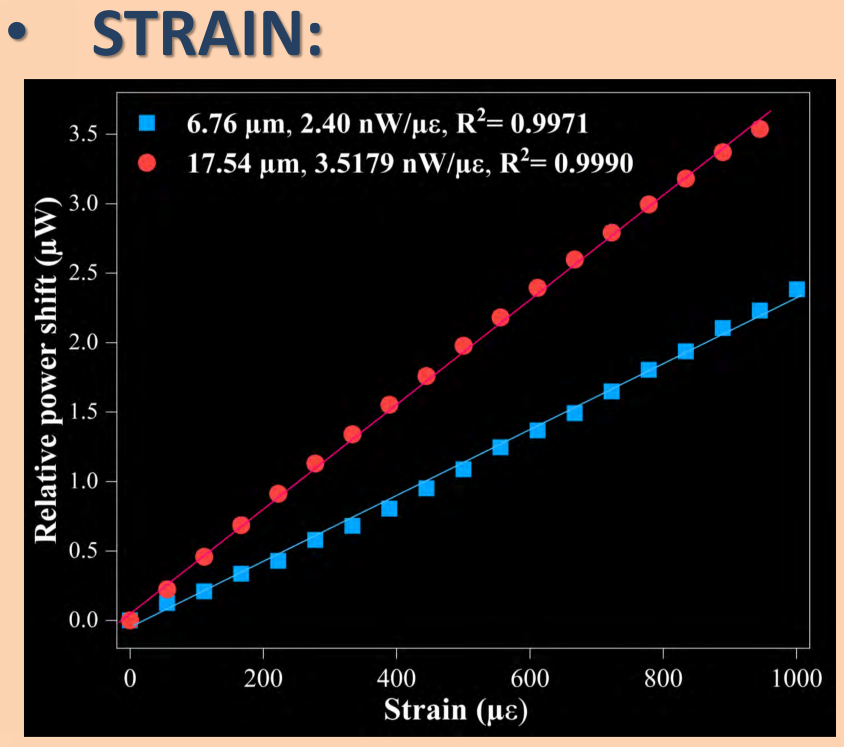

Fig. 13. Power response vs. strain for two different sensors.

Optical-power sensitivities:

- Strain **3.51 nW/με**
- Temperature **-60.79 nW/°C**

- **TEMPERATURE:**

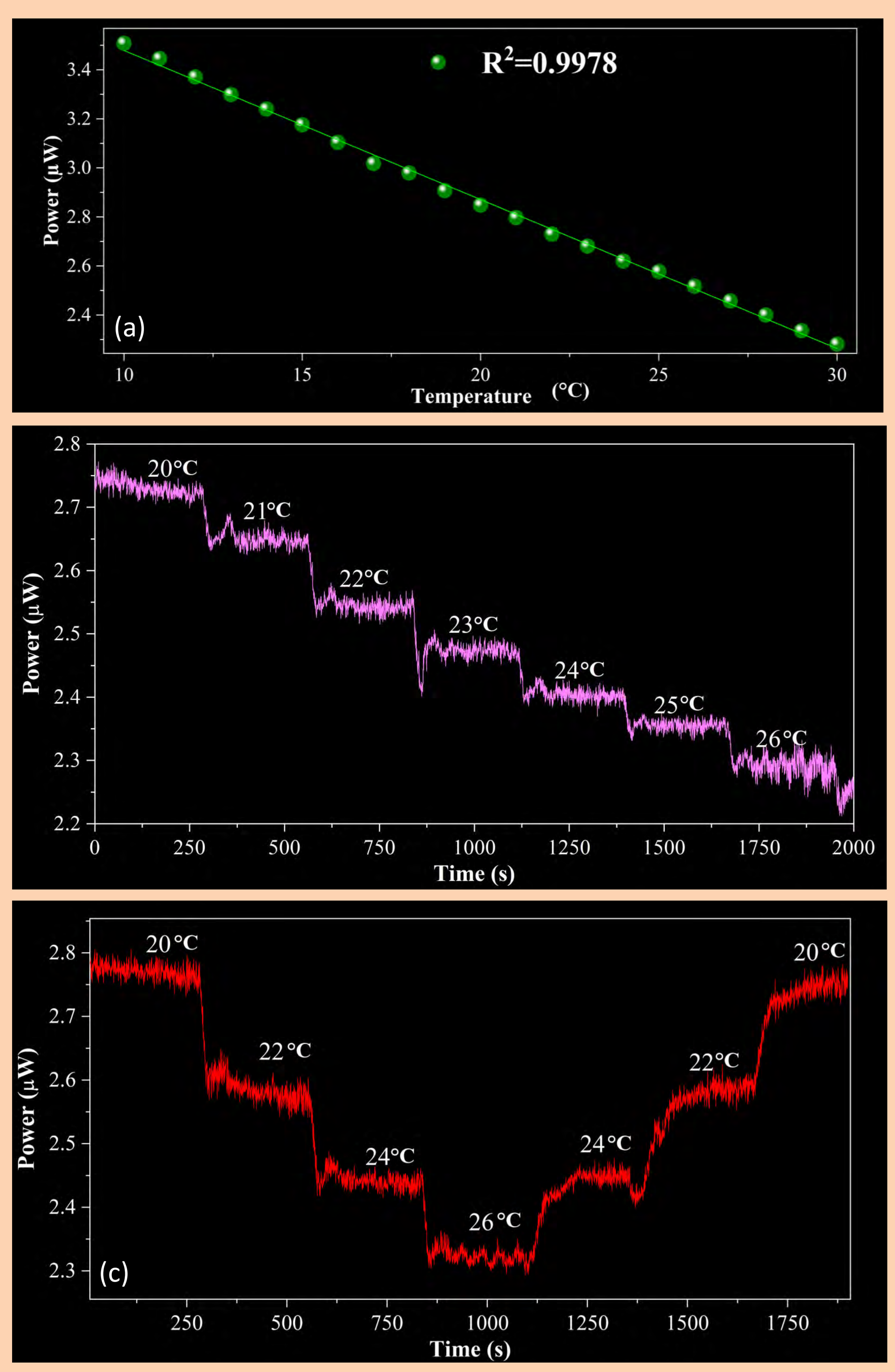

Fig. 14. (a) Power response vs temperature. (b), (c) Temporal response of the embedded temperature sensor.

CONCLUSION

FFPI sensors were fabricated using the simple and well-known cutting and splicing technique that consist of splicing a section of CF between two SMFs. Using a semi-automatic platform (which was designed and assembled) it was possible to fabricate a FFPI with a small cavity of 2.17 µm. Temperature and strain sensing with high sensitivity (27.53 pm/με and 327.3 pm/°C respectively) were demonstrated. Furthermore, due to the small size of the FFPI cavity, it was possible to measure strain and temperature by monitoring the optical power of the reflected signal, a sensitivity of 3.51 nW/με and -60.79 nW/°C was achieved.

REFERENCES

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[2] Domínguez-Flores Carmen E., Master degree thesis, "Diseño, fabricación y caracterización de inferferómetros Fabry-Perot de fibra óptica extrínsecos y su aplicación en sistemas de sensado de variables físicas".
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