Humidity sensor based on a long-period fiber grating coated with a hydrophobic thin film

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ABSTRACT

In this work it is proposed a novel fiber optic humidity sensor based on a functionally coated long-period fiber grating (LPG). The coating is composed of tetraorthosilicate matrix functionalized with perfluorooctyltriethoxysilane and its fabrication was performed by the sol-gel technique using a dip coating process using the LPG as substrate. The fabricated sensor was tested in a programmable temperature and climatic chamber. Relative humidity (RH) was varied in range from 20%RH to 80%RH at room temperature. The results showed a smooth exponential-like wavelength shift of the LPG attenuation band.

FABRICATION SENSOR

◇ It was used an arc-induced **LPG** with Λ = 395 µm and length of ~41 mm, written on a single mode fiber (Corning SMF28).

◇ The LPG was coated with a superhydrophobic film by sol-gel technique. LPG was dipped into gel solution of tetraorthosilicate, Perfluorooctyltriethoxysilane (PFOS), and ethanol (speed dipping 33mm/min). The dip-coating process was performed twice.

SET-UP

◇ An end of the coated LPG was connected to a broadband light source while the other end was connected to an optical spectrum analyzer (OSA) to register the transmission spectrum of the sensor.

◇ A programmable climatic chamber was used to expose the sensor to 25ºC from 20%RH to 80%RH. Next, RH variation was inverted from 80% to 20%, also at 25ºC.

RESULTS

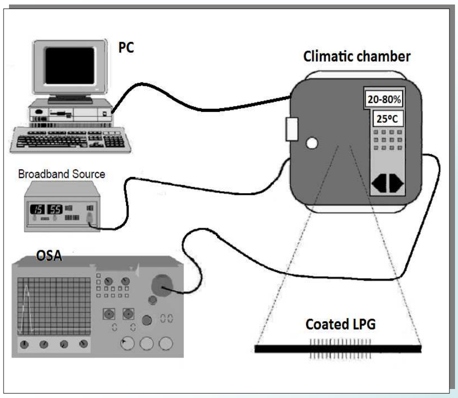

Figure 1

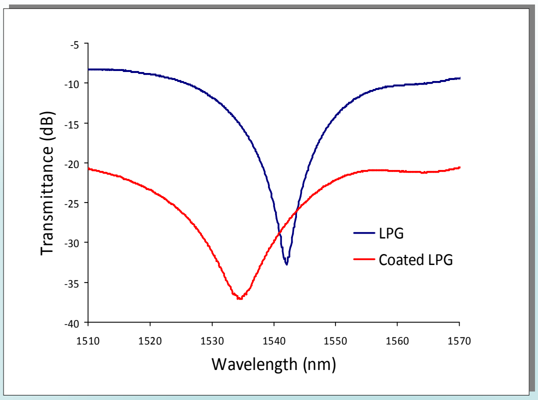

Figure 2

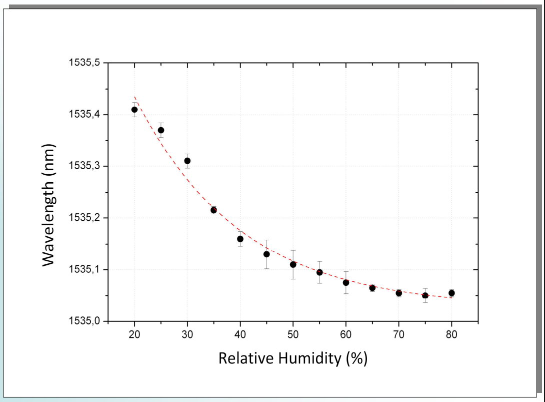

Figure 3

- **Figure 1:** Set-up used to measure the sensor variation.
- **Figure 2:** LPG spectra and coated LPG spectra measured with an OSA.
- **Figure 3:** Evolution of the center wavelength shift of the LPG attenuation band in function the RH.
- **Figure 4:** 10x10µm AFM image of the surface coating on the LPG.
- **Figure 5:** Image of a water droplet onto the sensitive coating. Contact angle of 122º.

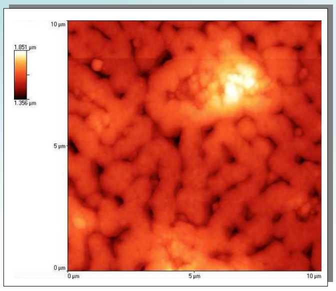

Figure 4

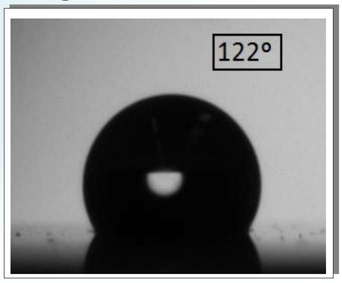

Figure 5

CONCLUSIONS

- ❑ We propose a new HR sensor based on a coated LPG. The hydrophobic sensitive overlay was fabricated using the sol-gel technology. The sensitive overlays have been successfully placed onto the LPG with a strong hydrophobic behavior.
- ❑ The resulting overlays were covalently crosslinked at room temperature, and consequently the sensors are stable and show a long lifetime.
- ❑ The coating deposited on the LPG causes a variation of the external refractive index modifying the spectra and the resonance characteristic of the LPG
- ❑ The coated LPG showed an exponential response to relative humidity variation.
- ❑ The performance of this sensor could be further improved using a multiple overlay sequence with special control of the refractive index of each layer.

ACKNOWLEDGEMENTS

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