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A fully distributed fibre optic sensor for relative humidity measurements

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Highlights:

- A 64 m long fully distributed fibre optic sensor for the measurement of relative humidity is presented.
- The sensor relies on the reversible expansion of a hygroscopic coating, imparting a strain on the fibre.
- Optical time domain reflectometry is used to interrogate the hygroscopically induced strain.
- A study of the sensor performance under a range of relative humidity and temperature conditions is presented.

Abstract

In this paper we describe the characteristics of a 64-meter-long distributed relative humidity sensor with cm spatial resolution. The sensing element is an optical fibre with a hygroscopic coating that undergoes a reversible expansion on water uptake, thereby transferring a strain on the fibre. The resulting distributed strain profile was interrogated using Rayleigh backscatter based optical frequency domain reflectometry. Investigations of the distributed sensor under controlled relative humidity and temperature were carried out. The distributed sensor is strongly humidity sensitive when polyimide coated fibre is used, and only weakly sensitive when acrylate coating is used. When using polyimide coated fibre the distributed sensor shows a near linear response across the entire range of relative humidity tested covering 15 to 92%, with a sensitivity $\sim 1.3 \mu\epsilon / \%RH$ and showing low hysteresis. The system is able to resolve relative humidity changes $\sim 0.1\%$. The response time of the sensor was found to be strongly dependent on temperature in the range tested, covering 30-50°C. Using reference temperature and humidity measurements, it was demonstrated that the distributed sensor accurately reported the combined effects of temperature and humidity variations over a cm spatial scale.

Keywords: Fibre optic sensors, distributed chemical sensing, relative humidity.

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