A simple intensity inclinometer sensor based on fused taper fiber

R. M. Silva, J. L. Santos, A. B. Lobo Ribeiro, P. A. S. Jorge and O. Frazão

***Abstract*— In this work, a simpler inclinometer sensor using a fiber taper was proposed. When a rotation angle is applied to the sensor it is originated an intensity loss variation in the region of the taper. This tilt sensor is very easy to fabricate by the arc discharge technique. This sensor was tested to measure rotation/bending angles in a range angles of 0° and 70°.**

***Index Terms* — tilt sensor, taper, intensity power**

I. Introduction

Sensors using fiber tapers have been widely investigated and employed in a diversity of applications such as strain [1], curvature [2], temperature [3], refractive index [4], surface plasmon resonance sensors [5], hydrogen sensing [6], etc. In relation to inclinometer sensors, Frazao *et al* [7] proposed a new approach for a fiber-optic modal Mach–Zehnder configuration with a single LPG. This concept was applied to the implementation of a fiber-optic inclinometer sensor. In 2010, Shao *et al* [8] demonstrated a concatenated non-adiabatic taper and weakly tilted fiber Bragg grating to measure rotation angle. The reflection power of the core mode and the taper re-coupled cladding modes, changed in opposite directions upon bending, and their ratio provided the measurement of the rotation angle. Recently Amaral *et al* [9], reported a compact inclinometer sensor based on the fiber-modal interferometer by using a fiber taper-tip combination, originating this way a Michelson interferometer. Also, Silveira *et al* [10] presented an optimization study of an optical inclinometer based on fiber-taper Michelson interferometer

In this work, it is proposed a simple inclinometer sensor using a fiber taper, originating this way an intensity losses when a rotation angle is applied in the region of the taper. This device is easily to fabricate using a conventional splice machine.

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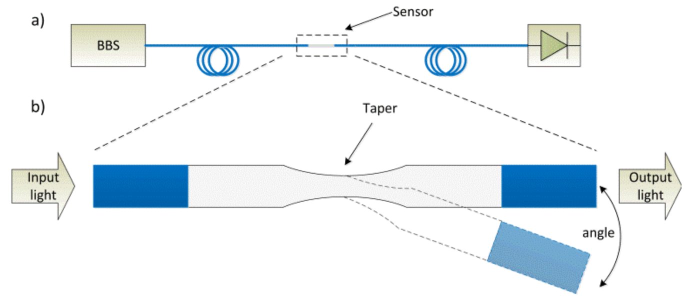

Fig. 1 – a) Schematic representation of the experimental setup, b) the representation of the tilt sensor.

II. Experimental and Discussion

The schematic diagram of the experimental configuration is shown in Fig. 1a. An optical broadband source with a bandwidth of 100 nm and a central wavelength of 1550 nm was used. The fiber-taper (Fig. 1b) was fabricated in a Corning SMF-28 fiber by elongating it during an arc-discharge provided by a splicing machine (Fujikura's FSM-40S). The fabrication parameters were adjusted to reduce the fiber diameter of the SMF-28 from 125 to 80 μm in the taper waist. The length of the taper is ~100 μm. A photodetector (HP8153a lightwave multimeter) was used to measure the response in power intensity of the sensor at 1550 nm.

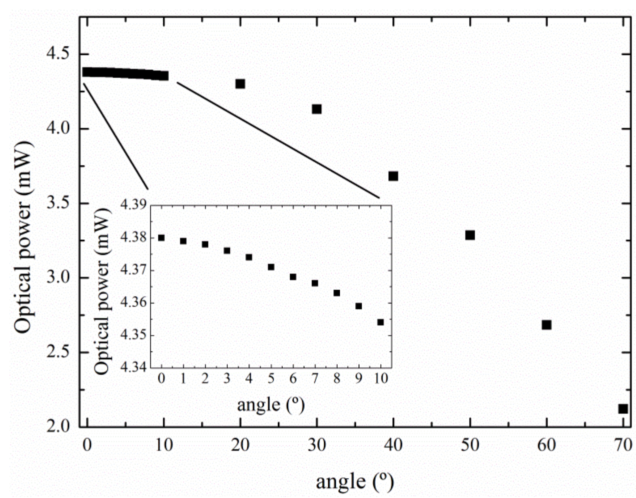

Fig. 2 Intensity power versus the bend angle.

The intensity power change against the bend angle is illustrated in Fig. 2. It is observable when bending is applied in the taper region the optical power decreases. This happens because light is coupled to the cladding region and are absorbed by the polymer jacket when the rotation is applied. The inset figure illustrates the variation in the bending angle from 0 to 10 degrees, and it is also verified a small decrease in optical power. For large bending angles [10º to 70º] the bending sensitivity is higher and presents a non-linear response. However, is possible to distinguish two sensing regions with high and low sensitivities. In the range of 0 and 10 degree the sensitivity is approximately |0.00304| mW/degree and between 10 and 70 degrees is higher and presents |0.05017| mW/degree.

III. Conclusion

To summarize, a simpler inclinometer using a fiber taper was reported. This sensor head is easy to fabricate and has high sensitivity for large angles. The concept was tested on the measurement of a rotation/bending in a range of 0 and 70 degrees. This configuration can be applied in different engineering applications namely in civil and aeronautic.

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