Optical Fiber based Lean Angle Sensor

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1. Introduction:

Various electronic, mechanical, and MOEM sensors are available for the measurement of lean angles [1-3]. Optical fiber based sensors are the most precise and contemporary devices for the scientific as well as commercial sensing applications due to their measurement accuracy [4]. With the wide available range of fibers, one can easily outfit and calibrate the sensor for various sensing applications. In this paper a reflection based fiber optic sensor was demonstrated and standardized for the measurements of small angles of the order of a degree or less.

2. Construction of the sensor:

The set-up of the sensor is shown in the figure 1. Two single mode fibers (SMF) are used for transmitting and receiving the light signal. He-Ne laser (λ = 632.8 nm) is used as optical source. The transmitting fiber is coupled with the laser and the other end is placed at the reflecting surface. The receiving fiber is connected with the photo diode and the measurement unit to measure the reflected light. The reflecting surface is fixed on a rotational stage (least count 6’ of arc) to introduce the tilt between sensor head and reflecting surface.

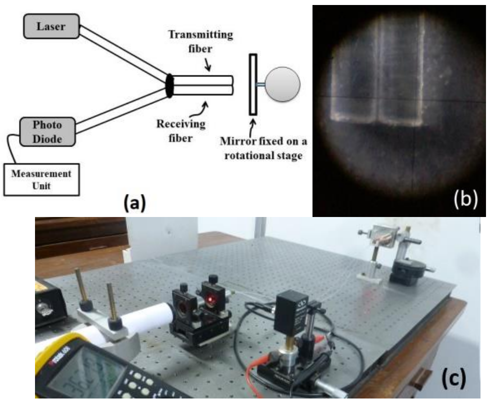

Figure 1: (a) Schematic of the sensor (b) Microscopic view of head of the sensor (fibers), placed at the reflecting surface (c) Experimental set-up

3. Calibration of the sensor:

First the sensor was examined to identify the maximum response region. For this, initially the reflecting surface is placed in contact with the sensor head. The set-up shows zero current in the contact position. Gradually the reflecting surface is moved away from the fiber tip. The corresponding photocurrents are noted and the response is plotted. Initially the photocurrent was increasing and reaches a maximum point. The maximum response was observed at 2mm distance. Now the fiber probes are placed at a distance of 2 mm to apply the tilt. The reflecting surface is now rotated by 6’ of arc angle and the corresponding values of photocurrents were obtained. A plot between the lean angle and the photocurrent was plotted. From the graph, it can be concluded that the increase in tilt angle causes linear decrease in photocurrent.

4. Results:

Figure 2(a) shows the plot between normalized photo-current and the distance from the reflector, which reveals that the maximum response of the sensor is present at a distance of 2 mm. At this position, the sensor head is placed and the reflecting surface is tilted. Figure 2(b) shows the response of the sensor. A linear decrease in the photo-current is observed with increase in the tilt angle. This confirms the promising use of this sensor as a lean angle measurement device.

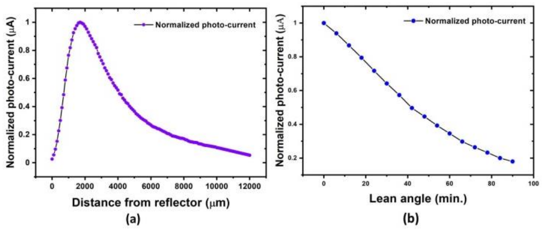

Figure 2: (a) Identifying the maximum response point (b) Response of the sensor.

5. Conclusions:

To conclude, the sensor is showing a linear response with applied tilt. This can be used for the measurement of lean angles with an accuracy of 6’ of arc. Also, the sensor can be used for the accurate measurement of tilt angles in various industrial applications.

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