# Fabrication of a Flexible Tactile Sensing System with Macro-Bend Optical Fiber Sensors

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**Abstract:** The fabrication steps of a sensing system composed of four optical fiber macro-bend sensors embedded in a silicone sheet are described. Sensing ability was tested by applying individually loads of up to 3.0 kg on the sheet surface. Preliminary results show the system ability of detecting loads applied in areas not coinciding with the sensors positions.

## 1. Introduction

Optical fiber and its based technologies have been extensively exploited in the last decades promoting advances and innovations in different areas. Industries, mainly those related with optoelectronics and optical communications, have experienced a remarkable growing by reducing fabrication costs and providing new technologies also used to leverage other areas as optical fiber sensing [1]. Optical fiber inherent characteristics as reduced weight and size, electromagnetic immunity, high sensitivity and high temperature resistance enable its application for sensing parameters as electrical and magnetic fields, temperature, pressure, vibration, deformation, humidity, among others [2]. As a consequence of the optical fibers great versatility, more complex applications have emerged requiring simultaneous monitoring of single or multiple parameters. As a result of the efforts spent to fulfill the special sensing needs, a great variety of multiplexing and distributed optical fiber systems have been proposed [3]. A multiplexed sensing system allows collecting information from each sensor of a sensing array enabling the mapping of the measurand over a large area.

Among the optical fiber sensors, those based on macro-curvatures which are intensity-modulated sensors play an important role due to the simple and low-cost characteristics of fabrication as well as interrogation. Intensity losses, resulting from coupling between guided and radiation modes that occur when the fiber bending changes, are the basis of the macro-bend sensors operation. This class of devices was applied, e.g., for voltage and temperature sensing as well as part of a refractometer [4-6].

In a previous work, it was proposed a method for multiplexing a set of in-series optical fiber macro-bend sensors [7]. The method was tested in the detection of the location and magnitude of loads applied directly on the sensors. In this work, a set of macro-bend sensor elements was embedded in silicone elastomer forming an array of four in-series sensors. Preliminary tests were carried out in order to determine the system ability in detecting loads applied in areas that are not coinciding with the sensors locations.

## 2. Methodology

The sensing array is composed of four in-series macro-curvature sensors embedded in a silicone elastomer sheet (Dow Corning, BX3-8001). First, the four sensor elements were individually fabricated using monomode optical fiber (SSMF, G-652, Draktel). Each element is an optical fiber loop with diameter of 5.0 mm encapsulated in silicone elastomer (Dow Corning, BX3-8001) resulting in a small cylinder, Figure 1. Then, the four elements were adequately arranged in a square mold, with the lateral surface of the cylinders kept in contact with the mold. After than, the mold is filled with silicone elastomer in order to completely embed the elements forming a square sheet with smooth and flat surface and dimensions of (100.00 ± 0.05) mm x (100.00 ± 0.05) mm x (8.00 ± 0.05) mm, Figure 2(a). Sensing is based on the intensity changes of the optical signal transmitted by the set of sensors when loads are applied on the sheet surface. Five different regions of sensing indicated in Figure 2(b) were tested by detecting the transmitted signal when loads of 0.5 kg, 1.0 kg, 1.5 kg, 2.0 kg, 2.5 kg or 3.0 kg were positioned on one of the sensing regions. The transmitted spectra were recorded 10 s after the loads application. Each test, carried out at a controlled temperature of (22.0 ± 0.5) ºC, was repeated 10 times with time intervals of 20 s.