Etched Fiber Bragg Gratings Sensors for Water-Ethanol Mixtures: a Comparative Study

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***Abstract*— In this work is evaluated the performance of etched fiber Bragg gratings, assembled in different configurations to operate as a refractometric sensor, in the analysis of water-ethanol mixtures. Two fiber Bragg gratings operating close to 1300 nm and 1500 nm were wet-etched and employed in the sensor design. Four configurations for the refractometric sensor were studied, in dual-wavelength and single-wavelength operation modes, and at two sample temperatures. Calibration curves were determined for the range between 0.0 and 100.0 % v/v of water in ethanol, and the sensor performance for each configuration was analyzed by comparing its sensitivity, conformity, repeatability and combined uncertainty. The best results showed that the sensor can be used to measure the ethanol-water concentration with combined uncertainty of 2.8 % v/v for the range up to 80.0 % v/v of ethanol concentration and 7.0 % v/v of uncertainty for the range above 80.0 % v/v of ethanol concentration for the single-wavelength operation mode at two temperatures.**

***Index Terms*—** Ethanol-water mixture, etched fiber Bragg grating, optical sensor.

I. INTRODUCTION

The ethanol is a substance miscible in both non-polar substances as hydrocarbons and polar substances as water. This characteristic makes the ethanol a versatile solvent used in several industrial sectors such as chemical, pharmaceutical, beverage and fuel. Particularly in the fuel sector, due to the inevitable depletion of the world's petroleum supply, there is an increasing worldwide interest in alternative, non-petroleum-based sources of energy.

The ethanol production process is characterized by sequential procedures, and in several cases for which water is a constituent of the final product, the water-ethanol proportion must be periodically monitored and compared to standardized conditions to preserve the product quality. In Brazil, the ethanol used as fuel is obtained by the fermentation of sucrose. In the production process, sulfuric acid is employed to hydrolyze the carbohydrate and after the hydrolysis, the acid is separated from the sugar which is fermented to obtain the ethanol [1]. A careful monitoring of water content in ethanol is fundamental for the product commercialization as the product cost and destination are specified as a

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