# Etched FBG written in multimode fibers: sensing characteristics and applications in the liquid fuels sector

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***Abstract*— In this work, a refractometric fiber sensor for the liquid fuels sector is described. The use of etched FBGs produced in multimode fibers is proposed to overcome the drawbacks associated with sensing high refractive index samples employing fiber transducers. The transducer sensitivity can be tailored by adjusting the final diameter of the etched Bragg grating. Due to a trade-off between the signal-to-noise ratio and the sensitivity, operational parameters of the sensor must be designed to match the expected refractive index dynamic range for specific applications. Metrological properties of the sensor are determined, resulting in resolution from 5.6 % v/v to 0.4 % v/v for refractive indexes ranging from 1.4562 to 1.4729. Specific applications regarding the quality assessment of biodiesel and conformity analysis of diesel-biodiesel blends are discussed.**

***Index Terms*—**Optical fiber transducer, chemical sensor, refractometric sensor, biodiesel analysis.

## I. INTRODUCTION

In recent years, the Brazilian government has increased incentives for the research and development of renewable energy sources. Within this scenario, biodiesel plays an important role, as biofuel can either be incorporated as part of or even replace diesel - the liquid fuel most produced, commercialized and consumed in Brazil [1, 2]. Besides the renewability, biodiesel combustion brings less impact to the environment than the use of other fossil fuels. From 2005 on, the addition of biodiesel to diesel was mandatory and the biodiesel percentage in biodiesel-diesel blend has been increased in the long run [3]. According to the Brazilian law number 13.033/2014, biodiesel percentage in biodiesel-diesel blend commercialized in Brazil must reach 7 % until the end of 2014, and in the following years it is expected to reach an upper limit of 27.5 %. As a new technology, its production as well as quality and conformity monitoring still presents few methods and instruments to assess standards, for both production and commercialization sectors [4 – 6].

The biodiesel is produced by a chemical reaction known as transesterification, with the conversion of a fatty acid into an ester and generating glycerin as a by-product. Some authors [7, 8] showed that it is possible to monitor the ester conversion by the determination of the sample refractive index. Such possibility instigated studies about the performance of optical fiber devices as long period gratings

*Brazilian Microwave and Optoelectronics Society-SBMO* *received 1 Oct 2014; for review 6 Oct 2014; accepted 6 Nov 2014*
*Brazilian Society of Electromagnetism-SBMag*  *ISSN 2179-1074*