HIGH TEMPERATURE BRAGG GRATING SENSORS FOR OIL AND GAS APPLICATIONS

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Abstract: The development of optical fiber Bragg (FBG) grating sensors for high temperature measurements in the oil and gas industries is presented. High temperature (400-800ºC) gratings were obtained by direct recording and thermal regeneration both in standard and high-birefringence (HiBi) fibers.

1. INTRODUCTION

Oil and gas processing usually includes many high temperature stages, up to several hundreds degrees. The use of FBG as temperature sensors for those applications has a drawback in the survival of the sensor because the normal FBG is stable in the low temperature zone of those processes (~ 100-200ºC) [1].

Several published methods are used to obtain FBG that can sustain several hundreds degrees [2]. However, these methods require special fibers (co-dopants, photosensitive) [3–4], special processing techniques [5–7] or different materials[8–9].

In this paper we present results of obtaining high temperature FBG sensors using less tricky procedures. A class of sensors is obtained by the simplest recording of Bragg gratings [10]. Efficient thermal regeneration of seed gratings inscribed in standard, commercial, fibers was also obtained[11], as well as regenerated high-birefringence gratings [12].

2.MATERIALS AND METHODS

The used optical fibers are standard, telecommunications grade single-mode (in the O – C-bands) fibers. Glass chemical composition is not known, but the typical Ge contents in the core of such fibers is a few percent (~3%). Optical fibers were acquired from several commercial dealers, as well as donated from some manufacturers. High birefringence optical fibers are of IEC (internal elliptical clad), PANDA and Bow-Tie types.

Some samples (usually for obtaining regenerated gratings) were previously loaded with Hydrogen, using a high-pressure chamber (~ 100 atm), at room temperature. Typically the loading time was in the order of one week.

Gratings are recorded using illumination from an UV (248 nm) Excimer laser. The laser beam passed through a phase mask before being focused into the fiber core by a cylindrical lens. A standard diaphragm is used to limit the beam diameter. The resulting gratings have lengths of approximately 3 mm. Laser repetition rate was in the range from 30 Hz to 500 Hz, pulse energy from 5 mJ to 10 mJ.

Grating growth is monitored during recording by using a fiber Bragg Grating Interrogator (Micron Optics SM 125) or an Optical Spectrum Analyzer (Agilent 86142B). The same apparatus is used to determine the Optical Reflection Spectra from the