ROYAL INSTITUTE OF TECHNOLOGY

Study of high temperature decay mechanisms of Fiber Bragg Gratings

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Master of Science Thesis

TRITA-FYS 2014:01

ISSN 0280-316X

ISRN KTH/FYS/--14:01—SE

Laser Physics

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Stockholm Sweden 2012

Abstract

FBG are intracore structures that select specific wavelengths of light passing through them, so act like narrow-band filters for specific wavelength. They reflect some wavelengths, called Bragg wavelength, transmitting the rest.

FBGs have many applications e.g. optical filters in Telecom applications for wavelength filtering in WDM (wavelength division multiplexing) systems or in DBR lasers (distributed Bragg reflectors), where they are capable of limiting the emission to a very narrow spectral range. Furthermore, they are suitable for sensing applications for monitoring the strain or temperature variation through the Bragg shift.

One problem with normal FBGs is their temperature stability. Typical FBGs can be made stable below 300-400 °C, but will be completely erased at temperatures above 700 °C.

On the other hand, Chemical Composition Gratings (CCGs) have been shown to survive temperatures above 1000 °C. They are believed to be formed due to a change in chemical composition in the core of the fiber. In this case the decay mechanism is due to diffusion.

This project aims to study the thermal decay mechanism of FBGs at high temperatures. Normal FBGs start to decay around 150 °C and typically the periodic refractive index modulation is completely erased around 600-700 °C. A special type of FBG, Chemical Composition Gratings (CCGs), survive temperatures in excess of 1000 °C and are believed to result from a modification of the core composition. In this case the decay mechanism should depend on diffusion.

The project goal is to study the decay of CCGs, specifically F-CCGs, in order to assess the decay mechanism, experimentally together with simulations.

Conclusion

In conclusion I showed that the decay characteristics of CCGs in fluorine-doped fibers differ from type I gratings and the experimental results supported the assumption that the CCG decay is wavelength dependent due to fringe to fringe diffusion of dopants. Thus the decay mechanism of CCG is related to exponential behavior of dopant diffusion.

As a result the refractive index modulation of such gratings is caused by change in chemical composition rather than electronic defects and change in glass matrix and therefore the thermal stability will depend on much higher activation energy.

(For the full version please contact KTH)

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