CLEO '92
567

HOLOGRAPHICALLY WRITTEN REFLECTIVE POLARISATION FILTER: A NEW OPTICAL FIBER GRATING DEVICE

A. Kamal, S. Bardal, P.St.J. Russell,
Yuk-Tak Chow and D.P. Hand

Optoelectronics Research Centre,
University of Southampton,
Hants SO9 5NH, United Kingdom
Tel: +44 703 593083
Fax: +44 703 593149

S.E. Kanellopoulos, V.A. Handerek and A.J. Rogers

Department of Electronic and Electrical Engineering,
King's College London,
London WC2R 2LS, United Kingdom

Abstract

A novel grating device, consisting of a holographically induced birefringence that rocks periodically at half the optical wavelength, is proposed; and its first realisation in photosensitive single-mode fibre reported.

HOLOGRAPHICALLY WRITTEN REFLECTIVE POLARISATION FILTER: A NEW OPTICAL FIBER GRATING DEVICE

A. Kamal, S. Bardal, P.St.J. Russell,
Yuk-Tak Chow and D.P. Hand

Optoelectronics Research Centre,
University of Southampton,
Hants SO9 5NH, United Kingdom
Tel: +44 703 593083
Fax: +44 703 593149

S.E. Kanellopoulos, V.A. Handerek and A.J. Rogers

Department of Electronic and Electrical Engineering,
King's College London,
London WC2R 2LS, United Kingdom

Summary

Parent et al[1] were the first to report that the refractive index change induced in optical fibres is anisotropic for linearly polarized exposure, the induced birefringence lining up with the optical electric field. This effect was recently used to realise a distributed feed-forward (DFF) polarization converter in Hi-Bi (high birefringence) fibre[2,3]. This device was formed by

launching linearly polarized light at 45° to the axes of the fibre. After exposure, the result is a gently rocking net high-birefringence that couples from one eigenstate to the other within a narrow wavelength band. Here we report a distributed feed-back (DFB) polarization state converter that reflects, within a narrow wavelength range, a linearly polarized mode into the orthogonal counter-propagating mode. This filter is formed by launching two orthogonal linearly polarized counter-propagating beams into a photosensitive optical fibre; the resulting fine-period polarization fringe pattern is transferred to a corresponding rocking pattern of induced birefringence. The behaviour of light in this type of structure has been examined by Yeh[4].

In our experiment we used an elliptical-core Andrew Hi-Bi fiber[4] with a beat length of 4 mm at 514.5 nm. An in-line quarter wave plate was fashioned by fusion-splicing two pieces of fibre with Hi-Bi axes at an angle of 45° and cleaving one piece 5 mm from the splice. The length of the fibre from the splice to the opposite end (A in Figure 1) was 32 cm. This arrangement resulted after some adjustment in two counter-propagating beams each confined to one of the fibre's polarization eigenmodes.

The grating was written with the laser operating single frequency and a dielectric mirror placed against end B. The fibre was then exposed for 30 min to an in-core intensity of 17 mW/μm^2. Thermal stability was achieved by immersing the fibre in oil on an aluminium plate whose temperature was measured with a thermocouple. The filter characteristics (Figure 2) were measured by analysing the spectrum of the reflected light with the laser operating multimode, the mirror removed, end B immersed in index matching oil and a polariser (P1) placed after the laser to prevent any reflections from entering the laser cavity. The light was reflected from a beam splitter set close to normal incidence and passed through an analyser (P2) before it entered a confocal scanning Fabry-Perot interferometer with a free spectral range of 2 GHz. Figure 2 shows the reflected spectrum from the fibre with the analyser set at 90° to the polarization state of the light reflected from the fibre front face. The signal was observed consistently upon temperature tuning of the fibre by cooling the plate with a freezing spray and then allowing the temperature to rise while this plate was gently heated. The estimated filter reflectivity was 0.8%, and its linewidth of order 250 MHz. Following Yeh's analysis[4], we estimate the induced birefringence modulation depth to be of order 9×10^{-8}; this was limited by the available laser power. The grating was erased after about 25 min of exposure to the reading beam (~1 mW/μm^2 in-core intensity).

In conclusion, a novel photo-generated reflective rocking filter, formed by holographic polarization interference, has been proposed and experimentally realized.

References

1. M. Parent, J. Bures, S. Lacroix and J. Lapierre, "Propriétés de polarization des réflecteurs de Bragg induits par

photosensibilité dans les fibres optiques monomodes", Appl. Opt., **24** (354-357) 1985.

2. P.St.J. Russell and D.P. Hand, "Rocking filter formation in photosensitive high birefringence fibres", Electr. Lett. **26** (1846-1848) 1990.

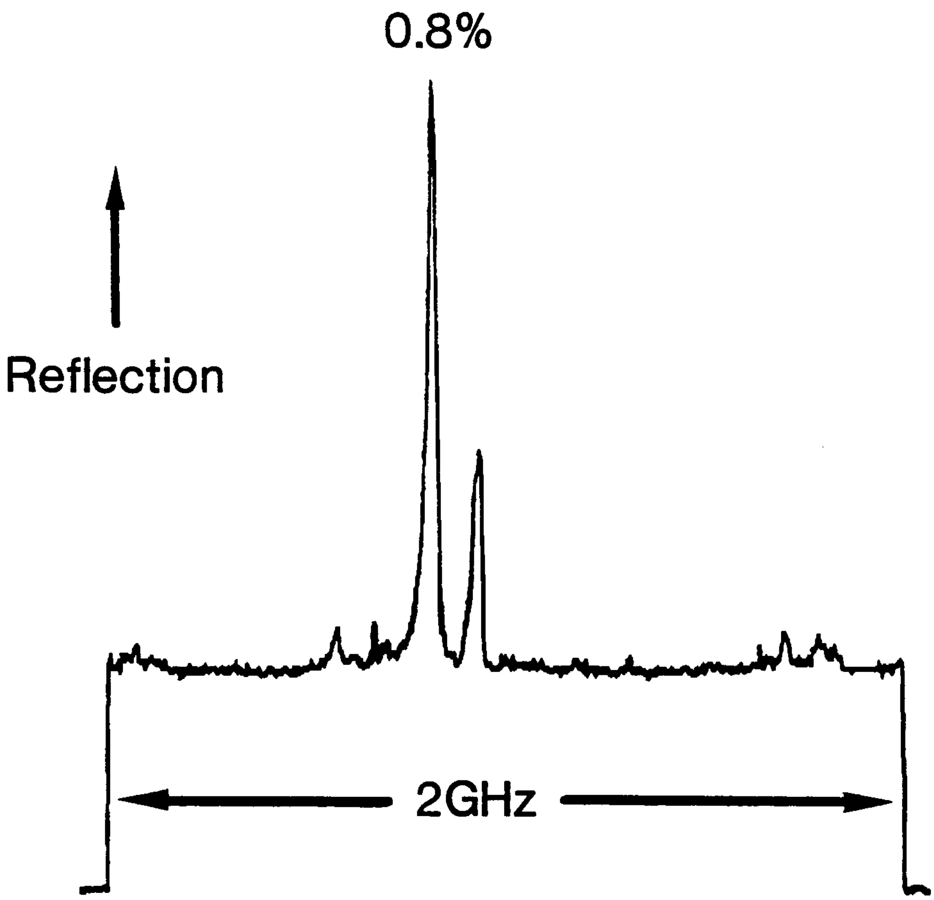
3. S.E. Kanellopoulos, L.C.G. Valente, V.A. Handerek and A.J. Rogers, "Photorefractive polarisation couplers in elliptical core fibres", IEEE Phot. Tech. Lett., 3 (806-) 1991.

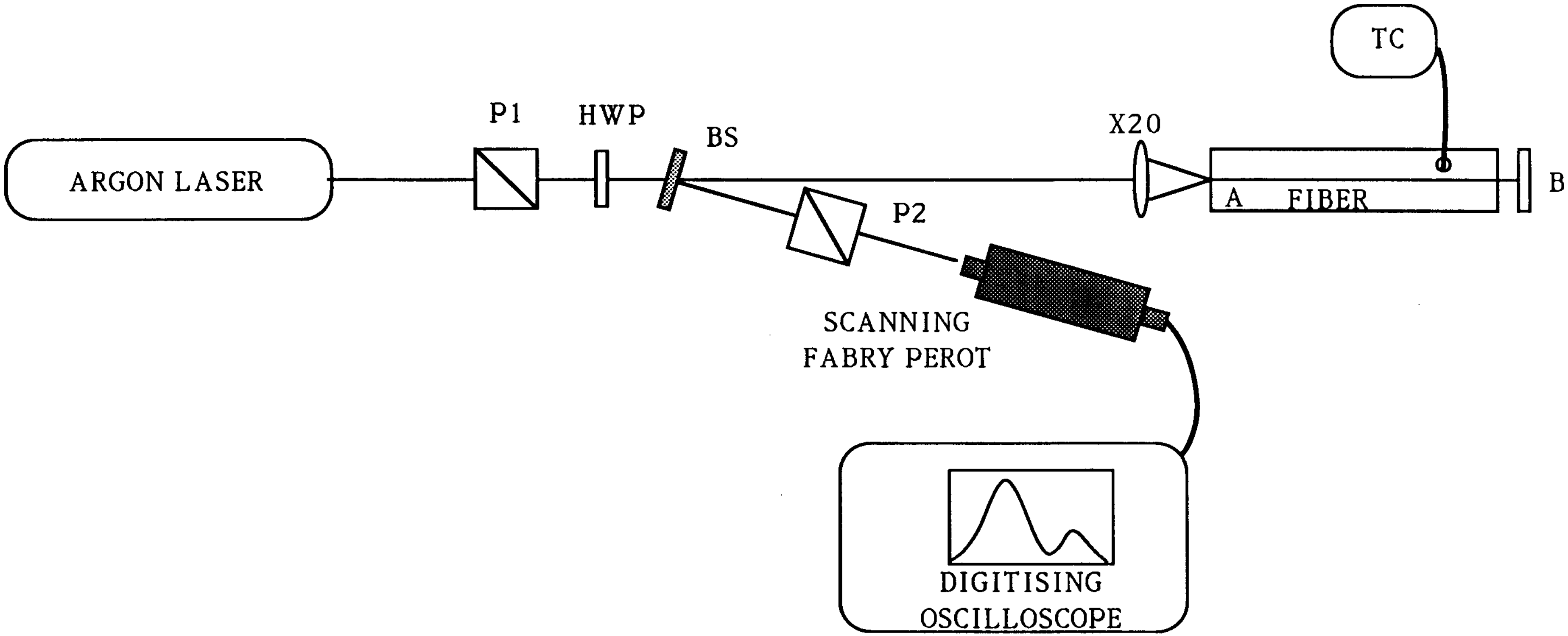
4. P. Yeh, "Electromagnetic propagation in birefringent layered media," J. Opt. Soc. Am. **69** (742-756) 1979.

Figure Captions

1. Experimental arrangement used for the writing and reading of the reflective rocking filter characteristics. The mirror was removed during the reading stage and the fibre was immersed in liquid paraffin. P: polariser; HWP: half-wave plate; BS: beamsplitter; M: dielectric mirror, TC: thermocouple.

2. Reflected laser modes polarised orthogonally to launched beam showing the spectral response of a 32 cm long reflective rocking filter.


0.8%
Reflection
2GHz


ARGON LASER
P1
HWP
BS
P2
SCANNING
FABRY PEROT
DIGITISING
OSCILLOSCOPE
X20
A
FIBER
TC
B