Démonstration expérimentale de la réduction de la PDL et du DGD des réseaux de Bragg par inscription dans des fibres tournées

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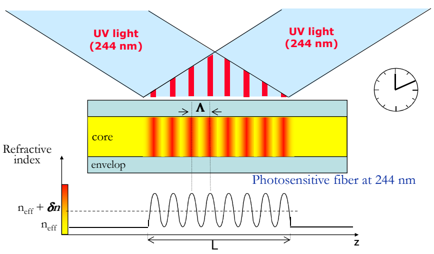
Nous démontrons expérimentalement la possibilité de réduire la PDL et le DGD causés par la biréfringence photo-induite des réseaux de Bragg en considérant un processus de fabrication original pour lequel la fibre est tournée avant inscription, puis relâchée. Cette technique permet d'induire un couplage de mode de polarisation, ce qui a pour conséquence de réduire les effets de la biréfringence photo-induite.

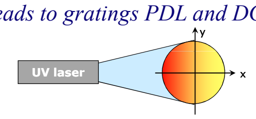
The one-side UV illumination causes UV induced birefringence that leads to grating PDL and DGD

FBGs are commonly obtained by one-side UV illumination of photosensitive fiber



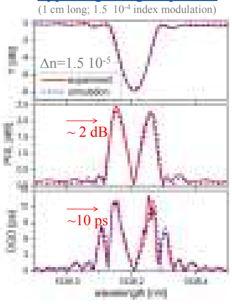
⇒ FBG corresponds to a periodic and permanent core refractive index modulation

The one-side illumination is an asymmetric writing process that leads to gratings PDL and DGD



- ❑ The induced refractive index is non-uniform through the fiber section
  - ⇒ *photo-induced birefringence* Δn (10^{-6} - 10^{-5})
- ❑ The presence of grating birefringence leads to polarization dependent effects :
  - ✓ effects not directly perceived in the amplitude response
  - ✓ grating exhibits PDL and DGD with significant values (PDL ~2 dB and DGD ~10 ps)

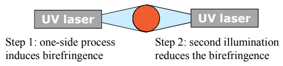
Typical grating responses
(1 cm long; 1.5 10^{-4} index modulation)



It is therefore important to find solutions to reduce the photo-induced birefringence effects

⇒ two methods can be investigated

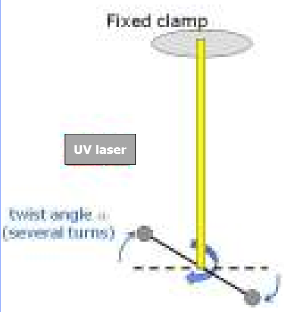
1. decreasing the birefringence value itself
   - How ? ⇒ by a more symmetric manufacturing process
   - e.g., dual exposure method [Vengsarkar, Opt. Let. 1994]



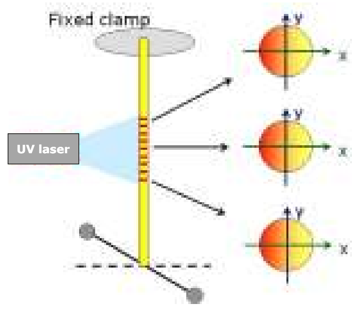
2. decreasing the effects of the birefringence
   - How? ⇒ by inducing polarization mode coupling (PMC) (birefringence value remains constant)
   - NB: same principle that used in the case of "spun fibers" to obtain optical fibers with low DGD values

We use a 3 steps manufacturing process in which gratings are written in twisted-fibers along their axis

1. Twist the fiber

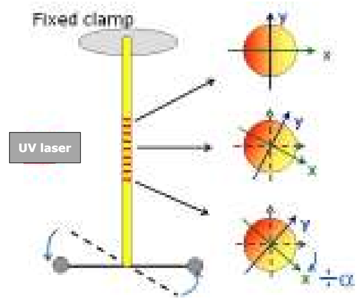


2. Write the FBG



⇒ *uniform birefringent FBG*

3. Relax the fiber



⇒ *birefringent FBG with PMC*

⇒ Compare to grating written in non-twisted fiber:

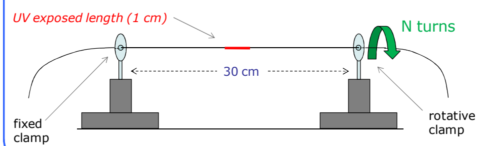
- ➢ photo-induced birefringence is the same
- ➢ there exists PMC (evolution of polarization axis along the fiber length)
  - → expected consequences: reduction of birefringence effects (PDL and DGD)

Experimental realizations

4 FBG were written over1 cm of 30 cm twisted-fiber

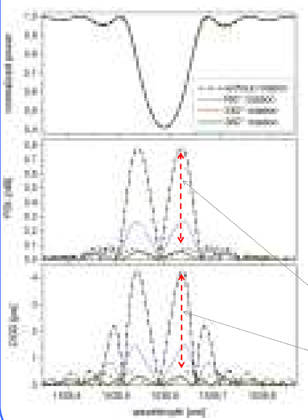
- ❑ FBGs written
  - in co-doped Bore/Germanium photosensitive SMF
  - by means of phase mask technique using 244 nm laser (frequency-doubled argon-ion)
  - 1 cm long; 12 dB amplitude rejection
- ❑ Twisted fibers:
  - N = number of turns over 30 cm
  - θ = rotation angle over FBG (1cm) = (N*360°)*(1/30)

N	θ
0	0°
12	188°
18	216°
24	288°



Simulations and experimental results point out the reduction of PDL and DGD for our twisted-FBG

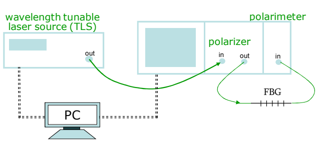
Simulations



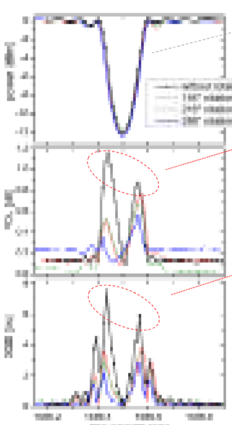
- ❑ Simulations parameters
  - – 8.10^{-5} modulation index, 1 cm length
  - – birefringence Δn : 8.10^{-6}
- ❑ 0°, 180°, 240°, 360° twisted-FBG
  - (*angle value*: rotation of polarization axis over the grating length)
- ❑ Results
  - ➢ Unchanged amplitude responses
  - ➢ PDL and DGD
    - curves shape are globally the same
    - weaker values when rotation angle increases:
      - → rotation: 0° → 360°
      - ➢ PDL: 0.8 dB → 0.1 dB
      - ➢ DGD: 4 ps → 0.5 ps
    - ⇒ reduction ~1/8

Experimental results

PDL(λ) et DGD(λ) curves are obtained by an automated setup using a polarimeter and a TLS with 10 pm resolution

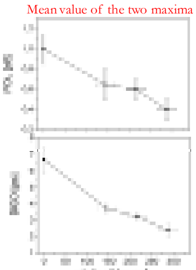


- ❑ Automated setup
  1. Polarizer controlled by the polarimeter
     - ⇒ J_{FBG} (Jones matrix of FBG)
  2. PC controls TLS and polarimeter
     - ⇒ J_{FBG} (λ)
  3. PDL/DGD calculus (Jones matrix eigenanalysis)
     - ⇒ PDL(λ) and DGD(λ) of FBG



Same amplitude spectrum for the 4 FBG

Mean value of the two maxima



⇒ *Experimental results point out an important reduction (>50%) of PDL and DGD for 288° rotationFBG*

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