Minutes of the WG1 meeting in Les Houches , Jan. 31-Feb. 2, 2007

The following reports on ongoing research were presented during the meeting:

Tutorial Lecture of WG1

Modeling of photonic crystal fibers: a brief review of the main methods and basic properties of linear fibers (tutorial lecture)

Gilles Renversez,
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Summary

First, we review three numerical methods used to study microstructured optical fibres when these fibres are assumed to be invariant along theiraxis. These methods are the multipole method, the differential method and the finite element method. All these methods are modal methods what are able to deal with complex propagation constants. We describe the common properties of these methods and also their differences in terms of accuracy, versatility and required computer resources. In the second part of this talk, we review the main linear properties of microstructured optical fibres with low index inclusions in an high index matrix. We describe the second mode transition both in terms of guiding losses and of spatial localization. Then, we explain how the operating diagram of these microstructured optical fibres can be build. Finally, we describe how these fibres can be used to manage simultaneously the guiding losses and the chromatic dispersion, an innovative profile which ensures both low losses and ultraflatenned chromatic dispersion around 1.55 µm is given.

WG1 Technical Presentations:

SG1: Fabrication, modeling and characterization of PCFs, chair: Philippe Roy (XLIM)

Preparation of large-mode-area laser fibers with microstructured cores

Kay Schuster, IPHT

Summary

The preparation route of active LMA fibers via microstructuring of the laser core allows the preparation of rare earth doped cores with effective areas larger or equal 1200 µm2. The limitation of the primary active structure elements (i.e. filaments) to small dimensions plays an important role to obtain a homogenously mode field structure of the propagated light. It is shown, that filament cross sections of about 1 µm show a suitable coherent coupling of laser light and generate a comprehensive large mode field. A suitable method to compensate the highly increase of refractive index by rare earth oxide / alumina / (phosphorus oxide) doping is to deposit the active layer in fluorine doped silica tube. The cross section relation between fluorine doped cladding and the active doped core can be decreased by etching the overcladding. Obviously, a small passive cross section area with depressed index is favorably for a good mode field homogeneity. Investigations of laser core light transmission of the filamented fibers show a background loss between 0.15 dB/m and 0.4 dB/m. The background loss can be depressed by interposing of an additionally purging step with chlorine gas. The prepared fibers show pump absorption intensities between 0.48 dB/m and 0.66 dB/m by pumping at 914 nm. The pump efficiency is inferior in comparison to conventional single layer d-shaped laser fibers without LMA-laser cores. The laser experiments show the possibility to implement the microstructured fibers in laser setups.

Fabrication of solid bandgap fibers with increased bandwidth by modification of outer cladding

Philippe Roy, XLIM

Summary

Solid core bandgap fibres have already demonstrated low confinement (<10dB/km) and bending (R_c < 3cm) losses simultaneously with the propagation of a large effective area mode (A_{eff}>700$\square^2$). Such fibres, exhibiting alternating layers of high and low index surrounding a large core, can propagate one single mode over a broad band of wavelengths (few hundreds nm depending on their design). The purpose of the talk is to show how the transmission spectrum depends on the external silica layer which acts as an additional Fabry-Perot resonator. This phenomenon is due to the confinement mechanism of the electric field which amplitude remains non zero in the silica cladding. The influence of the pure silica outer cladding has been studied both theoretically and experimentally. This property can be useful to improve singlemode behaviour, enlarge bandwidth or sensing applications.

New fibers developed in PERFOS

Nick Traynor,
PERFOS

Summary- not available

Photonic crystal fibers in IRCICA

Alexandre Kudlinski
University of Lille, Lab. PhLAM, IRCICA

Summary

General activities of the « photonics » group of IRCICA (Univ. of Lille) have been presented. Our work mainly focuses on glass synthesis, photonic crystal fibres fabrication, optical characterization and applications.
Recent bend loss measurements performed at the Institute of Physics (Wroclaw University of Technology) with solid bandgap fibres fabricated at IRCICA have also been presented. It was found that photonic bandgap fibres with a cladding made of 7 periods of Ge-doped rods strongly suffer from bend loss. We have proposed and demonstrated a new design consisting of only 3 periods of Ge-doped rods with an extra ring of air holes in order to reduce bend loss. It was indeed experimentally demonstrated that this fiber is significantly less sensitive to bend loss.

Bending losses in index guided PCFs

Waclaw Urbanczyk
Wroclaw University of Technology (WRUT)

Summary

We present an analytical formula for bending loss oscillations in photonic crystal fibers (PCFs). We follow the approach originally adopted for conventional double-clad fibers and show that it can be applied to PCFs by substituting the structural parameters of the conventional fiber by their PCF counterparts. We then examine the spectral dependence of the critical bending radius and the position of the first order loss peak as a function of structural parameters of the PCF cladding such as the fill factor and the number of hole rings. we evaluate the precision of the analytical model by comparing the results to finite element calculations for a selection of PCF geometries. Finally, the results of modeling are compared with measurements of bending losses in selected LMA fibers.

SG2: Devices based on PCFs

chair: Theis P. Hansen (COM-DTU)

Photonics Engineering Group of the University of Cantabria R&D results and potential collaboration topics

Jose Miguel Lopez-Higuera
University of Cantabria

Summary

The main recent R&D activities, available experimental facilities and results of the Photonics Engineering Group of the University of Cantabria (PEG-UC) will be addressed. The Lines and Topics in which we are interested to collaborate are, finally, mentioned. They are:

UC-PEG R&D&i Lines (in New European Projects proposals)

- *i) New Sensor &Devices for Sensing and Communications*
- *ii) Optoelectronic Instrumentation*
- *iii) Optical Spectroscopy, Infrared Thermography and Imaging based techniques for NDT Materials detection*
- *iv) Sensing and subsystems based on Nonlinear effects.*
- *v) Devices and Subsystems based in Fibre Grating Technology*

UC-PEG Topics to collaborate in COST299

- a) Fibre and Fibre Devices Characterization
- b) Sensor devices based on PCF
- c) Brillouim Effect on PCF and its application on sensing
- *d)* New techniques to improve the resolution of distributed sensors based on Brillouin scattering

Optical fiber polarizers based on long-period-grating microstructured fibers

D. C Zografopoulos and E. E. Kriezis
AUTH

Summary

A preliminary theoretical analysis of the polarization properties of long-period-gratings (LPGs) inscribed in birefringent microstructured fibers (MOFs) is presented. Numerical studies by means of a multipole method show that the coupling between the fundamental birefringent guided mode and the cladding modes induced by the LPG in an endlessly-single-mode index-guiding MOF is highly polarization dependent. This leads to ample separation of the grating's Bragg resonances corresponding to the two polarization states. We further show that extensive thermal tuning of these resonances is possible by infiltrating the cladding holes with an isotropic fluid. Thus, such PCFs may, in principle, find interesting applications as tunable wavelength selective polarization elements by thermally controlling the polarization-dependent resonance wavelengths of the LPG; applications in sensing might also be another possible alternative.

We decided to change the structure of WG1 by establishing new study groups that are more focused on defined tasks. The new structure of the WG1 approved by the MC meeting is presented below. Persons responsible for particular activity are underlined.

SG1: Improvement of technology and development of new PCF structures

leaders: Kay Shuster (IPHT) & Philippe Roy (XLIM)

potential partners: CUDOS, COM-DTU, IPHT, IRCICA, PERFOS, SU, UMCS, XLIM …..

Current and future activities (person responsible underlined):

1 Development of the Side-hole fiber for distributed measurements
(Waclaw Urbanczyk, UMCS, WRUT, DII-SUN)

2 Development of the SBF for SCG applications (STM expected)
(Sébastien Février, XLIM, WRUT, …..)

3. Development of the microstructured fiber for slow light experiments (demand from EPFL)
(Waclaw Urbanczyk, EPFL, UMCS, IPHT …..)

4. Characterization of Bragg Fibers
(Sébastien Février XLIM, IPHT, UZ, WRUT…)

5. Characterization of ARROW SBFs
(Geraud Bouwmans, IRCICA, WRUT …..)

6. Characterization of Ge dopped PCFs,
(Kay Shuster, IPHT, XLIM, GAP, WRUT,)
request for measurements of birefringence, dispersion, bending losses and other parameters

SG2: Modeling and optimization of SBFs

leader: Gilles Renversez (IFRES)

potential partners: IFRES, XLIM, IRCICA, IREE, TECHNION, WRUT,

Suggested activities:

1. Influence of lattice symmetry and microstructure of inclusions on propagation characteristics of SBFs;
2. Birefringent SBFs

SG3: Microstructured Polymer Optical Fibers

leader: Theis Peter Hansen (COM-DTU)

potential partners: COM-DTU, FPMs, INESC, NIT, ZU…

SG4: Development of Bragg gratings in HB PCFs for sensing applications

leader: Tomasz Nasilowski, VUB

partners: VUB, SCK-CEN, IPHT, UMCS, WRUT…..

Planned activities:

1. Design of PCF fiber with high birefringence and selective sensing characteristics (VUB, WRUT)
2. Fiber manufacturing (UMCS)
3. Grating manufacturing (IPHT)
4. Grating characterizations (SCK-CEN, VUB, WRUT)

SG5: LPGs in liquid-infiltrated PCFs for sensing applications

leaders: Emmanouil E. Kriezis/Dimitrios Zografopoulos, AUTH

Potential partners: AUTH, K. Kalli-Cyprus, XLIM, TAU ?

Conditionally:

SG6: Hollow core fiber for infrared applications

leader: Tomasz Nasilowski, VUB

(2-3 um, demand comes from SCK-CEN)

Potential partners: SCK-CEN, VUB, SU