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Datasheet for the decision of 22 February 2011

Case Number: T 1691/08 - 3402

Application Number: 98308351.0

Publication Number: 909965

IPC: G02B6/16, G02B6/293, G02B6/34, H04B10/12

Language of the proceeding: EN

Title of invention:
Recoatable temperature-insensitive long-period gratings

Applicant:
LUCENT TECHNOLOGIES INC.

Opponent:

Headword:

Relevant legal provisions:
EPC Art. 84, 56

Keyword:
Inventive Step (yes)

Decisions cited:

Catchword:

Europäisches Patentamt | European Patent Office | Office européen des brevets

Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T1691/08 - 3402

D E C I S I O N
of the Technical Board of Appeal 3402
of 22 February 2011

Appellant: (Applicant)
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 28 February 2008 refusing European application No. 98308351.0 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: A.G. Klein
Members: A. Maaswinkel
D.S. Rogers

Summary of Facts and Submissions

I. The appellant lodged an appeal against the Decision of the Examining Division, refusing the European patent application 98308351.0.

II. According to the Decision of the Examining Division the patent application did not fulfil the requirements of Article 84 EPC. Furthermore, insofar as claim 1 could be understood, its subject-matter did not involve an inventive step (Articles 52(1) and 56 EPC 1973) in view of the disclosure in the following documents:

D1: Electronics Letters, vol.33, No.5, pp. 417 - 419, T. Iwashima et al.: "Temperature compensation technique for fibre Bragg gratings using liquid crystalline polymer tubes";
D4: J.Lightwave Techn., vol.14, pp. 58 - 65, A.M. Vengsarkar et al.: "Long-Period Fiber Gratings as Band-Rejection Filters";
D5: J.Opt.Soc. Am. A, Vol. 14, pp. 1760 - 1773, T. Erdogan: "Cladding-mode resonances in short- and long-period fiber grating filters".

III. In the notice of appeal the appellant requested that the Decision under appeal be set aside and a patent be granted. With the statement containing the grounds of appeal the appellant stated that the claims of the main request included those considered in the decision under appeal and also filed a second set of claims as an auxiliary request.

IV. In a Communication under Rule 100(2) EPC the Board pointed out a number of deficiencies in the application documents and remarked that an amended set of documents

in which these were overcome could possibly also meet the further provisions of the Convention.

V. The appellant filed a revised request supported by new first and second sets of claims and revised description pages.

The documents comprising the main ("first") request include:

Claims:	1 to 10, as received with the letter of 16 November 2010;
Description:	pages 1 and 4 to 13 as originally filed; pages 2, 3 and 3A received with the letter of 16 November 2010;
Drawings:	sheets 1/5 - 5/5 as originally filed.

VI. The wording of independent claim 1 of the main request reads as follows:

" A long-period grating with a center wavelength $_p$ having enhanced stability to variations in temperature comprising:

an optical fiber (10) including a core (11) having an effective mode index of refraction n_{core} , a cladding (12,13) surrounding said core (11) having an effective mode index $n_{cladding}$ less than n_{core}, said core (11) having a grating region (14) comprising a plurality of perturbations (15) in its refractive index spaced apart by a periodic distance to form the long period grating with a center wavelength $_p$;

AND CHARACTERIZED IN THAT:

a polymeric overcoat layer (20) is located on said cladding (12,13), said cladding (12,13) being located between said grating region (14) and said polymeric overcoat layer (20), said polymeric overcoat layer (20)

having a refractive index n_p that is lower than an index of refraction of the cladding (12,13) and has a first derivative with respect to temperature dn_p/dT, and wherein n_p and dn_p/dT are chosen so that the rate of change of $_p$ with respect to temperature is less than 1 nm/100°C ".

The wording of independent claim 8 reads as follows:

" An optical fiber communications system comprising:
a source (51) of an optical signal;
optically coupled to said source, an optical signal path comprising length of optical fiber (52) for transmitting said optical signal;
disposed in said optical path, an optical amplifier (54) for amplifying said optical signal;
a pair of pumping sources (55,56) for pumping said optical amplifier (54) with optical pumping energy of wavelength $_{p1}$ and $_{p2}$;
AND CHARACTERIZED IN THAT:
disposed in the path of energy from each pump (55,56) after said pumping energy has passed through said amplifier unused is a spectral shaping device (57) for removing said unused pumping energy from said optical path comprising a long-period grating (10) according to claim 1 ".

The wording of independent claim 10 reads as follows:

" An optical fiber communications system comprising:
a source (51) of at least one optical signal;
optically coupled to said source, an optical signal path comprising a length of optical fiber (52) for transmitting said optical signal;
disposed in said optical signal path, an optical amplifier (54) having a gain spectral dependence with

one or more peak regions providing different gain for different wavelengths,
AND CHARACTERIZED IN THAT:
disposed in said optical signal path is a spectral shaping device (57) comprising a long-period grating device according to claim 1 for removing energy from the spectral region of one or more of said peak regions in order to provide a more uniform spectral output ".

Claims 2 to 7 are 9 dependent claims.

The wording of the claims of the auxiliary ("second") request is not relevant for the purpose of the present Decision.

VII. The appellant's arguments may be summarised as follows:

Claim 1 includes the feature that the polymeric overcoat layer has a refractive index n_p, that is lower than an index of refraction of the cladding and has a first derivative with respect to temperature dn_p/dT, and wherein n_p and dn_p/dT are chosen so that the rate of change with respect to temperature is less than 1 nm/ 100°C. In the Decision under appeal it is argued that such a feature is unclear under Article 84 EPC because it does not account for the strain and stress effects in the term d/dT in equation (3). This reasoning, however, is based on mathematical considerations that imply that stress and strain are most probably responsible for the achieved low thermal sensitivity of the center wavelength of the polymer coated long-period fiber grating. The appellant disagrees with the Examining Division on this point and believes that this conclusion is ill-founded because the specification of the present patent application clearly rebuts the Examining Division's analysis. First, it should be

pointed out that reference D1 is directed to a short period Bragg grating in which reflection is occurring, therefore the teaching in that document is not necessarily applicable to a long-period grating. Second, the patent application sets forth an example of an off-the-shelf cladded fiber. The change in the temperature dependence of the fiber without the extra cladding was measured. Then, that same fiber was coated with the polymeric coating and the temperature dependence was again measured. Since the same fiber was used in both measurements, any stress or strain associated with the fiber itself was inherently taken into account in the present invention and is negligible in view of the substantial change in temperature dependence values associated with the polymeric coating as given by the example in the specification. In view of the foregoing, it is believed that the claims are supported by the description and meet the requirements of Article 84 EPC.

With respect to the issue of inventive step, the invention as defined in independent claims 1, 8 and 10 is directed to improving long (period) fiber Bragg gratings. This is clearly reflected in the two-part form of the claims which enumerate the typical features of these devices as disclosed e.g. in D4, D5 or US-A-5,703,978. As is discussed in the introductory part of the present patent application, see page 1, "Background of Invention", long-period gratings are fundamentally different from short (period) fiber Bragg gratings as disclosed in document D1. Document D1 does not disclose a long-period grating with the features of the preamble of the independent claims and, therefore, cannot be considered as disclosing the closest prior art.

The Examining Division, incorrectly, asserts that the teaching of document D1 is applicable to long (period) fiber Bragg gratings. However, the only reference in D1 to long-period fiber Bragg gratings is that the technique is "potentially applicable" to long-period fiber Bragg gratings without giving any clues or teaching how such an application should be carried out. In any case, neither this document D1 alone, nor the further documents D4 and D5, teach or suggest the elements of independent claims 1, 8 and 10, therefore these claims define patentable subject-matter.

Reasons for the Decision

1. The appeal is admissible.

2. *Main Request*

2.1 Amendments

The Board is satisfied that the set of claims of the main ("first") request finds support in the patent application as originally filed.

2.2 Article 84 EPC

2.2.1 In the Decision objection was raised under Article 84 EPC for the reason that the analysis of the temperature dependence of the centre wavelength $_p$ of the long-period fiber grating concentrated on the influence of the refractive index change of the polymer cladding with temperature but that, according to the Examining

Division, it was immediately apparent that for a proper solution the inclusion of stress and strain related effects was necessary. Since this influence was not taken into account claim 1 was unclear and not supported by the description.

2.2.2 The Board does not share this position. The Board notes that the present patent application discusses the underlying technical problem in the Section "Principles of design". In this section the patent application discloses the solution to this problem and illustrates in Figure 5 the obtained improvement by showing a comparison of a long-period fibre without coating (curve 1) and an exemplary recoated fibre (curve 2). Furthermore the Board understands that the lower dependency of temperature in the recoated fibre is obtained by selecting the value of the refractive index of the polymer overcoat layer n_p and its first derivative with respect to temperature dn_p/dT (see page 8, lines 14 to 16 of the patent application).

2.2.3 It appears to the Board to be mere speculation whether a further inclusion of stress and strain-related effects in the problem analysis would have led to an even "better" technical solution, but such a consideration is irrelevant for the question whether the conditions of Article 84 EPC are met: as is set-out in point 2.2.2, the technical problem of prior art long-period gratings defined in the preamble of claim 1 is solved by the further features defined in the characterising portion of the claim. Thus it appears that claim 1 is not objectionable under Article 84 EPC. The same conclusion holds for the further claims of the main request.

2.3 Patentability - *Novelty - Claim 1*

2.3.1 In the decision under appeal there was no objection of lack of novelty against the claims. With respect to the available prior art, document D1 discloses a temperature compensation technique for a short-period Bragg grating, therefore this document does not disclose the features of the preamble of claim 1. Documents D4, D5 and US-A-5,703,978 (acknowledged in the patent application) disclose long-period grating fibre gratings of the type defined in the preamble of claim 1. These documents do not disclose the further features of the characterising portion of the claim.

2.3.2 Therefore the subject-matter of claim 1 is novel (Art. 52(1) EPC and 54 EPC).

2.4 *Inventive step*

2.4.1 In point 3 of the Reasons for the Decision addressing the issue of inventive step, document D1 was used as a starting point. The Board concurs with the appellant that this document cannot be considered as the closest prior art, because, with the exception of a cursory reference to "long FBGs" in its final sentence, the entire document is devoted to reducing temperature dependence in short fibre Bragg gratings. On page 1, lines 15 to 18 of the present patent application, it is disclosed that "the major functional difference between long-period gratings and conventional short-period Bragg gratings (periods <1µm) is that there is no backreflected mode in a long-period grating. As an example, the light can be coupled out of the core from a fundamental mode and into the cladding of a fiber on a wavelength selective basis". In order to enable such fibre cladding modes, the cladding may be surrounded with a medium with a refractive index lower than that

of the cladding, see document D5, page 1760, Section "1. Introduction", lhc, lines 11 - 14. This implies that the short-period fibre grating disclosed in D1 does not only differ from a long-period grating in its periodicity, but that because of the application of an epoxy resin around the fibre (see Figure 1 of D1) it would also be completely unsuitable for propagation of cladding modes. Therefore document D1 is not a proper starting document for the discussion of inventive step.

2.4.2 The further documents on file (D4, D5 and US-A-5,703,978) may be regarded as closest prior art, since these documents disclose long-period fibre gratings. In particular document US-A-5,703,978 addresses the temperature dependence of such gratings. As acknowledged on page 2, third paragraph of the present patent application, the solution proposed in that document is to select the fibre composition and profile whereby the temperature dependence can be reduced to below 4nm/100°C. However, this document does not disclose the feature of applying a polymer overcoat layer (the outer layer being an undoped silica layer, see Figure 2) and, even less, to select this polymer for a refractive index and its first derivative with respect to temperature as defined in the characterising portion of claim 1.

2.4.3 Such a selection is also not disclosed or suggested in the other available documents, including document D1.

2.4.4 Since this selection of the polymer overcoat layer results in a considerable improvement of the temperature dependence to less than 1nm/100°C (see Figure 5), and is not obviously derivable from the prior art, it is concluded that claim 1 defines patentable subject-matter.

2.5 Claims 8 and 10 address optical fiber communication systems including a long-period grating according to claim 1, therefore these claims define patentable subject-matter for the same reasons as set out *supra*. The further claims are dependent claims and are equally allowable.

3. Since the main request is allowable, there is no need to address the auxiliary request.

4. For the above reasons, the Board finds that the appellant's main request meets the requirements of the EPC and that a patent can be granted on the basis thereof.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the following documents:

Claims:	1 to 10, of the main ("first") request as received with the letter of 16 November 2010;
Description:	pages 1 and 4 to 13 as originally filed; pages 2, 3 and 3A received with the letter of 16 November 2010;
Drawings:	sheets 1/5 - 5/5 as originally filed.

The Registrar: The Chairman:

M. Kiehl A. G. Klein