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Datasheet for the decision of 22 July 2015

Case Number: T 2092/11 - 3.3.05

Application Number: 07011759.3

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Title of invention:
Radiation-resistant fluorine doped optical fiber

Applicant:
Draka Comteq B.V.

Headword:
Fluorine doped fiber/DRAKA COMTEQ B.V.

Relevant legal provisions:
EPC Art. 56

Keyword:
Inventive step - main request (yes)

Decisions cited:

Catchword:

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Case Number: T 2092/11 - 3.3.05

D E C I S I O N
of Technical Board of Appeal 3.3.05
of 22 July 2015

Appellant: (Applicant)	Draka Comteq B.V. De Boelelaan 7 1083 HJ Amsterdam (NL)
Representative:	Algemeen Octrooi- en Merkenbureau B.V. P.O. Box 645 5600 AP Eindhoven (NL)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 23 March 2011 refusing European patent application No. 07011759.3 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	G. Raths
Members:	H. Engl
	P. Guntz

Summary of Facts and Submissions

I. European patent application 070110759.3 was refused by a decision of the examining division posted on 23 March 2011. The examining division decided that the subject-matter of claim 1 of the main request and of auxiliary requests 1 and 2 did not involve an inventive step having regard to document D1.

II. The documents cited in the examination procedure included the following:

D1: US 4 690 504 A

D2: SANADA K et al: "*Radiation resistance of fluorine-doped silica core fibers*", JOURNAL OF NON-CRYSTALLINE SOLIDS, NORTH-HOLLAND PHYSICS PUBLISHING, AMSTERDAM, NL, vol. 179, 1994, pages 339-344, XP004067827, ISSN: 0022-3093

D3: KAKUTA T et al: "*Development of in-core monitoring system using radiation resistant optical fibers*", NUCLEAR SCIENCE SYMPOSIUM AND MEDICAL IMAGING CONFERENCE, 1994, 1994 IEEE CONFERENCE RECORD NORFOLK, VA, USA 30 OCT. - 5 NOV. 1994, NEW YORK, NY, USA, IEEE, USA, vol. 1, 30 October 1994 (1994-10-30), pages 371-374, XP010150153, ISBN: 0-7803-2544-3

D4: US 4 988 162 A

D5: US 5 681 365 A

III. The instant appeal, which lies from this decision, was filed with letter dated 19 May 2011. With the statement of grounds of appeal, dated 13 July 2011, the applicant (henceforth: the appellant) submitted new claims as a main and an auxiliary request.

IV. Claim 1 in accordance with the main request reads:

"1. A single mode optical transmission fiber, comprising a core-and-cladding structure, wherein each of the core portion and the cladding portion contains fluorine as dopant to decrease the refractive index, characterized in that:

- said depressed core has at least 0.41 wt% of Fluorine and an absolute refractive index difference ($|\Delta n_1|$) with pure silica greater than $1.5.10^{-3}$; and
- a depressed cladding having at least 1.2 wt% of Fluorine, an absolute refractive index difference ($|\Delta n_2|$) with pure silica greater than $4.5.10^{-3}$ and an absolute refractive index difference ($|\Delta n_2|-|\Delta n_1|$) with the depressed core greater than 3.10^{-3}, wherein said core has at most 1.4 wt% of Fluorine."

Claims 2 to 10 represent particular embodiments of the subject-matter of claim 1 on which they depend.

Independent claim 11 is directed at the use of at least a portion of the fiber according to any one of the preceding claims in a communication optical system.

Claim 12 represents a particular embodiment of the subject-matter of claim 11 on which it depends.

V. The appellant essentially argued as follows:

D1 represented the closest prior art. Said document D1 taught that the core portion of the fiber had a refractive index lower by 0.01% to 0.1% than that of an undoped fused quartz glass. Although D1 qualified said range of 0.01 to 0.1 % as a "preferred" one, the teachings of document D1 as a whole clearly suggested a stricter interpretation. D1 also taught that the concentration of fluorine should not be too high, that is higher than 0.1%, because in such a case a sufficiently large difference between the refractive indices of the fiber core and cladding could not be obtained.

At low concentrations of fluorine in the quartz glass rod, the desired effect of fluorine doping may be reduced to eliminate the adverse influences of the oxygen deficiency in the fused quartz glass.

In any event, D1 did not suggest how to amend the amount of fluorine doping for solving the problem of low resistance to ionizing radiation. There was no hint that a "high concentration", i.e. a concentration above 0.1 %, was desirable, let alone a reason was given why such a high concentration would be desirable. D1 gave no indication as to which technical problem would be solved by increasing the fluorine content of the core portion above the value of 0.1 %.

D3 showed only two optical fibers having excellent radiation resistance. D3 failed to teach which specific components, i.e. the content of OH in the pure silica core, the fluorine doping to the pure silica core, or the fluorine doping to the pure silica clad or a combination of these possibilities, was responsible for the excellent resistance against radiation. Therefore, the skilled person starting from D1 would not be motivated to vary the fluorine content in the core and/ or the cladding.

VI. Requests:

The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims of the main request or, in the alternative, on the basis of the claims of the auxiliary request, both filed with the statement of grounds of appeal.

Reasons for the Decision

1. Amendments

Claim 1 of the main request is based on claims 1 and 8 as originally filed.

The dependent claims 2 to 7, 8, 9, 10 and 12 are based on the respective claims 2 to 7, 9 to 11 and 13, of the application documents as originally filed.

The requirements of Article 123(2) EPC are thus met.

2. Novelty (main request)

2.1 D1 deals with single mode transmission optical fibers of the step-index type with no Germanium doping in the core (column 1, lines 15 to 39).

D1 proposes single mode transmission optical fibers of the step-index type (i.e. fibers whose refractive index profile along the fiber's radius shows a "step") comprising a depressed core containing fluorine and having an absolute refractive index difference ($|\Delta n_1|$) with pure silica of 0.01% to 0.1% (up to $1.46.10^{-3}$; see the appellant's letter dated 26 September 2008, page 2, line 15); and a depressed cladding containing fluorine, wherein the absolute refractive index difference ($|\Delta n_2|-|\Delta n_1|$) with the depressed core is at least 0.2% (at least about $2.9.10^{-3}$), and the absolute refractive index difference ($|\Delta n_2|$) with pure silica is about $4.4.10^{-3}$. See D1, claims 1 and 2; Examples 1 and 2.

The subject-matter of claim 1 of the main request therefore differs from the disclosure of D1 in that the $|\Delta n_i|$ values are superior to those according to D1, namely greater than $1.5.10^{-3}$ instead of $1.46.10^{-3}$ for the core, and greater than $4.5.10^{-3}$ instead of $4.4.10^{-3}$ for the cladding.

Furthermore, claim 1 of the application under appeal defines a fluorine content in the core of from 0.41 to 1.4 wt%, whereas D1 teaches a preferred fluorine content in the core of from 0.01% to 0.1% (see column 2, line 68 to column 3, line 9).

2.2 D2 is a paper on improving the radiation resistance of multimode fluorine-doped step-index optical fibers. Experimental fiber B contained 1.6 wt% F in the core (i.e. higher than 1.4 % according to the upper value of the claimed range) and 5.6 wt% F in the cladding; fiber C 2.8 wt% F in the core (i.e. higher than 1.4 % according to the upper value of the claimed range) and 5.6 wt% F in the cladding, whereas comparison fiber A was only F-doped in the cladding (see page 340, Table 1). Fiber B with 1.6 wt% F in the core exhibited the optimum F content for achieving radiation resistance. The radiation resistance could still be further improved by H_2 doping (see pages 341 and 342; sections 3.2 and 3.3; page 343: section 5 "Conclusion").

The disclosure of D3 is similar. In particular, the fluorine contents of the multimode optical step-index fibers Nos. 1 (OH doping in the core, 4 wt% F in the cladding) and Nos. 2 (1.6 wt% F in the core and 5.6 wt% F in the cladding) of Table 1 of D3 are the same as in fibers A and B of D2, respectively. According to D3, both fibers Nos. 1 and 2 exhibit excellent radiation resistance.

2.3 The requirements of Article 54 EPC are thus met.

3. Inventive step (main request)

3.1 Invention

The invention is concerned with a single mode optical transmission fiber and the use of at least a portion of such a single mode optical transmission fiber in a communication optical system located in an environment exhibiting ionising radiation (see claims 1 and 11) .

3.2 Closest prior art

The board shares the view that D1 represents the closest prior art, because it also relates to single mode transmission optical fibers of the step-index type and also deals with the problem of radiation resistance of such fibers.

3.3 Problem

According to the application in suit, the problem was to improve the resistance to high-dose radiation i.e. above 100 Gray (Gy)(see [0011] and [0012]).

3.4 Solution

As a solution to this problem, the application under appeal proposes a single mode optical transmission fiber in accordance with claim 1 characterized in that:

- the depressed core has at least 0.41 wt% of fluorine and an absolute refractive index difference ($|\Delta n_1|$) with pure silica greater than $1.5.10^{-3}$;
- the depressed cladding has at least 1.2 wt% of fluorine, an absolute refractive index difference ($|\Delta n_2|$) with pure silica greater than $4.5.10^{-3}$ and an absolute refractive index difference ($|\Delta n_2|-|\Delta n_1|$) with the depressed core greater than 3.10^{-3}, and
- wherein said core has a fluorine content of at least 0.41 wt% and at most 1.4 wt%.

3.5 Success of the solution

The board has to examine whether a meaningful comparison between the results achieved by the claimed fiber and a fiber according to the closest prior art can be made. To this end all technical information at hand will be taken into account.

In the state of the art, Ge-doped fibers are known to exhibit poor resistance against ionizing radiation. Therefore, optical fibers were proposed in which the core is made of high purity quartz glass and the cladding of fused quartz glass doped with a dopant having an effect of decreasing the refractive index, such as fluorine (F) and boron (B). However, these fibers suffer from the problem of structural defects formed in the high-purity quartz glass core in the course of melt spinning which give rise to increased absorption loss of light by hydrogen molecule trapping.

The experimental results summarized in Figure 3 of the application and discussed in paragraphs [0031] to [0035] demonstrate that the fiber No. 3 in accordance with the invention exhibits reduced transmission losses at high radiation dosages (above 100 Gy).

The board acknowledges that the goal of the invention is achieved, but in the absence of a direct comparison with the fibers in accordance with the closest prior art document D1, the board cannot acknowledge that the claimed invention provides an improvement over the fibers according to D1.

Therefore, the object of the patent application under appeal is redefined in a less ambitious manner, namely as providing an alternative single mode optical fiber.

This problem is indeed solved.

3.6 Obviousness

It remains to be decided whether the claimed subject-matter is obvious in view of the prior art.

D1 discloses in Figure 1 an optical fiber having a core-and-cladding structure composed of a core portion and a cladding portion on and around the core portion, of which each of the core portion and cladding portion contains fluorine as a dopant to decrease the refractive index of diffused quartz glass. The concentration of the fluorine is higher in the cladding portion than in the core portion. The core portion has a refractive index lower by 0.01% to 0.1% than that of an undoped high-purity fused quartz glass (see column 1, lines 61 to 68, and column 2, line 68 to column 3, line 4).

D1 teaches that the fluorine concentration in the core should not exceed the limit of 0.1 wt% because in such a case, no sufficiently large difference between the refractive indices of the core and the cladding can be obtained (column 3, lines 5 to 9). It will be understood by the skilled person that said difference is important for the propagation of light signals through the fiber.

D1 does not teach to increase the fluorine dopant concentration in the core as a solution to the problem of resistance to ionizing radiation. In accordance with D1, radiation resistance is improved by eliminating the Ge dopant from the core which is made from high-purity fused quartz glass. The invention of D1 consists in the finding that a low percentage of fluorine dopant in the Ge-free core prevents the formation of structural defects such as oxygen deficiencies during melt spinning (see column 1, lines 40 to 52).

Therefore, the board concludes that D1 does not suggest a fluorine doping of the fiber core in the range as now claimed (0.41 wt% to 1.4 wt%).

The board is not convinced by the examining division's argument in the contested decision (see Reasons, point 2), according to which the skilled person *"confronted with specific customer needs in terms of guiding properties (loss, dispersion, etc.) and* H_2 *contamination"* would consider modifying the fibers of D1 so as to fall within the claimed range. This argument firstly appears to involve an unwarranted redefinition of the problem of the application. Secondly, the examining division failed to show why such "particular customer needs" should be attainable with a fiber having the claimed fluorine content in the core and the cladding. The board observes that the fluorine contents of the fibers of D2 and D3 fall outside the claimed range.

According to another argument of the examining division, the skilled person starting from D1 would be motivated to increase the fluorine content because this would increase the fiber's resistance against H_2 contamination. However, this statement appears to be at odds with the technical problem as formulated by the examining division which relates to improving radiation resistance. In fact, as observed by the examining division, the patent application under appeal does not deal with the problem of hydrogen contamination. The problem is discussed in D1 in connection with Ge-free fibers where it is solved by a low fluorine doping in the core and the cladding, in concentrations different from those used in the instant application. There is no hint in D1 or any other prior art that an increase of the fluorine doping would further improve the fiber's resistance against H_2 contamination.

Still further, the examining division argued that the skilled person reading D3 would be motivated to increase the fluorine content in view of the statement on page 371 (last sentence of the first paragraph of the introduction) and page 372 (line four of the first paragraph). Indeed, D3 shows that fibers having a core doped with OH or F are excellent in terms of radiation resistance under doses exceeding 10^6 Gy (see page 372, left hand column, first paragraph). Apart from the fact that the fibers of D3 are multimode fibers (core diameter 200 µm), the F doping is outside the claimed range. Therefore, even the combination of D1 and D3 (or D2) would not lead to the claimed invention.

D4 discloses a radiation resistant multiple fiber wherein each of the elemental fibers comprises a core doped with chlorine, OH groups and 200 to 10,000 ppm of fluorine (see abstract; column 2, lines 33 to 57; figures 1 to 3; claim 1). The cladding may consist of silica glass containing B and/or F such that the difference in refractive index (Δn) between the core and the cladding is at least 0.008, preferable from 0.01 to 0.020 (see column 3, lines 35 to 47, and column 2, lines 1 to 3). The fiber of D4 is a multiple fiber having a number of elemental optical fibers which are integrated into a single fiber by mutual heat-fusion of neighboring cladding layers. It is thus substantially distinct from the fibers in accordance with the patent application under appeal, so that the skilled person would not take D4 into account in view of the problem posed.

D5 reveals a radiation resistant optical fiber wherein the fluorine doping is substantially constant across the core and a portion of the clad adjacent the core is doped with fluorine or Ge (see abstract; Example 1). D5 does not teach a fiber having a fluorine content of at least 0.41 wt% and at most 1.4 wt% in the depressed core, an absolute refractive index difference ($|\Delta n_1|$) of the core with pure silica greater than $1.5.10^{-3}$, a fluorine doped depressed cladding having an absolute refractive index difference ($|\Delta n_2|$) with pure silica greater than $4.5.10^{-3}$ and an absolute refractive index difference ($|\Delta n_2|-|\Delta n_1|$) with the depressed core of greater than 3.10^{-3}. Therefore, the combination of D1 and D5 would not lead towards the claimed invention.

3.7 In conclusion, the subject-matter of claim 1 of the main request involves an inventive step (Article 56 EPC).

Dependent claims 2 to 10 and 12 and independent use claim 11 derive their patentability from claim 1 on which they depend.

3.8 As the main request can be allowed, there is no need to examine the claims of the auxiliary request.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a patent on the basis of claims 1 to 12 of the main request, filed with the statement of grounds of appeal, and a description and drawings to be adapted thereto.

The Registrar: The Chairman:

C. Vodz G. Raths

Decision electronically authenticated