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File Number: T 142/89 - 3.2.2

Application No.: 85 114 363.6

Publication No.: 0 182 250

Title of invention: Method for producing glass preform for optical fiber

Classification: C03B 37/012

D E C I S I O N
of 27 February 1991

Applicant: Sumitomo Electric Industries Limited

Proprietor of the patent:

Opponent:

Headword:

EPC Art. 56

Keyword: "Inventive step (affirmed, after amendment)"

Headnote

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number : T 142/89 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 27 February 1991

Appellant : Sumitomo Electric Industries Limited
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Decision under appeal : Decision of Examining Division 088 of the European Patent Office dated 14 October 1988 refusing European patent application No. 85 114 363.6 pursuant to Article 97(1) EPC

Composition of the Board :

Chairman : G. Szabo
Members : P. Dropmann
L. Mancini

Summary of Facts and Submissions

I. European patent application No. 85 114 363.6 filed on 12 November 1985 and published under publication No. 0 182 250 was refused by a decision dated 14 October 1988. The decision was based on Claim 1 filed during the oral proceedings on 6 July 1988 and Claims 2 to 6 as originally filed.

II. The reason given for the refusal was that the subject-matter of the claims did not involve an inventive step in the light of the disclosures of FR-A-2 441 594 (D1), EP-A-0 082 305 (D2) and EP-A-0 100 998 (D4) bearing in mind the normal activities of a person skilled in the art. In particular, the Examining Division argued that the presence of halogen-containing compounds in the gap between the core and cladding materials at high temperatures would cause etching of the outer surface of the core and the inner surface of the cladding material, thus leading to irregularities in the finished preform and to high attenuation in the drawn optical fibre. These irregularities could only be avoided by thermal polishing of the above surfaces during the collapse of the cladding material. The skilled person would perform laboratory tests in order to find the collapsing temperature that gives the best results.

III. On 29 November 1988 the Appellant lodged an appeal against the decision, paying the appeal fee at the same time. In the Statement of Grounds received on 13 February 1989, the Appellant essentially argued that the claimed method and, in particular, the collapsing and fusing temperature of at least 1900°C resulted in very considerably reduced levels of attenuation of light transmission in the drawn optical fibre. Document D1 taught against the use of high temperature fusing and document D2 was silent on this

point. The Examining Division's speculation that a high fusing temperature would be arrived at by performing laboratory tests was based upon hindsight. Thus, in the Appellant's view, the claimed method involved an inventive step.

IV. In response to a Communication from the Board, in which doubts were expressed in respect of Articles 123(2), 84 and 56 EPC, the Appellant filed on 19 December 1990 an amended Claim 1 and page 3 and submitted further arguments in support of an inventive step.

V. Claim 1 now reads as follows:

"A rod-in-tube method for producing a glass preform for use in the fabrication of an optical fiber, which comprises the steps of:

inserting a glass rod as a core material in a glass tube as a cladding material,

filling the gap between the core and cladding materials with an atmosphere containing at least one gaseous halogen-containing compound,

heating the core and cladding materials to collapse the gap between them and to fuse them together,

characterised by the steps of fusing and closing one end of the cladding material prior to collapsing said gap, and heating said materials at a temperature of at least 1900°C to remove flaws from the inner surface of the tube and to bring about said collapse and fusing of the core and cladding materials whilst maintaining a sufficient pressure of said halogen-containing atmosphere within said gap so that it does not collapse at a temperature lower than 1900°C."

VI. On the request of the Board the Appellant submitted revised pages 1, 2, 2a, 5, 6 and 7 of the description on 18 February 1991.

VII. The Appellant requests, by implication, that the decision under appeal be set aside and that a European patent be granted on the basis of the following documents:

- Claim 1 received on 19 December 1990,
  Claims 2 to 6 as originally filed,

- Description, pages 1, 2, 2a, 5, 6 and 7 received on 18 February 1991,
  page 3 received on 19 December 1990, and
  pages 4, 8 and 9 as originally filed,

- Figures 1 and 2 as originally filed.

Reasons for the Decision

1. The appeal is admissible.

2. **Formal aspects**

No formal objections arise in respect of the amended Claim 1 and description. In particular, the claim is clear as prescribed by Article 84 EPC and is admissible under Article 123(2) EPC, the features added to Claim 1 being originally disclosed on page 5 of the description. Furthermore, such Claim 1 meets the requirement of Rule 29(1) EPC, since it is correctly delineated over the prior art as known from FR-A-2 441 594 (D1).

3. Novelty

The subject-matter of Claim 1 is novel over the prior art documents cited in the European search report. None of the documents discloses a rod-in-tube method comprising, in combination, all the features specified in Claim 1.

4. Closest state of the art

As acknowledged by the Appellant in the Statement of Grounds, FR-A-2 441 594 (D1) represents the state of the art which is closest to the subject-matter of Claim 1. Indeed, this document discloses a rod-in-tube method for producing a glass preform for use in the fabrication of an optical fibre, which method comprises all the features specified in the pre-characterising portion of Claim 1, i.e. it reveals the steps of inserting a glass rod as a core material in a glass tube as a cladding material, filling the gap between the core and cladding materials with an atmosphere containing at least one gaseous halogen-containing compound, and heating the core and cladding materials to collapse the gap between them and to fuse them together.

The purpose of filling the gap with the gaseous halogen-containing compound and carrying out the heat treatment is, as stated in document D1, to remove contaminations on the surfaces of the core and cladding materials, which contaminations would become incorporated into the preform during its formation, and thus to improve the conditions at the interface between the core and the cladding. As a consequence, optical fibres formed from the preform produced in accordance with the prior art method have reduced attenuation of light transmission. More specifically, the attenuation of the fibres made in accordance with Examples 1 to 16 of document D1 ranges from 2.9 to 5.0 dB/km at a wavelength of 0.8 or 0.85 μm.

5. Problem and solution

The values of light attenuation achieved by the prior art method are considered as being still too high, in particular in view of the fact that optical fibres having attenuation of light transmission of less than 1 dB/km are desirable at a wavelength of longer than 1.2 μm (cf. page 2, lines 5 to 7 of the application in suit).

Hence, in accordance with the Appellant's statements on page 2a, first paragraph of the application in suit, the objective technical problem to be solved over the closest state of the art is to be seen in the provision of an improved rod-in-tube method for producing a glass preform for use in the fabrication of an optical fibre having low attenuation of light transmission particularly in a long wavelength range.

The further object mentioned on page 2a, second paragraph of the application and concerning the prevention of the contamination with water or moisture at the interface between the core and the cladding, cannot be considered as forming part of the objective technical problem underlying the present application. Such an object has already been solved by the method known from document D1 (cf. point 4 above).

The problem discussed above is solved in a method according to the preamble of Claim 1 by the added steps of fusing and closing one end of the cladding material prior to collapsing the gap between the core and cladding materials, and heating said materials at a temperature of at least 1900°C to remove flaws from the inner surface of the tube and to bring about said collapse and fusing of the core and cladding materials whilst maintaining a sufficient pressure of said halogen-containing atmosphere

within said gap so that it does not collapse at a temperature lower than 1900°C.

Optical fibres produced in accordance with this claimed method have very low light attenuation. According to Examples 1 and 2, the attenuation is 0.46 dB/km and 0.43 dB/km, respectively, both at a wavelength of 1.3 μm.

6. **Inventive step**

6.1 The question to be discussed is whether or not it was obvious to a person skilled in the art and faced with the problem indicated above, to modify the method as known from the closest prior art document, i.e. document D1, so as to arrive at the method according to Claim 1 of the application in suit. In this respect, two of the characterising features will be considered, i.e. the features that the core and cladding materials are heated at a temperature of at least 1900°C to remove flaws from the inner surface of the cladding material and to bring about the collapse and fusing of the core and cladding materials and that a sufficient pressure of the halogen-containing atmosphere is maintained within the gap so that it does not collapse at a temperature lower than 1900°C.

6.2 As to the posed problem, document D1 does not contain any information or hint that the light attenuation disclosed in this citation and ranging from 2.9 to 5.0 dB/km could be substantially further reduced to values as low as about 0.5 dB/km at somewhat increased wavelengths.

The heat treatment of the core and cladding surfaces in the halogen-containing atmosphere according to the rod-in-tube method revealed in document D1 is carried out at temperatures between 500 and 1600°C. It is further stated there that if the temperature of the heat treatment is

above 1600°C, the silica glass softens and deforms conspicuously, which renders the treatment more difficult. The heat treatment is followed by a fusing step after increasing the temperature and, as mentioned in the examples, after replacing the halogen-containing atmosphere by a gas such as oxygen or nitrogen. Citation D1 is silent on the fusing temperature.

It follows from the statements above that the same document does not give any indication or encouragement to raise the temperature of heat treatment in the given atmosphere to at least 1900°C. On the contrary, it specifically teaches against the use of such a high temperature treatment in a halogen-containing atmosphere because of the problems of deformation mentioned there and the fact that in all examples the halogen-containing atmosphere is removed from the gap before its collapse. Furthermore, no suggestion is made that, in order to carry out the heat treatment at such temperatures, any collapsing of the cladding material at a temperature lower than 1900°C is to be prevented by maintaining a sufficient pressure.

Hence, the person skilled in the art receives no clue from the document itself to solve the posed problem in the way set out in Claim 1.

6.3 Document EP-A-0 082 305 (D2) does not hint at the claimed method either. This document mentions that attenuation of light caused by the presence of hydroxyl groups within the optical fibre should be less than 5 dB/km at a wavelength of 1.395 μm. It is disclosed that in order to reduce the content of hydroxyl groups in an optical fibre, a halogen-containing atmosphere is being circulated through the hollow centre of the preform tube before and/or during the fabrication of the fibre, at least during the drawing

step. Document D2 further discloses that this technique may be applied to a rod-in-tube method.

However, there is no indication or discussion in the whole document of the temperature and pressure conditions before and during collapsing the gap between the core and cladding materials. Thus, the person skilled in the art could not have obtained any hint from this in the direction that a temperature of at least 1900°C, i.e. this temperature is the lowest to be selected, is crucial to heat treatment and collapse of said materials in order to reduce the level of attenuation considerably.

6.4 Document GB-A-2 084 988 (D3) relates to methods of etching materials containing silicon. In a first aspect, a method for manufacturing glass fibres having a reduced concentration of hydroxyl groups is described. According to this method, a tubular substrate having layers of doped silica deposited on its inside (CVD method) is collapsed and a gaseous fluorine-containing compound is passed through the tube during the collapse stage, which gaseous atmosphere reacts with the inner deposited surface to remove a layer of previously deposited material. As is further revealed in the disclosure, the temperature used to collapse the tube is in the region of 1900°C which temperature leads to the wanted reaction and vaporisation of the inner layers.

In contrast to this prior art CVD method, the method according to the application in suit concerns a rod-in-tube method in which no problems arise with vapour deposited inner silicon layers and evaporation of dopants in the last deposited layers inside the tubular substrate during the collapse stage at 1700 to 1900°C as mentioned in the document. Thus, the person skilled in the art would not have considered such statement concerning the

collapsing temperature as a guidance for determining the collapsing temperature in the present rod-in-tube method since there appears to be no need to vaporise silicon layers. In particular, the statement in document D3 could not have led the skilled person to recognise that collapsing at a temperature lower than 1900°C has to be prevented and that, for that purpose, the pressure of the halogen-containing atmosphere within the gap must be kept at a sufficiently high level. Neither could he have expected that a collapsing temperature of at least 1900°C would result in fibres having a surprisingly low light attenuation of below 0.5 dB/km.

The same argument applies to the method according to the second aspect disclosed in document D3 which method relates, without indicating any suitable temperature, to the removal of a layer from the surface of silicon-containing compound comprising applying a vapour containing a fluorine-containing compound to the surface.

6.5 Document EP-A-0 100 998 (D4) concerns a method for producing a glass fibre having a reduced refractive index in the centre. The method comprises the step of collapsing a glass tube in the presence of a dopant in the interior of the tube, reducing the refractive index of the tube. Preferably, collapsing takes place in an etching atmosphere having a concentration such that the diffusion rate of the dopant is higher than that of the etching atmosphere. It is true that this document mentions a collapsing temperature of about 2050°C. However, this statement cannot have led the skilled person to the teaching of Claim 1, since the citation concerns a method comprising a diffusion step which per se requires an elevated temperature not necessary if diffusion is not important.

6.6 Documents DE-A-3 315 156 and US-A-4 123 483 further cited in the search report do not suggest to the skilled person that he or she could have solved the problem of remarkably reducing the attenuation of light transmission in the way specified in Claim 1. The first one of these documents does not mention a collapsing temperature at all and the second one just reveals a temperature of 1900°C which is to be considered as being the drawing temperature. These documents do not contain any suggestion that collapsing of the core and cladding materials should be avoided at a temperature lower than 1900°C.

6.7 It has been shown on the basis of the two discussed features that the method according to Claim 1 already therefore involves an inventive step. Claim 1 is thus allowable.

7. Claims 2 to 6 concern further embodiments of the invention and are also allowable.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a European patent on the basis of the documents specified in paragraph VII of the Summary of Facts and Submissions above.

The Registrar: The Chairman:

S. Fabiani G. Szabo

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