AUSTRALIA 649519

PATENTS ACT 1990

PATENT REQUEST : STANDARD PATENT

I/We being the person(s) identified below as the Applicant(s), request the grant of a patent to the person(s) identified below as the Nominated Person(s), for an invention described in the accompanying standard complete specification.

Full application details follow:

[71/70] Applicant(s)/Nominated Person(s):

Sumitomo Electric Industries, Ltd.

of

5-33, Kitahama 4-chome, Chuo-ku, Osaka-shi, Osaka-fu, Japan

[54] Invention Title:

Method for producing glass preform for optical fiber

[72] Name(s) of actual inventor(s):

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Basic Convention Application(s) Details:

[31] Application Number	[33] Country	Code	[32] Date of Application
29869/1991	Japan	JP	25 February 1991

DATED this TWENTY FIFTH day of FEBRUARY 1992

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a member of the firm of
DAVIES COLLISON CAVE for
and on behalf of the
applicant(s)

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NOTICE OF ENTITLEMENT

We, **Sumitomo Electric Industries, Ltd.**, the applicant/Nominated Person named in the accompanying Patent Request state the following:-

The Nominated Person is entitled to the grant of the patent because the Nominated Person derives title to the invention from the inventors by assignment.

The Nominated Person is entitled to claim priority from the basic application listed on the patent request because the Nominated Person made the basic application, and because that application was the first application made in a Convention country in respect of the invention.

DATED this TWENTY FIFTH day of FEBRUARY 1992

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a member of the firm of
DAVIES COLLISON
CAVE for and on behalf
of the applicant(s)

(DCC ref: 1479768)

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(12) PATENT ABRIDGMENT (11) Document No. AU-B-11189/92
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 649519

(54) Title
METHOD FOR PRODUCING GLASS PREFORM FOR OPTICAL FIBER

International Patent Classification(s)
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(56) Prior Art Documents
EP 196671
US 4264347

(57) Claim

1. A method for producing a glass preform for use in the fabrication of an optical fiber, which method comprises the steps of:

inserting a glass rod as a core material in a glass tube as a cladding material having a lower refractive index than that of the core material, and

heating a composite of the glass rod and the glass tube from outside after introducing a mixed gas comprising a halogen-containing gas and oxygen gas to a space between the glass rod and the glass tube to fuse them together to produce the glass preform, wherein the concentration of the oxygen gas is from 20% to 70% by volume.

649519

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COMPLETE SPECIFICATION

NAME OF APPLICANT(S):

Sumitomo Electric Industries, Ltd.

ADDRESS FOR SERVICE:

DAVIES COLLISON CAVE
Patent Attorneys
1 Little Collins Street, Melbourne, 3000.

INVENTION TITLE:

Method for producing glass preform for optical fiber

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a method for producing a glass preform for use in the fabrication of an optical fiber having a low transmission loss.

Description of the Related Art

As one of methods for the production of a glass preform for an optical fiber, a rod-in-tube method is known, which comprises inserting a rod as a core material in a glass tube as a cladding material having a lower refractive index than that of the core material and fusing and integrating them together. Since the glass preform produced by the rod-in-tube method tends to have defects at an interface between the core material and the cladding material, the optical fiber fabricated from the preform has a large transmission loss.

To solve such problem of the rod-in-tube method, Japanese Patent Publication No. 34938/1989 proposes a method comprising inserting a glass rod as a core material in a glass tube as a cladding material, mounting a composite of the rod and the tube on a glass lathe, and heating the composite with an oxyhydrogen burner to shrink the tube, whereby the tube and rod are molten and integrated together.

In this method, the oxyhydrogen burner is moved from one end of the composite to the other and a gas such as a halogen gas is flowed in a space between the rod and the tube. However, in this method, bubbles may remain at the interface between the glass tube and the glass rod of a produced preform, so that an optical fiber fabricated from such preform does not have sufficient mechanical strength and the transmission loss is adversely affected.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an improved rod-in-tube method producing a glass preform for use in the fabrication of an optical fiber.

Another object of the present invention is to provide a rod-in-tube method which can avoid the formation of bubbles at an interface between the glass rod and the glass tube.

According to the present invention, there is provided a method for producing a glass preform for use in the fabrication of an optical fiber, which method comprises the steps of:

inserting a glass rod as a core material in a glass tube as a cladding material having a lower refractive index than that of the core material, and

heating a composite of the glass rod and the glass tube from outside after introducing a mixed gas comprising a halogen-containing gas and oxygen gas to a space between the

glass rod and the glass tube to fuse them together to produce the glass preform, wherein the concentration of the oxygen gas is from 20% to 70% by volume.

Preferably, the glass rod consists of a quartz glass containing a dopant which increases a refractive index of the glass, and the dopant is distributed to a peripheral surface of the glass rod.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross sectional view of one example of an apparatus for carrying out the method of the present invention, and

Fig. 2 is a graph showing relationships of the number of bubbles and the transmission loss with the oxygen concentration in the mixed gas which was filled in the space between the glass rod and the glass tube in the Example.

DETAILED DESCRIPTION OF THE DRAWINGS

The method of the present invention can be carried out under substantially the same conditions as those in the conventional rod-in-tube method except that the mixed gas is introduced to the space between the glass rod and the glass tube during fusing them together by heating.

Usually, the glass rod as the core material consists of a quartz glass containing a dopant which increases the refractive index of the core material, such as Ge or Ti. Such dopant element is present in the form of an oxide such as GeO_2 or TiO_2. When the composite of the glass rod and the glass tube is heated and fused together, the quartz glass should be sufficiently softened. Therefore, the composite is heated at

a temperature of 1900°C or higher. At such high temperature, the metal oxide is reduced. For example, in the case of GeO_2, gaseous GeO and molecular oxygen are formed according to the following reaction:

$$GeO_2 \rightarrow GeO + 1/2O_2$$

Such gasses generated during the integration are trapped at the interface between the core material and the cladding material and form bubbles. A halogen-containing gas accelerates the above reduction reaction. To suppress this reaction, the present invention uses oxygen gas.

The mixed gas to be introduced contains 20 to 70% by volume of oxygen gas. When the oxygen content is less than 20% by volume, bubbles may be formed at the interface. When the oxygen content is larger than 70% by volume, water or moisture on the glass surfaces is not sufficiently removed because of the shortage of the halogen content so that the finally fabricated optical fiber has increased transmission loss due to hydroxyl groups in the fiber.

Examples of the halogen-containing gas are pure halogen such as fluorine and chlorine gasses, compounds containing a halogen atom such as CF_4, SF_6 and the like.

Preferably, the pressure in the space between the glass rod and the glass tube is maintained at reduced pres-

sure, for example, around 300 mmHg during fusing them together. By reducing the pressure, the shrinkage of the glass tube is accelerated.

In one preferred embodiment, at least one, preferably both of the inner wall of the glass tube and the peripheral surface of the glass rod is etched before fusing. The glass surface is etched with fluorohydric acid with an amount of 10 to 200 μm in thickness.

The present invention will be explained further in detail by way of example only, by making reference to the accompanying drawings.

Fig. 1 is a cross sectional view of one example of an apparatus used in the rod-in-tube method of the present invention, in which numerals 1, 2 and 3 stand for a glass rod as a core material, a glass tube as a cladding material and supporting glass tubes. The glass rod and the glass tube are preferably produced by the VAD method. At both ends of the glass tube 2, respective supporting glass tubes are connected by fusing, and the supporting glass tubes are vertically suspended by, for example, chucks 11 and moved up and down by a lifting mechanism 12. The glass tube 2 is placed in an inner chamber of a heating furnace 13. The furnace 13 has a ring heater 14, a heat insulator 15 and a muffle tube 16 which prevents deposition of impurities liberated from the heater and the insulator onto the glass preform.

The glass rod 1 is inserted in the glass tube 2 and a lower end of the glass rod 1 is supported by a supporting rod 17. Both free ends of the supporting tubes 3 are provided with capping tools 18, 18' to maintain a specific atmosphere or specific pressure in the tubes. The lower tool 18 supports the glass rod 1 via the supporting rod 17. The mixed gas is supplied in the space between the glass rod 1 and the glass tube 3 from a gas supplying line by opening an upper valve 19. Then, the upper end of the glass tube 2 in which the glass rod 1 is set is moved to a level of the ring heater 14, whereby, the glass tube 2 is heated and softens from the upper end, and shrinks due to surface tension and the pressure difference between the inside and outside of the glass tube 2, so that the glass tube and the glass rod are fused together. Under such conditions, the composite of the glass tube and the glass rod is lifted up and fused together in the longitudinal direction to complete the fusion bonding of the glass rod and the glass tube, during which the gas in the space between the glass rod 1 and the glass tube 2 is exhausted by a used gas-treating apparatus 20.

Example

A glass rod as a core material containing germanium homogeneously and then having a uniform refractive index profile in the glass rod and a glass tube as a cladding material made of pure quartz glass were used. They

were mounted in the apparatus of Fig. 1. A space between the glass rod and the glass tube was filled with a mixed gas of chlorine gas and oxygen gas in various volume ratios from a gas supplying line having valves 19 and a used gas-treating apparatus 20. Then, the composite of the glass rod and the tube was heated from its upper end and fused together to produce a glass preform.

The results are shown in Fig. 2.

When the oxygen concentration in the mixed gas was 50% by volume or larger, no bubble was formed. At the oxygen concentration of 20% by volume, only two bubbles per meter were formed.

The transmission loss of an optical fiber fabricated from the above produced glass preform had a constant small transmission loss of about 0.345 dB/km at a 1.3 μm wavelength band at the oxygen concentration of 70% by volume or smaller. The transmission loss increased somewhat from above 70% to 80% by volume and, at an oxygen concentration larger than 80% by volume, the transmission loss greatly increased. When the oxygen concentration range is from 20 to 70% by volume the number of bubbles is small and the transmission loss is constantly low.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A method for producing a glass preform for use in the fabrication of an optical fiber, which method comprises the steps of:

inserting a glass rod as a core material in a glass tube as a cladding material having a lower refractive index than that of the core material, and

heating a composite of the glass rod and the glass tube from outside after introducing a mixed gas comprising a halogen-containing gas and oxygen gas to a space between the glass rod and the glass tube to fuse them together to produce the glass preform, wherein the concentration of the oxygen gas is from 20% to 70% by volume.

2. The method according to claim 1, wherein said glass rod consists of a quartz glass containing a dopant which increases a refractive index of the glass, and said dopant is distributed to a peripheral surface of said glass rod.

3. A method for producing a glass preform according to claim 1 and substantially as hereinbefore described with reference to the drawings and/or Example.

DATED this 9th day of March, 1994.

SUMITOMO ELECTRIC INDUSTRIES, LTD.

By its Patent Attorneys

DAVIES COLLISON CAVE

Fig. 1

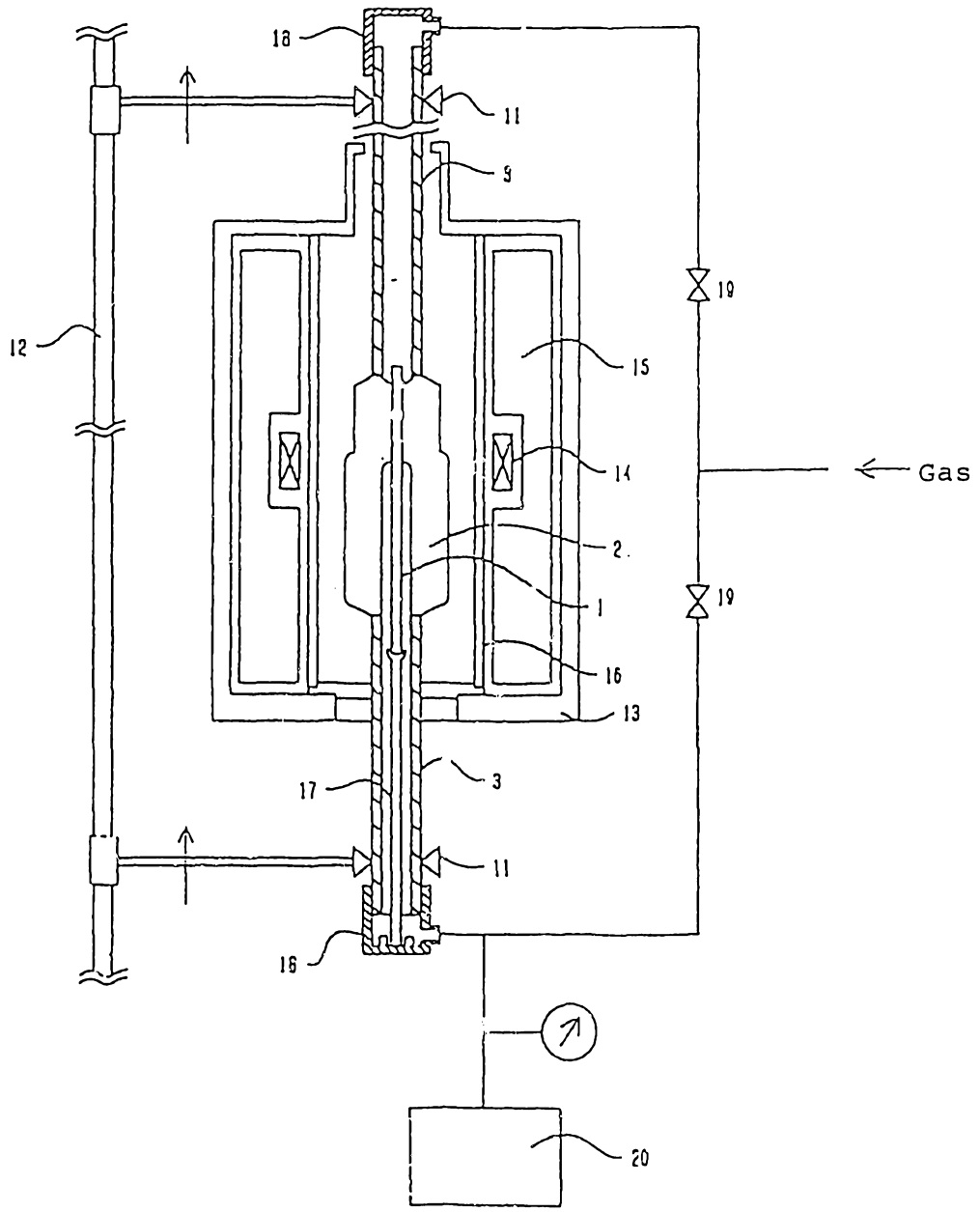
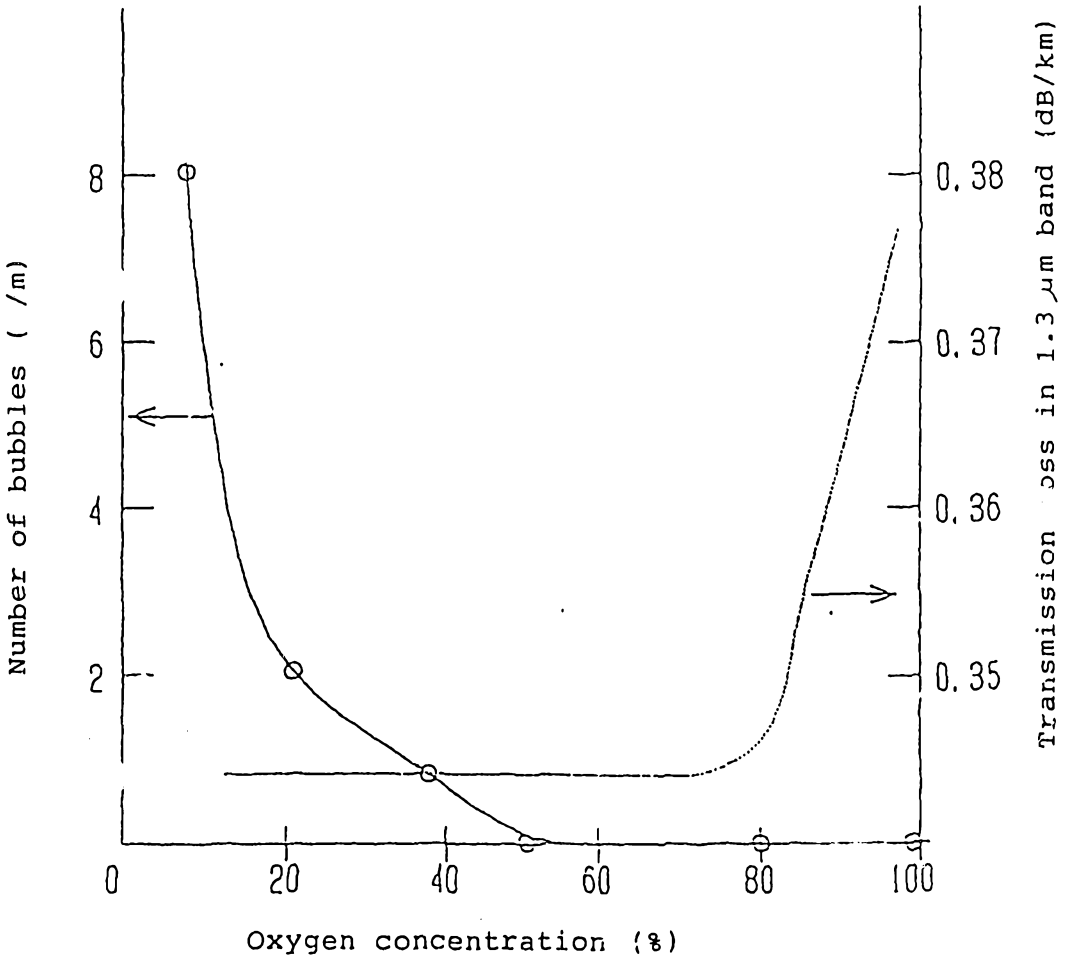


Fig. 2


Number of bubbles (/m)
8
6
4
2
0
20
40
60
80
100
Oxygen concentration (%)
0.38
0.37
0.36
0.35
Transmission loss in 1.3 μm band (dB/km)