

PATENT SPECIFICATION

(11) 1456371

- (21) Application No. 54609/73 (22) Filed 23 Nov. 1973
 (31) Convention Application No. 118345/72 (32) Filed 25 Nov. 1972
 (31) Convention Application No. 118346/72 (32) Filed 25 Nov. 1972 in
 (33) Japan (JA)
 (44) Complete Specification published 24 Nov. 1976
 (51) INT CL² G02B 5/14 C03B 37/00 C03C 13/00
 (52) Index at acceptance

CIM 11A1 11B4 11J3 11K1 11K5 11S 11X2 16B 5A
 5D10 5D12 5D7 D15B1 D15B2 D15C D18
 D22 D8 S10B S10D S19 S9A2 S9A4



(54) OPTICAL TRANSMISSION FIBRE

(71) We, SUMITOMO ELECTRIC INDUSTRIES, LTD, a Japanese Company, of No. 15, Kitahama, 5-Chome, Higashi-ku, Osaka-Shi, Osaka, Japan, do hereby declare the invention for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an optical transmission fibre and to processing of making such a fibre.

Many known optical transmission fibres are made of optical glass and shown considerable light absorption losses, since such transmission fibres are more liable to contain impurities than fibres made of a fused silica. Another known optical transmission fibre is a fused-silica-clad fibre. This clad fibre is produced by depositing a fused silica layer doped with metal oxides on the inner surface of a fused silica tube (the dopants acting to increase the refractive index above that of fused silica), sintering the doped layer in an oxygen atmosphere, and heating, softening and drawing the coated tube to eliminate the tubular cavity. The fibre thus formed is thereafter annealed in an oxygen atmosphere so as completely to oxidize the metal component.

The heat-treatment, however, weakens the strength of the fibre.

The present invention provides an optical transmission fibre comprising a first portion of fused silica doped with B_2O_3 or F, and a second portion, of higher refractive index than said first portion, of fused silica.

The invention also provides a process for producing an optical transmission fibre, in which a layer of fused silica doped with B_2O_3 or F is deposited on the outer surface of a rod or tube of fused silica and the rod or tube is then softened and drawn into a fibre. A further SiO_2 layer may be deposited on the outer surface of said doped fused silica layer, thereby to obviate the defects caused by the lowering of the melting point in the SiO_2 - B_2O_3 system below that of the fused silica, and further lowering the refractive index in the SiO_2 - B_2O_3 portion due to the

tensile stress exerted thereon after the formation of the fibre.

In addition the invention provides a process for producing an optical transmission fibre in which the heating may be effected at rather low temperatures, which result in less evaporation of B_2O_3 than do conventional temperatures; although gas bubbles may be formed at these lower temperatures, they are sufficiently mobile to be eliminated, also according to the invention, under vacuum or by the application of supersonic waves, to increase the content of B_2O_3 in the SiO_2 - B_2O_3 system.

The invention also provides a process for producing an optical transmission fibre, comprising inserting a rod or tube of fused silica, having on its outer surface a layer of fused silica doped with B_2O_3 or F, into a tube of a doped fused silica containing B_2O_3 or F, and then softening and drawing the assembly into a fibre. Preferably, before softening and drawing the assembly, the assembly is inserted into a fused silica or water-repellent glass tube.

The invention also provides a process for producing an optical transmission fibre, comprising depositing first a layer of fused silica doped with B_2O_3 or F, and then a layer of fused silica or water-repellent glass, on a rod or tube of fused silica, and then softening and drawing the rod or tube with the deposited layers thereon into a fibre.

The invention also provides a process for producing an optical transmission fibre, comprising inserting a rod or tube of fused silica, having on its outer surface a layer of fused silica doped with B_2O_3 or F, into a tube of fused silica or water-repellent glass, and then softening and drawing the assembly into a fibre.

The invention also provides a process for producing an optical transmission fibre, comprising softening and drawing into a fibre a tube of fused silica or water-repellent glass having on the inner surface of said tube a layer of fused silica doped with B_2O_3 or F, and on the inner surface of said layer a layer of pure fused silica.

The invention also provides a process for producing an optical transmission fibre, comprising inserting a fused silica rod into a tube of fused silica or water-repellent glass, the tube having on its inner surface a layer of fused silica doped with B_2O_3 or F, and then softening and drawing the assembly into a fibre.

The invention also provides a process for producing an optical transmission fibre, comprising inserting a fused silica rod into a tube of fused silica doped with B_2O_3 or F, inserting the rod/tube assembly into a tube of fused silica or water-repellent glass, and then softening and drawing the rod/tube/tube assembly into a fibre.

The invention also provides a process for producing an optical transmission fibre, comprising depositing successively fused silica doped with B_2O_3 or F, fused silica, and further, fused silica doped with B_2O_3 or F onto the inner surface of a tube of fused silica or water-repellent glass, and softening and drawing said coated tube into a fibre.

The invention also provides a process for producing an optical transmission fibre, comprising inserting a rod of fused silica doped with B_2O_3 or F into a fused silica tube, inserting said fused silica tube into a tube of the fused silica doped with B_2O_3 or F, then inserting said tube of fused silica doped with B_2O_3 or F into a cylinder of fused silica or water-repellent glass, and then softening and drawing the cylinder assembly into a fibre.

Finally, this invention provides a process for producing a fibre which is formed by depositing a SiO_2 layer or a water-repellent glass layer on the outer periphery of the doped fused silica layer containing B_2O_3 or F, so as to inhibit water permeation which may cause destruction of the network structure of the glass.

The invention will now be described by way of example with reference to the accompanying drawings, in which

Figure 1(a) shows cross-sections of a rod (A) and a tube (B) of fused silica before drawing to form fibres according to the invention;

Figure 1(b) shows cross-sectional structures of preferred embodiments of the fibres of this invention resulting from the rod or tube of Fig. 1(a), and also shows how the refractive index varies across each; A_1 represents a clad type fibre, B_1 and B_2 are O-shaped optical wave guides and A_2 is a fibre having a parabolic refractive index distribution;

Figure 2 is a schematic view illustrating an example of a process using an oxy-hydrogen burner for producing a fused silica rod or tube to be drawn into the fibres shown in Figure 1(b);

Figure 3 shows a suitable apparatus for

feeding BBr_3 and $SiCl_4$ to the oxy-hydrogen burner shown in Figure 2; and

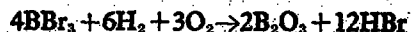
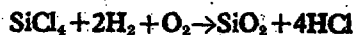
Figure 4 shows cross-sections of other embodiments of this invention comprising a further SiO_2 layer or a water-repellent glass layer deposited on the periphery of the fused silica rod or tube shown in Figure 1.

In Figure 1(b), a clad fibre A_1 or A_2 consists of a highly pure fused silica core 1 surrounded by a layer 2 of fused silica doped with B_2O_3 . In fibres B_1 and B_2 , there is additionally a cavity 3, filled with air in the case of B_1 but with fused silica doped with B_2O_3 in the case of B_2 .

The softening and drawing of a rod A or tube B shown in Fig. 1(a) (the inner cavity of the tube being either left as it is or filled with a $SiO_2-B_2O_3$ glass after cleaning the cavity) results in the fibres A_1 , A_2 , B_1 and B_2 shown in Figure 1(b), B_1 resulting when the cavity 3 in B is left empty and B_2 resulting when the cavity is filled.

Figure 1(b) also shows how the refractive index of the fibres A_1 , A_2 , B_1 and B_2 varies along the fibre diameter. The portion 2 has a lower refractive index than the portion 1, and light therefore travels preferentially in the portion 1 in the fibres A_1 , B_1 and B_2 . In the fibre A_2 , the portion 1 merges smoothly into the portion 2 so that the refractive index decreases parabolically towards the surface of the portion 2 since the surface regions contain more B_2O_3 . This is also applicable to a fibre which contains F instead of B_2O_3 as the dopant in the silica.

Figure 2 illustrates the production of the fused silica rod A or tube B (Fig. 1(a)) which is to be spun-drawn to become a respective fibre shown in Figure 1(b). Generally, it is possible to oxidize hydrides, halides or organic compounds of boron and silicon to form SiO_2 containing B_2O_3 , and the $SiO_2-B_2O_3$ component can be deposited on the outer surface of a rod or tube which has been previously cleaned and smoothed such as by mechanical polishing, laser finishing, sapphire polishing, hydrofluoric acid washing or fibre polishing. A fused silica rod or tube 11 is reciprocable along and rotatable about its axis. BBr_3 and $SiCl_4$ carried in an oxygen stream are fed to an ignited oxy-hydrogen burner 12 and the following reaction occurs at the flame:



The reaction products B_2O_3 and SiO_2 deposit in a powdery or glassy state on the silica rod or tube 11.

Figure 3 shows a suitable apparatus for carrying the BBr_3 and $SiCl_4$ in oxygen to the oxy-hydrogen burner 12 shown in Figure 2. Gaseous oxygen is purified in a purifier 21,

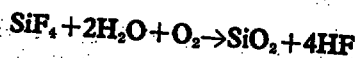
passed through a flow meter 22 and reaches a valve 23, from which the oxygen is bubbled through a liquid 26 of BBr_3 or SiCl_4 in an evaporator 25 provided in a thermostatically controlled bath 27. With the aid of a further three-way valve 24, BBr_3 or SiCl_4 vapour is entrained in the oxygen gas and the gas mixture is fed to the burner 12.

It is possible to use carrier gases other than oxygen, such as noble gases or hydrogen. The heat source need not be an oxy-hydrogen flame; furnaces such as an electrical furnace or high-frequency plasma furnace can be employed.

The tube B shown in Figure 1(a), in which the cavity 3 is filled with $\text{SiO}_2\text{--B}_2\text{O}_3$, can be produced by depositing a SiO_2 layer on a cleaned surface of $\text{SiO}_2\text{--B}_2\text{O}_3$, and depositing a further layer of $\text{SiO}_2\text{--B}_2\text{O}_3$ thereon.

A method of depositing an SiO_2 glass layer containing F will now be described.

A rod or tube 1 of a fused silica, pure in this case, having a cleaned surface is reciprocable along and rotatable about its axis just as previously described with reference to Figure 2. SiF_4 gas is fed around the outer surface of the rod or tube and reacted as follows to form SiO_2 .



A minor amount of F is then incorporated into this SiO_2 . SiF_4 can be synthesized, for example, by the thermal decomposition of well-known highly pure compounds such as BaSiF_6 , K_2SiF_6 , and H_2SiF_6 , by reacting SiO_2 and HSO_3F (useful if the starting SiO_2 is impure), or by reacting SiCl_4 and F_2 .

Halides, hydrides and organic compounds of silicon can be employed and they are oxidized with O_2 which contains F_2 . Alternatively, F_2O can be introduced in the oxidation stage, if desired. It is preferred to effect the oxidation by way of a reaction system in which hydrogen or H_2O is not present, such as a high frequency plasma, since production of HF can then be avoided.

In Figure 4(a) a rod F and a tube G are shown, in which (compared with A and B of Fig. 1(a)) an additional SiO_2 layer or water-repellent glass layer 4 is deposited on the outer surface (1, 2 and 3 having the same meanings as in Fig. 1(a)).

The layer 4 can be deposited in just the same manner as layer 2 by oxidizing SiCl_4 to SiO_2 , or by applying glass frit having a similar coefficient of thermal expansion.

Alternatively, a rod or tube as shown in Figure 1(a) may be inserted in a water-repellent glass or fused silica tube 4; then this tube 4 is heated and drawn at both ends to shrink the tube 4 onto the rod or tube. Further alternatively, the rod F can be made by depositing fused silica doped with B_2O_3

or F on the inner surface of a water-repellent glass or fused silica tube 4, to form a layer 2; then a pure fused silica rod 1 having a surface, which is clean or on to which fused silica doped with B_2O_3 or F has been deposited, is inserted inside the layer 2 and then this assembly is heated and drawn at both ends to collapse the assembly onto the rod 1.

The tube G in Figure 4(a) can be made by depositing fused silica doped with B_2O_3 or F, followed by a pure fused silica, on the inner surface of the water-repellent glass or fused silica tube 4. The tube G, if the cavity 3 is to be filled, can be made by depositing successively fused silica doped with B_2O_3 or F, and pure fused silica, on the inner surface of the water-repellent glass or fused silica tube 4, and then this tube, into which optionally a rod of fused silica doped with B_2O_3 or F has been inserted, is heated and drawn at both ends to shrink the tube.

The rod F and the tube G in Figure 4(a) are drawn into the fibres F_1 and G_1 , respectively in Figure 4(b) when the cavity 3 of the tube G is collapsed. The tube G is however drawn into fibre G_2 or G_3 shown in Figure 4(b) when the cavity 3 is not collapsed. The portions 1 and 2 of the fibre G_1 merge smoothly into each other to give the refractive index properties shown.

Unless otherwise indicated, all parts and percentages in the following Examples are by weight.

EXAMPLE

A process of this invention will be described by way of an experimental example, using the apparatus shown in Figure 3. Ar gas, selected as a carrier gas, was fed at a flow rate of 2 l/min, carrying BBr_3 and SiCl_4 to the burner while the temperature of the evaporator 25 was kept at 30°C . 60 l/min of hydrogen gas and 45 l/min of oxygen gas were fed to the burner shown in Figure 2. The outer surface of a pure fused silica rod of 10 mm in diameter was contacted with the burner flame and processed for 2 hours to form a rod of about 20 mm diameter. The rod was heated in a vacuum at 1300°C for 2 hours and the rod was then spun-drawn while heating the rod in a high frequency furnace to obtain a fibre having a core diameter of 75 microns and a deposition layer diameter of 150 microns. On passing laser light through this fibre, it was found that the light was completely trapped with low scattering losses, and the entire transmission losses were also low.

The optical transmission fibre of this invention may provide, as described above, a clad type fibre or an O-shaped optical wave guide having a highly pure fused silica portion in which the optical energy concentrates and a surrounding doped fused silica layer contain-

ing B_2O_3 or F, of a lower refractive index and thus it possesses high optical transmission characteristics and extremely low optical transmission losses.

Since completely oxidized SiO_2 or B_2O_3 may be deposited on the clean surface of a highly pure fused silica body in the doping with B_2O_3 , and likewise with F, the interface is neither contaminated nor are gas bubbles formed (bubbles, if entrapped, can be eliminated by heating in vacuum or by application of supersonic waves under heating), thereby decreasing the scattering losses in the interface between the two fused silica media each having a different refractive index.

In addition, the refractive index can easily be controlled by varying the amount of B_2O_3 contained in the fused silica. Moreover, the raw materials used in the process, such as halides, hydrides or organic compounds of B and Si, as well as O_2 gas, can be obtained in a highly pure state due to their physical and chemical characteristics thus reducing the impurity content in the fused silica which contains the B_2O_3 . This decreases the absorption losses and enables the preparation of a fibre with a parabolic refractive index distribution in which the transmission losses are extremely low.

Since the inclusion of F does not substantially affect the light absorption, this process can provide a fibre having a transmission loss as low as that of the fused silica fibre, can provide an easy way to control the index of refraction and can provide a transmission fibre having less overall transmission losses.

In one preferred embodiment, the transmission fibre according to this invention has a further SiO_2 layer deposited on the outer surface thereof. In the SiO_2 layer containing B_2O_3 , its melting temperature is lowered as the content of the B_2O_3 is increased for reducing the refractive index, which decreases the viscosity of that portion resulting in a deformation in the shape thereof in the heat softening step of drawing it. In order to avoid this deformation and draw a fibre satisfactorily, an additional SiO_2 layer is preferably deposited on this portion. A further effect is that the refractive index of the SiO_2 layer is lowered due to the tensile stress exerted thereon, after the drawing, because the coefficient of expansion of the SiO_2 - B_2O_3 system is higher than that of fused silica.

In the SiO_2 layer having F incorporated therein, the water-repellent glass layer is stable with respect to atmospheric conditions (primarily for humidity) at room temperature and inhibits water intrusion to the portion 2, which protects the portion of the fused silica doped with F from chemical attack by HF.

Further, the present process provides a

means to control the F content in the SiO_2 and to control uniformly the dispersion of the F therein. It can also prevent the incorporation of hydrogen in the production stage and beneficial effects on the softening drawing process and thus the protection of the fibre from destruction can be obtained.

The optical transmission fibre according to this invention provides great advantages for communication cables used in optical transmission, connecting feeders between equipment and light guides.

The fused silica employed in the present invention may be pure. Alternatively the fused silica employed in the present invention may contain one or more impurities. A silica which contains one or more impurities should have properties similar to those of pure silica i.e. its physical properties should be similar, it should not affect transmission loss to a greater extent than pure silica and its refractive index should not be less than that of pure fused silica.

WHAT WE CLAIM IS:—

1. An optical transmission fibre comprising a first portion of fused silica doped with B_2O_3 or F, and a second portion, of higher refractive index than said first portion, of fused silica.

2. A fibre as claimed in Claim 1, wherein the second portion comprises pure fused silica.

3. A fibre as claimed in Claim 2, wherein the second portion is surrounded by the first portion.

4. A fibre as claimed in Claim 3, further comprising an outer layer of fused silica or water-repellent glass on said first portion.

5. A fibre as claimed in claim 3 or 4, being a hollow tubular fibre in which said first and second portions comprise coaxial layers.

6. A fibre as claimed in Claim 3 or 4, being a solid fibre comprising a core of said doped fused silica, said first and second portions comprising coaxial layers surrounding said core.

7. An optical transmission fibre substantially as hereinbefore described with reference to and as shown in Figure 1(b) or 4(b).

8. A process for producing an optical transmission fibre, comprising depositing a layer of fused silica doped with B_2O_3 or F on the outer surface of a rod or tube of fused silica, and softening and drawing the rod or tube with the deposited layer thereon into a fibre.

9. A process for producing an optical transmission fibre, comprising inserting a rod or tube of fused silica, having on its outer surface a layer of fused silica doped with B_2O_3 or F, into a tube of a doped fused silica containing B_2O_3 or F, and then softening and drawing the assembly into a fibre.

10. A process as claimed in Claim 9,



ing B_2O_3 or F, of a lower refractive index and thus it possesses high optical transmission characteristics and extremely low optical transmission losses.

5 Since completely oxidized SiO_2 or B_2O_3 may be deposited on the clean surface of a highly pure fused silica body in the doping with B_2O_3 , and likewise with F, the inter-
10 face is neither contaminated nor are gas bubbles formed (bubbles, if entrapped, can be eliminated by heating in vacuum or by application of supersonic waves under heating), thereby decreasing the scattering losses in the interface between the two fused silica media each having a different refractive index.

15 In addition, the refractive index can easily be controlled by varying the amount of B_2O_3 contained in the fused silica. Moreover, the raw materials used in the process, such as halides, hydrides or organic compounds of B and Si, as well as O_2 gas, can be obtained in a highly pure state due to their physical and chemical characteristics thus reducing the impurity content in the fused silica which
20 contains the B_2O_3 . This decreases the absorption losses and enables the preparation of a fibre with a parabolic refractive index distribution in which the transmission losses are extremely low.

30 Since the inclusion of F does not substantially affect the light absorption, this process can provide a fibre having a transmission loss as low as that of the fused silica fibre, can provide an easy way to control the index of refraction and can provide a transmission
35 fibre having less overall transmission losses.

In one preferred embodiment, the transmission fibre according to this invention has a further SiO_2 layer deposited on the outer
40 surface thereof. In the SiO_2 layer containing B_2O_3 , its melting temperature is lowered as the content of the B_2O_3 is increased for reducing the refractive index, which decreases the viscosity of that portion resulting in a deformation in the shape thereof in the heat
45 softening step of drawing it. In order to avoid this deformation and draw a fibre satisfactorily, an additional SiO_2 layer is preferably deposited on this portion. A further effect is that the refractive index of the SiO_2 layer is lowered due to the tensile stress exerted thereon, after the drawing, because the coefficient of expansion of the SiO_2 — B_2O_3 system is higher than that of fused
50 silica.

55 In the SiO_2 layer having F incorporated therein, the water-repellent glass layer is stable with respect to atmospheric conditions (primarily for humidity) at room temperature and inhibits water intrusion to the portion 2, which protects the portion of the fused silica doped with F from chemical attack by HF.

60 Further, the present process provides a

means to control the F content in the SiO_2 and to control uniformly the dispersion of the F therein. It can also prevent the incorporation of hydrogen in the production stage and beneficial effects on the softening drawing process and thus the protection of the fibre from destruction can be obtained.

The optical transmission fibre according to this invention provides great advantages for communication cables used in optical transmission, connecting feeders between equipment and light guides.

The fused silica employed in the present invention may be pure. Alternatively the fused silica employed in the present invention may contain one or more impurities. A silica which contains one or more impurities should have properties similar to those of pure silica i.e. its physical properties should be similar, it should not affect transmission loss to a greater extent than pure silica and its refractive index should not be less than that of pure fused silica.

WHAT WE CLAIM IS:—

1. An optical transmission fibre comprising a first portion of fused silica doped with B_2O_3 or F, and a second portion, of higher refractive index than said first portion, of fused silica.

2. A fibre as claimed in Claim 1, wherein the second portion comprises pure fused silica.

3. A fibre as claimed in Claim 2, wherein the second portion is surrounded by the first portion.

4. A fibre as claimed in Claim 3, further comprising an outer layer of fused silica or water-repellent glass on said first portion.

5. A fibre as claimed in claim 3 or 4, being a hollow tubular fibre in which said first and second portions comprise coaxial layers.

6. A fibre as claimed in Claim 3 or 4, being a solid fibre comprising a core of said doped fused silica, said first and second portions comprising coaxial layers surrounding said core.

7. An optical transmission fibre substantially as hereinbefore described with reference to and as shown in Figure 1(b) or 4(b).

8. A process for producing an optical transmission fibre, comprising depositing a layer of fused silica doped with B_2O_3 or F on the outer surface of a rod or tube of fused silica, and softening and drawing the rod or tube with the deposited layer thereon into a fibre.

9. A process for producing an optical transmission fibre, comprising inserting a rod or tube of fused silica, having on its outer surface a layer of fused silica doped with B_2O_3 or F, into a tube of a doped fused silica containing B_2O_3 or F, and then softening and drawing the assembly into a fibre.

10. A process as claimed in Claim 9,

wherein, before softening and drawing the assembly, the assembly is inserted into a fused silica or water-repellent glass tube.

11. A process for producing an optical transmission fibre, comprising depositing first a layer of fused silica doped with B_2O_3 or F, and then a layer of fused silica or water-repellent glass, on a rod or tube of fused silica, and then softening and drawing the rod or tube with the deposited layers thereon into a fibre.

12. A process for producing an optical transmission fibre, comprising inserting a rod or tube of fused silica, having on its outer surface a layer of fused silica doped with B_2O_3 or F, into a tube of fused silica or water-repellent glass, and then softening and drawing the assembly into a fibre.

13. A process for producing an optical transmission fibre, comprising softening and drawing into a fibre a tube of fused silica or water-repellent glass having on the inner surface of said tube a layer of fused silica doped with B_2O_3 or F, and on the inner surface of said layer a layer of pure fused silica.

14. A process for producing an optical transmission fibre, comprising inserting a fused silica rod into a tube of fused silica or water-repellent glass, the tube having on its inner surface a layer of fused silica doped with B_2O_3 or F, and then softening and drawing the assembly into a fibre.

15. A process as claimed in Claim 14, wherein said fused silica rod bears a layer of fused silica doped with B_2O_3 or F.

16. A process for producing an optical transmission fibre, comprising inserting a fused silica rod into a tube of fused silica doped with B_2O_3 or F, inserting the rod/tube assembly into a tube of fused silica or water-repellent glass, and then softening and drawing the rod/tube/tube assembly into a fibre.

17. A process for producing an optical transmission fibre, comprising depositing successively fused silica doped with B_2O_3 or F, fused silica, and further, fused silica doped with B_2O_3 or F onto the inner surface of a tube of fused silica or water-repellent glass, and softening and drawing said coated tube into a fibre.

18. A process for producing an optical transmission fibre, comprising inserting a rod of fused silica doped with B_2O_3 or F into a tube of fused silica or water-repellent glass, the tube having on its inner surface first a layer of fused silica doped with B_2O_3 or F and next a fused silica layer, and softening and drawing the assembly into a fibre.

19. A process for producing an optical transmission fibre, comprising inserting a rod of fused silica doped with B_2O_3 or F into

a fused silica tube, inserting said fused silica tube into a tube of the fused silica doped with B_2O_3 or F, then inserting said tube of fused silica doped with B_2O_3 or F into a cylinder of fused silica or water-repellent glass, and then softening and drawing the cylinder assembly into a fibre.

20. A process as claimed in Claims 8 to 14, 17 and 18, wherein said layer of fused silica is pure and said layer of doped fused silica is doped with B_2O_3 , the layers each being deposited by entraining highly pure halides, hydrides or organic compounds of Si and B in a carrier gas, and oxidizing said halides, hydrides or organic compounds to form a fused silica layer or a doped fused silica layer, the B compound(s) being omitted when a pure fused silica layer is being formed.

21. A process as claimed in Claims 8 to 14, 17 and 18, wherein the doped fused silica layer, the dopant being F, is deposited by combustion of a halide, hydride or organic compound of Si with OF_2 or oxygen containing F_2 , or by the oxidation of SiF_4 .

22. A process as claimed in Claim 8, 20 or 21, further comprising, after the depositions of the doped and of the pure silica layers, heating and melting the deposited layers in a vacuum to eliminate gas bubbles.

23. A process as claimed in Claim 18, 20 or 21, further comprising, after the depositions of the doped and of the pure silica layers, heating and melting the deposited layers while applying supersonic waves to said layers to eliminate gas bubbles therefrom.

24. A process of producing an optical transmission fibre, substantially as hereinbefore described.

25. A process of producing an optical transmission fibre as claimed in any of Claims 1—7, substantially as hereinbefore described with reference to Fig. 1(a) and (b), or to Figs. 4(a) and (b) of the accompanying drawings.

26. A process as claimed in Claim 18, 24 or 25, substantially as hereinbefore described with reference to Figs. 2 and 3 of the accompanying drawings.

27. An optical transmission fibre when produced by a process as claimed in any of Claims 8 to 26.

GEE & CO.,
Chartered Patent Agents,
Chancery House,
Chancery Lane,
London WC2A 1QU.
and
39 Emsom Road,
Guildford, Surrey.
Agents for the Applicants.

