(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
06 August 2020 (06.08.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/157767 A1

(51) International Patent Classification:
G02B 6/02 (2006.01)

(21) International Application Number:
PCT/IN2020/050029

(22) International Filing Date:
10 January 2020 (10.01.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201911003617 29 January 2019 (29.01.2019) IN

(71) Applicant: **STERLITE TECHNOLOGIES LIMITED** [IN/IN]; Sterlite Technologies Limited IFFCO Tower, 3rd Floor, Plot No. 3, Sector 29, Gurgaon, Haryana, Gurgaon 122002 (IN).

(72) Inventors: **PRASAD, Nivedita**; Sterlite Technologies Limited IFFCO Tower, 3rd Floor, Plot No. 3, Sector 29, Haryana, Gurgaon 122002 (IN). **GOMATAM, Badri**; Sterlite Technologies Limited IFFCO Tower, 3rd Floor, Plot No. 3, Sector 29, Haryana, Gurgaon 122002 (IN). **SAHA, Chandan**; Sterlite Technologies Limited IFFCO Tower, 3rd Floor, Plot No. 3, Sector 29, Haryana, Gurgaon 122002 (IN).

(74) Agent: **KISHORE NARASANI, Arun**; M/s. ipMetrix Consulting Group, No. 84, 1st Floor, 4th Cross, Panduranga Nagar, Bannerghatta Road, Bangalore 560076 (IN).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *as to the identity of the inventor (Rule 4.17(i))*

Published:
— *with international search report (Art. 21(3))*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*
— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

(54) Title: ULTRA-LOW LOSS OPTICAL FIBER

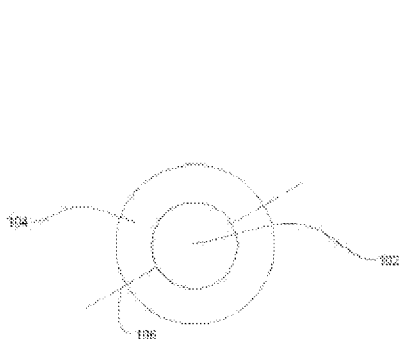

FIG. 1

(57) Abstract: The present disclosure provides an optical fibre. The optical fibre includes a core region (102) and a cladding region (104). The core region (102) is defined along a central longitudinal axis (106) of the optical fibre (100). In addition, the core region (102) of the optical fibre (100) has a first radius r1 and a first refractive index n1. Further, the cladding (104) concentrically surrounds the core region (102) of the optical fibre (100). Furthermore, the cladding region (104) of the optical fibre (100) has a second radius r_2 and a second refractive index n_2. Moreover, the optical fibre (100) has a step index profile.

WO 2020/157767 A1

ULTRA-LOW LOSS OPTICAL FIBRE

TECHNICAL FIELD

[0001] The present disclosure relates to the field of optical fibre, in particular, the present disclosure relates to an ultra-low loss optical fibre. The present application is based on, and claims priority from an Indian Application Number **201911003617** filed on **29th January 2019**, the disclosure of which is hereby incorporated by reference herein.

BACKGROUND

[0002] Optical fibre communication has revolutionized the telecommunication industry in the past few years. The use of optical fibre cables has supported to bridge the gap between the distant places around the world. One of the basic components of the optical fibre cable is an optical fibre. The optical fibre is responsible for carrying vast amount of information from one place to another. There are different methods for manufacturing glass bodies and optical fibres. These methods are primarily adopted to manufacture glass preform or glass preform. Few such methods employed for manufacturing optical fibres are powder-in-tube technique, rod-in-cylinder technique, vapor deposition techniques and the like. However, the currently available optical fibres have high attenuation losses.

[0003] In the light of the above stated discussion, there is a need for an optical fibre with extremely low attenuation loss.

OBJECT OF THE DISCLOSURE

[0004] A primary object of the present disclosure is to provide an optical fibre with an ultra-low losses.

[0005] Another object of the present disclosure is to provide the optical fibre with low attenuation.

[0006] Yet another object of the present disclosure is to provide the optical fibre having transmitting ability in infrared region.

SUMMARY

[0007] In an aspect, the present disclosure provides an optical fibre. The optical fibre includes a core region and a cladding region. The core region is defined along a central longitudinal axis of the optical fibre. In addition, the core region of the optical fibre has a first radius r_1 and a first refractive index n_1. Further, the cladding concentrically surrounds the core region of the optical fibre. Furthermore, the cladding region of the optical fibre has a second radius r_2 and a second refractive index n_2. Also, the optical fibre is an ultra-low loss optical fibre. Also, the optical fibre has a step index profile. Also, the step index profile corresponds to sudden change in a value of refractive index.

[0008] In an embodiment of the present disclosure, the core region of the optical fibre is made of calcium aluminum silicate.

[0009] In an embodiment of the present disclosure, the cladding region of the optical fibre is made of fluorine doped silica.

[0010] In an embodiment of the present disclosure, wherein the core region of the optical fibre has the first radius r_1 of about 38.35 microns.

[0011] In an embodiment of the present disclosure, the cladding region (104) of the optical fibre (100) has the second radius r_2 of about 62.5 microns.

[0012] In an embodiment of the present disclosure, the outer diameter of the optical

5 microns. (Not shown in figure)

[0013] In an embodiment of the present disclosure, the core region (102) of the optical fibre (100) has the first refractive index n_1 of about 1.625.

[0014] In an embodiment of the present disclosure, the core region (102) of the optical fibre (100) has the second refractive index n_2 of about 1.44.

[0015] In an embodiment of the present disclosure, the optical fibre (100) has low attenuation. In addition, the optical fibre (100) has attenuation up to 0.1 decibel/kilometer.

STATEMENT OF THE DISCLOSURE

[0016] The present disclosure provides an optical fibre. The optical fibre includes a core region and a cladding region. The core region is defined along a central longitudinal axis of the optical fibre. In addition, the core region of the optical fibre has a first radius r_1 and a first refractive index n_1. Further, the cladding concentrically surrounds the core region of the optical fibre. Furthermore, the cladding region of the optical fibre has a second radius r_2 and a second refractive index n_2. Also, the optical fibre has a step index profile. Also, the step index profile corresponds to sudden change in a value of refractive index.

BRIEF DESCRIPTION OF FIGURES

[0017] Having thus described the disclosure in general terms, reference will now be made to the accompanying figures, wherein:

[0018] FIG. 1 illustrates a cross-sectional view of an optical fibre, in accordance with various embodiments of the present disclosure; and

[0019] FIG. 2 illustrates a refractive index profile of the optical fibre, in accordance with various embodiments of the present disclosure;

[0020] It should be noted that the accompanying figures are intended to present illustrations of few exemplary embodiments of the present disclosure. These figures

are not intended to limit the scope of the present disclosure. It should also be noted that accompanying figures are not necessarily drawn to scale.

DETAILED DESCRIPTION

[0021] Reference will now be made in detail to selected embodiments of the present disclosure in conjunction with accompanying figures. The embodiments described herein are not intended to limit the scope of the disclosure, and the present disclosure should not be construed as limited to the embodiments described. This disclosure may be embodied in different forms without departing from the scope and spirit of the disclosure. It should be understood that the accompanying figures are intended and provided to illustrate embodiments of the disclosure described below and are not necessarily drawn to scale. In the drawings, like numbers refer to like elements throughout, and thicknesses and dimensions of some components may be exaggerated for providing better clarity and ease of understanding.

[0022] It should be noted that the terms "first", "second", and the like, herein do not denote any order, ranking, quantity, or importance, but rather are used to distinguish one element from another. Further, the terms "a" and "an" herein do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

[0023] FIG. 1 illustrates a cross-sectional view of an optical fibre **100**, in accordance with various embodiments of the present disclosure. In general, optical fibre is used for transmitting information in the form of light pulses from one end to another. In addition, optical fibre is a thin strand of glass or plastic capable of transmitting optical signals. Further, optical fibre is configured to transmit large amount of information over long distances. The optical fibre **100** is optical fibre with ultra-low losses. In an embodiment of the present disclosure, the optical fibre **100** is an ultra-low loss optical fibre. Further, the optical fibre **100** includes a core region **102** and a cladding region **104**.

[0024] The core region **102** is an inner part of the optical fibre **100**. The core region **102** is defined along a central longitudinal axis **106**. The central longitudinal axis **106** is an imaginary axis. In addition, the core region **102** of the optical fibre **100** has a first radius r_1 and a first refractive index n_1. Further, the core region **102** and the cladding

region **104** are made during the manufacturing stage of an optical fibre preform. In general, core has higher refractive index than that of cladding. In addition, refractive index is maintained as per desired level based on concentration of chemicals used for the production of optical fibre preform. In an embodiment of the present disclosure, the core region **102** has greater refractive index than that of the cladding region **104** of the optical fibre **100**.

[0025] In addition, the optical fibre **100** includes cladding region **104**. The cladding region **104** of the optical fibre **100** lies between the first radius r_1 and a second radius r_2. In addition, the cladding region **104** concentrically surrounds the core region **102** of the optical fibre **100**. Further, the cladding region **104** of the optical fibre **100** has the second radius r_2 and a second refractive index n_2.

[0026] In an embodiment of the present disclosure, the optical fibre **100** is a multimode fibre. The optical fibre **100** is manufactured from the optical fibre preform. The optical fibre preform may be manufactured by any conventional optical fibre preform manufacturing methods. Examples of such methods include powder-in-tube technique, rod-in-cylinder technique and the like. The optical fibre preform is made of glass. In general, glass is a non-crystalline amorphous solid, often transparent and has widespread applications. The applications of glass range from practical usage in daily life, technological usage, and decorative usage. In general, most common type of glass is silicate glass made of chemical compound silica.

[0027] The optical fibre preform is a large cylindrical body of glass having a core structure and a cladding structure. In addition, the optical fibre preform is a material used for fabrication of an optical fibres. Further, the optical fibres are used for variety of purposes. The variety of purposes includes telecommunications, broadband communications, medical applications, military applications and the like. The optical fibre preform is the optical fibre in a large form.

[0028] The core structure of the optical fibre preform is manufactured using a calcium aluminium silicate material. The calcium aluminium silicate material is a white free-

flowing powder suited for making the core **102** of the optical fibre **100**. In addition, the calcium aluminium silicate material is a multicomponent glass material having superior optical properties. The cladding structure of the optical fibre preform is a fluorine doped silica (hereinafter "F-doped silica") tube. The F-doped silica tube is a cylindrical shaped tube. In an embodiment of the present disclosure, the F-doped silica tube may have any other suitable shape.

[0029] In an embodiment of the present disclosure, the optical fibre preform may be manufactured using the powder-in-tube technology. The calcium aluminium silicate powder is added into hollow space inside the F-doped tube. The powder-in-tube technology involves use of a glass cladding tube and a powdery substance. The powdery substance is used for forming the core **102** of the optical fibre **100** and is inserted inside the glass cladding tube. In addition, the glass tube is sintered at a high temperature to form a glass preform. The powder-in-tube technique is employed for manufacturing the optical fibre preform. In an embodiment of the present disclosure, the optical fibre preform may be manufactured using the rod-in-tube method or RIC method. In general, the RIC method refers to a manufacturing process of a large-sized fibre preform by inserting a core rod assembly into a large cylindrical tube. The cylindrical tube is heated and collapsed onto the core rod assembly.

[0030] In an embodiment of the present disclosure, the calcium aluminum silicate material is utilized in a powdery form. In an embodiment of the present disclosure, the calcium aluminum silicate powder of a suitable size may be used. The size range may be selected such that the optical fibre preform can be manufactured. In an embodiment of the present disclosure, the optical fibre preform has a diameter of about 44 millimetres. In another embodiment of the present disclosure, the optical fibre preform may have any suitable diameter as per the requirement. In an embodiment of the present disclosure, the core structure of the optical fibre preform has a diameter of about 27 millimetres. In another embodiment of the present disclosure, the core structure of the optical fibre preform may have any suitable diameter as per the requirement.

[0031] **Fig. 2** illustrates a refractive index profile **200** of the optical fibre **100**, in accordance with various embodiments of the present disclosure. The refractive index profile **200** defines the properties of the core region **102** of the optical fibre **100**. The refractive index profile **200** illustrates a relationship between refractive index of the core region **102** and the cladding region **104** with the first radius r_1 and the second radius r_2. In addition, the refractive index profile **200** illustrates change in refractive index of the optical fibre with an increase in radius. The performance of the optical fibre **100** is monitored by controlling a plurality of parameters associated with the refractive index profile **200**. Further, the refractive index profile **200** is determined based on a concentration of dopants and materials used during manufacturing. Furthermore, dispersion and bending losses are controlled by varying the design parameters of the refractive index profile **200**.

[0032] In addition, the refractive index profile **200** is shown on ordinate axis or y-axis and radius are shown on abscissa or x-axis. The refractive index profile **200** is a step index profile (as shown in **FIG. 2**). The step index profile corresponds to a profile that has abrupt change in value of the refractive index. In addition, the first refractive index n_1 is of the core region **102** and the second refractive index n_2 is of the cladding region **104** of the optical fibre. In an embodiment of the present disclosure, n_1 corresponds to refractive of the calcium aluminum silicate material and n_2 corresponds to refractive index of the F-doped Silica.

[0033] In an embodiment of the present disclosure, the first refractive index n_1 of the core region **102** of the optical fibre **100** is about 1.625. In another embodiment of the present disclosure, value of the first refractive index of the core region **102** of the optical fibre **100** may vary. In an embodiment of the present disclosure, the second refractive index n_2 of the cladding region **104** of the optical fibre **100** is about 1.44. In another embodiment of the present disclosure, value of the second refractive index n_2 of the cladding region **104** may vary. In an embodiment of the present disclosure, the first radius r_1 of the core region **102** the optical fibre **100** is about 38.35 microns. In another embodiment of the present disclosure, value of the first radius r_1 of the core region **102** of the optical fibre **100** may vary. In an embodiment of the present

disclosure, the second radius r_2 of the cladding region **104** of the optical fibre **100** is about 62.5 microns. In another embodiment of the present disclosure, value of the second radius r_2 of the cladding region **104** of the optical fibre **100** may vary. The optical fibre **100** has low attenuation. In an embodiment of the present disclosure, the optical fibre **100** has attenuation up to 0.1 decibel/kilometer. In an embodiment of the present disclosure, the core region **102** of the optical fibre **100** is made of calcium aluminum silicate. In another embodiment of the present disclosure, the core region **102** of the optical fibre **100** may be made of any suitable material. In an embodiment of the present disclosure, the cladding region **104** of the optical fibre **100** is made of fluorine doped silica. In another embodiment of the present disclosure, the cladding region **104** of the optical fibre **100** may be made of any suitable material.

[0034] The present disclosure provides numerous advantages over the prior art. The present disclosure provides the optical fibre. In addition, the optical fibre has low attenuation. Further, the optical fibre has transmitting ability in infrared region.

[0035] The foregoing descriptions of pre-defined embodiments of the present technology have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the present technology to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the present technology and its practical application, to thereby enable others skilled in the art to best utilize the present technology and various embodiments with various modifications as are suited to the particular use contemplated. It is understood that various omissions and substitutions of equivalents are contemplated as circumstance may suggest or render expedient, but such are intended to cover the application or implementation without departing from the spirit or scope of the claims of the present technology.

STATEMENT OF CLAIMS

We claim:

1. An optical fibre (100) comprising:

a core region (102), wherein the core region (102) is defined along a central longitudinal axis (106) of the optical fibre (100), wherein the core region (102) of the optical fibre (100) has a first radius r_1 and a first refractive index n_1; and

a cladding region (104), wherein the cladding (104) concentrically surrounds the core region (102) of the optical fibre (100), wherein the cladding region (104) of the optical fibre (100) has a second radius r_2 and a second refractive index n_2,

wherein the optical fibre (100) is an ultra-low loss optical fibre, wherein the optical fibre (100) has a step index profile, wherein the step index profile corresponds to abrupt change in a value of refractive index.

2. The optical fibre (100) as claimed in claim 1, wherein the core region (102) of the optical fibre (100) is made of calcium aluminum silicate.

3. The optical fibre (100) as claimed in claim 1, wherein the cladding region (104) of the optical fibre (100) is made of fluorine doped silica.

4. The optical fibre (100) as claimed in claim 1, wherein the core region (102) has the first radius r_1 of about 38.35 microns.

5. The optical fibre (100) as claimed in claim 1, wherein the cladding region (104) of the optical fibre (100) has the second radius r_2 of about 62.5 microns.

6. The optical fibre (100) as claimed in claim 1, wherein the core region (102) of the optical fibre (100) has the first refractive index n_1 of about 1.625. (1.5 -1.7)

7. The optical fibre (100) as claimed in claim 1, wherein the cladding region (104) of the optical fibre (100) has the second refractive index n_2 of about 1.44. (1.42-1.44)

8. The optical fibre (100) as claimed in claim 1, wherein the optical fibre (100) has low attenuation, wherein the optical fibre (100) has attenuation up to 0.1 decibel/kilometer.

100

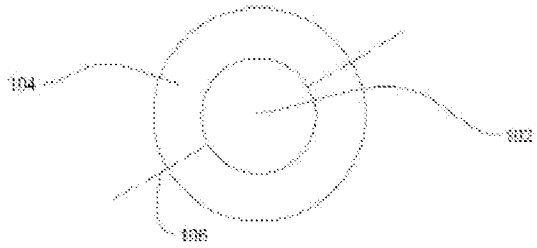

FIG. 1

200

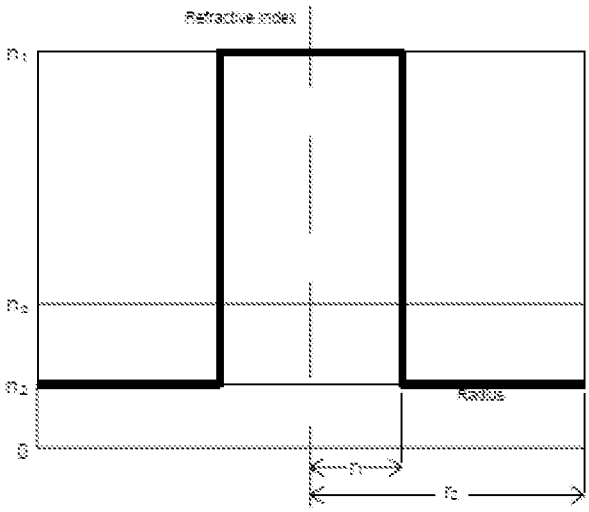

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2020/050029

A. CLASSIFICATION OF SUBJECT MATTER
G02B6/02 Version=2020.01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DATABASES: TotalPatent One, IPO Internal Database
KEYWORDS: Optical-fibre, core, cladding, calcium, silica, step-index

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 9618692 B2 (CORNING INCORPORATED) 11 APRIL 2017 (11/04/2017) ABSTRACT; CLAIMS 1, 2, 7, 9, 15, 19; FIGS. 1, 5, 6; COL.1,LINE 45-LINE 60,COL.2 LINE 5-LINE 20, COL.6 LINE 15-LINE 65	1,3-8
A	WHOLE DOCUMENT	2
X	US 9823413 B2 (OFS FITEL, LLC) 21 NOVEMBER (21/11/2017) ABSTRACT; FIGS.4, 19, 20; COL.2,LINE 10-LINE 25, COL.9 LINE 40- LINE 60,COL.15 LINE 05- LINE 50	1,3-8
A	WHOLE DOCUMENT	2

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15-07-2020	15-07-2020
Name and mailing address of the ISA/ Indian Patent Office Plot No.32, Sector 14,Dwarka,New Delhi-110075 Facsimile No.	Authorized officer Sadigama Mahesh Telephone No. +91-1125300200

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IN2020/050029

Citation	Pub.Date	Family	Pub.Date
US 9618692 B2	11-04-2017	CN 107076921 B	03-09-2019
		EP 3166899 A1	17-05-2017
		JP 6632600 B2	22-01-2020
		WO 2016007806 A1	14-01-2016
		RU 2706849 C2	21-11-2019
		KR 20170032376 A	22-03-2017
US 9823413 B2	21-11-2017	CN 103827708 B	20-06-2017
		EP 2678729 A4	06-08-2014
		JP 2014509410 A	17-04-2014
		WO 2012161810 A1	29-11-2012