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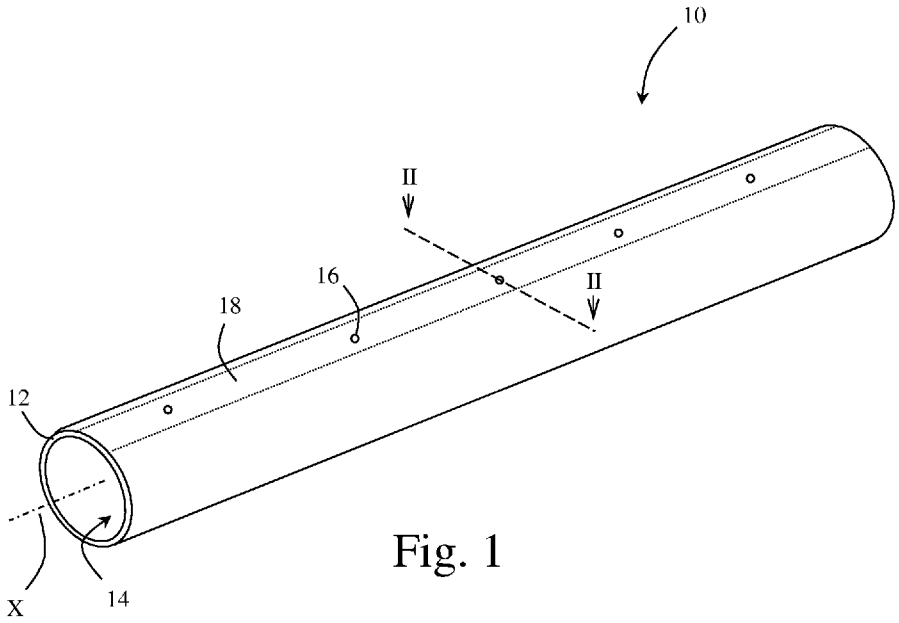

Fig. 1

(57) **Abstract:** A thin walled irrigating pipe has a tensile layer formed as a continuous strip upon an outer side of the pipe for increasing tensile strength of the pipe. The tensile layer includes a higher tensile strength than material of the remainder of the pipe outside of the tensile layer.

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IRRIGATION PIPE

TECHNICAL FIELD

[001] Embodiments of the invention relate to an irrigation pipe, possibly a drip irrigation pipe.

BACKGROUND

[002] Irrigation systems deliver liquid comprising water, often containing plant nutrients, pesticides and/or medications, to plants via networks of irrigation pipes.

[003] Relative thin walled irrigation pipes, sometimes called tapes, may be used for irrigation, for example when the irrigation pipes are used for short durations of time, such as a single season and then possibly disposed.

[004] During installment or use, the irrigation pipes may be exposed to wear and tear that may cause damage to the pipes in particular in cases where the irrigation pipe has a relative thin wall.

[005] Irrigation pipes may deliver liquid to plants via emitters or drippers that are installed on or integrated inside the irrigation pipes. Such emitters may be heat bonded to the pipe to form a so-called drip irrigation pipe or dripper pipe. In some cases such dripper pipes may be susceptible to damage at the areas of bonding and/or areas of connection to the drip emitter.

SUMMARY

[006] The following embodiments and aspects thereof are described and illustrated in conjunction with systems, tools and methods which are meant to be exemplary and illustrative, not limiting in scope.

[007] In an embodiment there is provided a thin walled irrigating pipe having a tensile layer formed as a continuous strip upon an outer side of the pipe for increasing tensile strength of the pipe, wherein the tensile layer comprising a higher tensile strength than material of the remainder of the pipe outside of the tensile layer

[008] In addition to the exemplary aspects and embodiments described above, further aspects and embodiments will become apparent by reference to the figures and by study of the following detailed descriptions.

BRIEF DESCRIPTION OF THE FIGURES

[009] Exemplary embodiments are illustrated in referenced figures. It is intended that the embodiments and figures disclosed herein are to be considered illustrative, rather than restrictive. The invention, however, both as to organization and method of operation, together with objects, features, and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanying figures, in which:

[010] **Fig. 1** schematically shows an irrigation pipe in accordance with at least certain embodiments of the present invention;

[011] **Fig. 2A** schematically shows a cross section of the irrigation pipe of Fig. 1 taken along plane II-II illustration a possible embodiment of the irrigation pipe; and

[012] **Fig. 2B** schematically shows a cross section of the irrigation pipe of Fig. 1 taken along plane II-II illustration another possible embodiment of the irrigation pipe.

[013] It will be appreciated that for simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For

example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity. Further, where considered appropriate, reference numerals may be repeated within the figures to indicate like elements.

DETAILED DESCRIPTION

[014] Attention is first drawn to Fig. 1 illustrating an irrigation pipe 10 in accordance with at least certain embodiments of the invention. The irrigation pipe has a pipe wall 12 formed about a longitudinal axis X of the pipe forming an internal through going lumen 14 serving as a main passageway of the pipe for axially channeling liquid through the pipe.

[015] The pipe includes in addition openings 16 formed axially along the pipe's wall 12 serving as passageways through which liquid flowing through lumen 14 can exit the pipe. Th openings 16 may take form of apertures drilled or punched through the pipe wall.

[016] In an embodiment of the invention, the irrigation pipe may include an operative layer 18 formed along the pipe's wall possibly as here illustrated along areas of the wall including the openings 16. The operative layer, in various embodiments of the invention may serve as a tensile layer for increasing tensile strength of the pipe so as to increase the maximal stress that the pipe can withstand while e.g. being stretched or pulled.

[017] In various embodiments, provision of such tensile layer may be especially useful in so called thin-walled pipes sometimes called 'tapes'. Such a thin walled pipe structure may be characterized by a wall thickness that may range from about 0.127 (5 mil) to about 0.2032 millimeter (8 mil) (measured in a radial direction on a pipe held in a cylindrical state). Such relative thin wall thickness may render the pipes relative weak, inter alia, when exposed to tensile stresses, such as when laid or retrieved from a field. In the example exhibited in Figs. 1 and 2, tensile layer 18 is illustrated formed at least along an outer side of wall 12.

[018] Attention is drawn to Fig. 2A schematically illustrating a cross section of an embodiment of pipe 10 taken along a plane generally orthogonal to axis X of the pipe, such as plane II-II marked in Fig. 1. In this embodiment, operative layer 18 is illustrated formed along an outer side of the pipe's wall 12 with the openings 16 penetrating through layer 18 and wall 12 into lumen 14 of the pipe.

[019] Attention is drawn to Fig. 2B schematically illustrating a cross of an embodiment of pipe 10 generally similar to that seen in Fig. 2A, however in this example including an irrigation emitter 20 attached here to an inner side of the pipe's wall. A plurality of emitters such as emitter 20 may be axially attached along the pipe's wall, with each emitter being located adjacent a respective opening formed through the pipe to serve as passageways through which liquid flowing in the pipe can be directed out of the pipe for irrigation.

[020] In an embodiment of the invention, operative layer in a tensile layer formation 18 may be arranged to be formed from materials with a strength-to-density ratio that is higher than a comparative strength-to-density ratio in the remainder material of the pipe.

[021] In a non-binding example, tensile layer 18 in a formation having a relative high strength-to-density ratio, may be made of materials such as: COC, PP or the like.

[022] In certain cases, materials suitable for forming tensile layer 18 may be defined as having a relative high secant-modulus (where secant-modulus when referred to herein being defined according to ASTM D638-14 - see section 11). For example, tensile layer 18 in one example may be chosen to be from Polypropylene having a secant-modulus of about 1500 MPa and density of about 0.9 gr/cm^3, while the material of the remainder of the pipe may be formed from Polyethylene having a secant-modulus of about 800 MPa and density of about 0.945 gr/cm^3.

[023] In certain embodiments, filler materials may be added to tensile layer 18 e.g. to increase the layer's secant-modulus. In some cases, the filler materials may act as a "reinforcing" filler.

[024] In yet further embodiments, tensile layer 18 may be defined as a layer having a relative high tensile-strength in relation to tensile strength of material forming the remainder of the pipe wall (where tensile strength possibly being defined acc. to ASTM D638-14).

[025] Possibly, such tensile layer may be formed from a material having a '1% Tension secant Modulus' that may be higher than similar modulus existing in the remainder of the pipe. For example, the '1% Tension secant Modulus' of tensile layer 18 may be greater than about 2000 MPa.

[026] Alternatively, or in addition - increased resistance to tension of tensile layer 18 may be defined by an increased Elastic Modulus of layer 18 in relation to same modulus as present in the remainder material of the pipe.

[027] In some embodiments, such tensile layer 18 may in addition or alternatively include Nano-fillers such as Nano-Graphene, Nano carbon tubes, Nano-clays, Nano-Cellulous (or the like), where such Nano-fillers being designed to form up to about 5% in wt% from the matrix forming tensile layer 18 in a final extruded pipe.

[028] In certain cases, tensile layer may in addition or alternatively be made from PP or PE materials including glass fibers. Such glass fibers may be non-continuous Fibers (short or long) and/or possibly such glass fibers forming between about 5% to about 50% and preferably between about 20% to about 30% in wt% of polyolefin material forming layer 18. In some examples, tensile layer 18 may be formed from COC (Cyclic Olefin Copolymer) material – while in some cases pre-stretched continuous fiber(s) (possibly fiber bundles) (coated or not coated) may be embedded within layer 18 for increasing its tensile strength.

[029] In one example, determination of relative tensile strength properties of a pipe including tensile layer 18 may be defined according to ASTM D638-14. Four sectors may first be marked on a circumference of a drip irrigation pipe in a section of the pipe not including a dripper or tape. Then, five dumbbell shape samples

(according to ASTM D638-14) may be cut from each one of the four sectors – resulting in a total of twenty such samples.

[030] In a subsequent step, each one of the samples may then be stretched in a Tensile test machine (according ASTM D638-14, speed 100 mm/min), while recording the yield force and maximum force (In Newtons) obtained for each sample. Then the five samples relating to each sector may be averaged to record an average value for each sector – and existence of material forming a tensile layer 18 according to the various embodiments of the invention, may be identified by a sector having an average result that is higher by about 30% or more than results present in the other tested sectors of the pipe.

[031] In at least certain embodiments, operative layer 18 (in addition or in alternative to forming a tensile) may be arranged to include materials suitable for at least partially limiting formation of biological matter and/or entry of plant roots into passageways of the pipe, such as openings 16.

[032] Operative layer 18 may include operative-material(s) in the form of metallic materials, e.g. copper preferably copper oxide. In addition, operative layer 18 preferably includes such operative-material(s) mixed within polymeric material to consequently form a meltable polymeric substance that can be e.g. extruded and/or co-extruded during manufacturing of the pipe in order to integrally form at least part of the pipe's wall 12.

[033] In the description and claims of the present application, each of the verbs, "comprise" "include" and "have", and conjugates thereof, are used to indicate that the object or objects of the verb are not necessarily a complete listing of members, components, elements or parts of the subject or subjects of the verb.

[034] Further more, while the present application or technology has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and non-restrictive; the technology is thus not limited to the disclosed embodiments. Variations to the disclosed embodiments can be understood and effected by those

skilled in the art and practicing the claimed technology, from a study of the drawings, the technology, and the appended claims.

[035] In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single processor or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures can not be used to advantage.

[036] The present technology is also understood to encompass the exact terms, features, numerical values or ranges etc., if in here such terms, features, numerical values or ranges etc. are referred to in connection with terms such as "about, ca., substantially, generally, at least" etc. In other words, "about 3" shall also comprise "3" or "substantially perpendicular" shall also comprise "perpendicular". Any reference signs in the claims should not be considered as limiting the scope.

[037] Although the present embodiments have been described to a certain degree of particularity, it should be understood that various alterations and modifications could be made without departing from the scope of the invention as hereinafter claimed.

CLAIMS:

1. A thin walled irrigating pipe having a tensile layer formed as a continuous strip upon an outer side of the pipe for increasing tensile strength of the pipe, wherein the tensile layer comprising a higher tensile strength than material of the remainder of the pipe outside of the tensile layer.

2. The thin walled irrigating pipe of claim 1, wherein the tensile layer comprising a higher strength-to-density ratio than a comparative strength-to-density ratio in the remainder material of the pipe outside of the tensile layer.

3. The thin walled irrigating pipe of claim 1 or 2, wherein the tensile layer comprising a secant-modulus higher than a comparative secant-modulus in the remainder material of the pipe outside of the tensile layer.

4. The thin walled irrigating pipe of any one of the preceding claims, wherein the tensile layer comprising filler materials, possibly non-inert filler materials and/or further possibly Nano filler materials such as at least one of Nano-Graphene, Nano-clays, Nano-Cellulous.

5. The thin walled irrigating pipe of any one of the preceding claims, wherein the tensile layer comprises polymer reinforced glass fibers.

6. The thin walled irrigating pipe of any one of the preceding claims, wherein determination of relative tensile strength properties of the tensile layer in relation to material of the remainder of the pipe outside of the tensile layer being defined according to ASTM D638-14.

7. The thin walled irrigating pipe of any one of the preceding claims, wherein a wall thickness of the pipe ranging from about 0.127 millimeters (5 mil) to

about 0.2032 millimeter (8 mil) when measured in a radial direction on a pipe held in a cylindrical state.

8. The thin walled irrigating pipe of any one of the preceding claims, wherein in a cross section orthogonal to the pipe axis and taken along any location along the pipe's axis, the tensile layer extends only along a portion of the pipe's periphery.

9. The thin walled irrigating pipe of any one of the preceding claims, wherein the pipe comprises axially spaced apart apertures for communicating liquid out of the pipe and the apertures being formed also through the tensile layer.

10. The thin walled irrigating pipe of any one of the preceding claims, wherein the tensile layer comprises metallic materials, e.g. copper, preferably copper oxide.

11. An irrigating pipe having an operative layer formed as a continuous strip upon an outer side of the pipe, wherein the tensile layer comprises metallic materials, e.g. copper, preferably copper oxide.

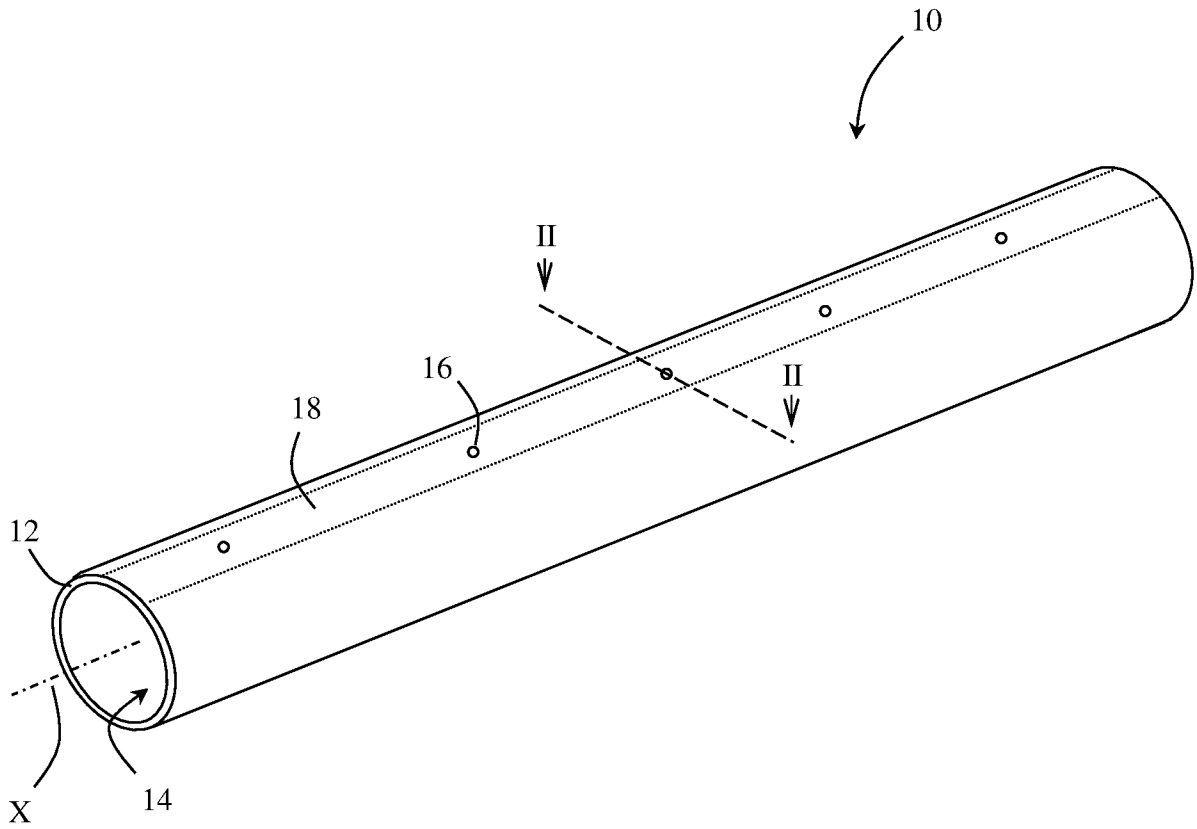

Fig. 1

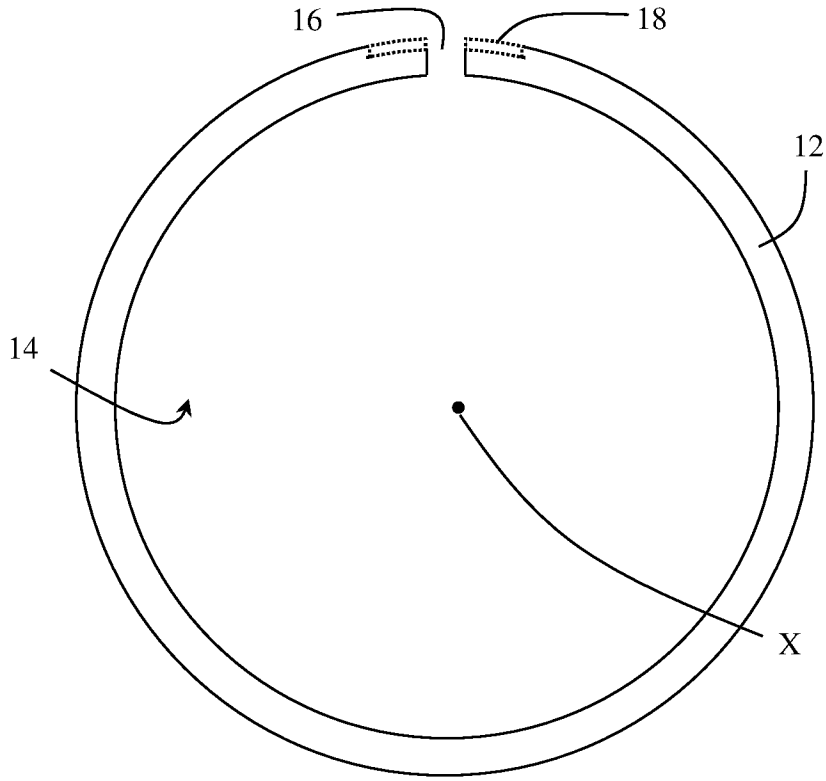

Fig. 2A

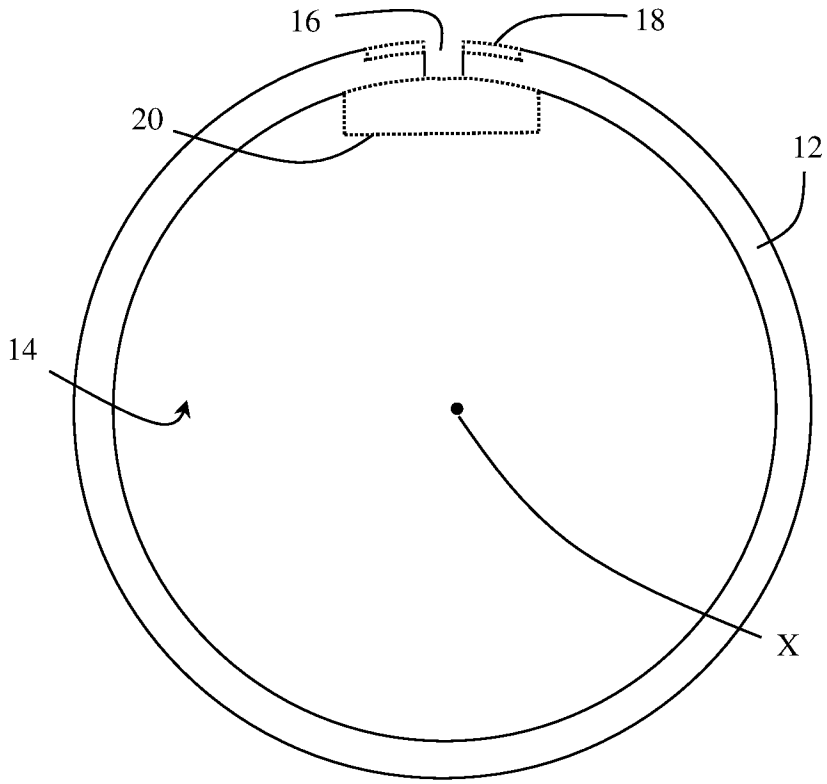

Fig. 2B

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/053295

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01G25/02
ADD.

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)
A01G C08L

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5 141 360 A (ZEMAN DAVID [US]) 25 August 1992 (1992-08-25) abstract figures 20-23 column 5, line 15 - column 13, line 23 -----	1-3,6, 8-11 7
X	US 6 513 734 B2 (BERTOLOTTI GIACOMO [US]) 4 February 2003 (2003-02-04) abstract figures 1-7 column 4, line 34 - column 8, line 34 -----	1-3,6,9
X	US 5 816 742 A (CORDEWENER CHARLES H [US]) 6 October 1998 (1998-10-06) abstract figures 1-6 column 6, line 36 - column 7, line 26 column 9, lines 8-40 ----- -/--	1-6,8-10

[X] Further documents are listed in the continuation of Box C.

[X] 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

"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
23 July 2019	30/07/2019

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2019/053295

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 91/03155 A1 (MEULEN ALFRED V D [AT]) 21 March 1991 (1991-03-21) abstract figures 1-5 page 4, line 29 - page 6, line 4 -----	1
Y	WO 2016/065497 A1 (ABU DHABI POLYMERS CO LTD BOROUGE LLC [AE]; BOREALIS AG [AT] ET AL.) 6 May 2016 (2016-05-06) abstract claim 3 -----	7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2019/053295

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