



(51) International Patent Classification:

F24S 25/65 (2018.01) F24S 25/60 (2018.01)

F24S 25/67 (2018.01) F24S 80/00 (2018.01)

F24S 25/634 (2018.01)

(21) International Application Number:

PCT/EP2020/065409

(22) International Filing Date:

04 June 2020 (04.06.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

PCT/CN2019/091216

14 June 2019 (14.06.2019) CN

19181366.6 19 June 2019 (19.06.2019) EP

(71) Applicant: COVESTRO INTELLECTUAL PROPERTY GMBH & CO. KG [DE/DE]; Kaiser-Wilhelm-Allee 60, 51373 Leverkusen (DE).

(72) Inventors: HOCKE, Heiko; Morsbroicher Straße 48, 51375 Leverkusen (DE). CHEN, Ruqi; Room 602, No.34, Lane 1770 South Hongmei Road, Shanghai, 200237 (CN).

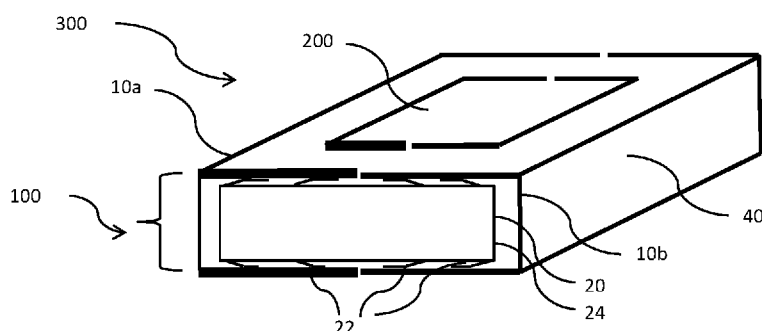
(74) Agent: LEVPAT; Covestro AG, Gebäude 4825, 51365 Leverkusen (DE).

(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,

(54) Title: CONNECTING SYSTEM FOR FRAMES ESPECIALLY IN CONNECTION WITH SOLAR PANELS

Figure 7



(57) Abstract: The invention is directed to a connecting system (100) comprising: A1) at least one first connecting part (10) and A2) at least one second connecting part (20), wherein the at least one first connecting part (10) and the at least one second connecting part (20) are arranged in a way to be mechanically connectable to each other to build a joint between the at least one first connecting part (10) and the at least one second connecting part (20), wherein at least one of the at least one first connecting part (10) or the at least one second connecting part (20) comprises a thermoplastic polymer. Further aspects of the invention relate to a first connecting part or a second connecting part, a process to produce a connecting system, a solar panel comprising a connecting system and a kit of parts comprising at least one first connecting part and at least one second connecting part.

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 applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

- *with international search report (Art. 21(3))*

Connecting System for frames especially in connection with solar panels

The invention is directed to a connecting system comprising A1) at least one first connecting part and A2) at least one second connecting part, wherein the at least one first connecting part and the at least one second connecting part are arranged in a way to be mechanically connectable to each other to build a joint between the at least one first connecting part and the at least one second connecting part at least partly, wherein at least one of the at least one first connecting part or the at least one second connecting part comprises a thermoplastic polymer as well as a production process of at least a first or second connecting part.

There exist many different frames for fragile articles like solar panels. Most of these frames are made of metal as described in DE 3408600A1. However, metal as profile for fragile articles may provide several disadvantages like:

- its hardness which may create cracks when utilized in combination with glass panes or solar panels, or
- its stiffness which can result in breaks if forces like torsion are too high
- its low isolation properties against heat or electricity
- its high weight
- its high costs
- its inability to be molded
- its corrosion .

Thus, there is a need for connecting systems as frame for fragile articles like solar panels in an efficient manner.

One aim of the invention is to provide a connecting system which avoids at least partly one of the above mentioned disadvantages. A further aim is to provide a connecting system which is flexible in geometry and/or has a low weight and/or low cost in production and/or high stiffness without being too hard to avoid scratches when coming into contact with glass, and can be easily implemented in highly efficient industrial assembling processes.

At least one of these aims is surprisingly achieved by the feature combination of claim 1. Dependent claims of claim 1 provide preferred embodiments of the invention.

A first aspect of the invention corresponds to a connecting system comprising:

A1) at least one first connecting part and

A2) at least one second connecting part,

wherein the at least one first connecting part and the at least one second connecting part are arranged in a way to be mechanically connectable to each other to build a preferably detachable joint between the at least one first connecting part and the at least one second connecting part at least partly,

5 wherein at least one of the at least one first connecting part or the at least one second connecting part comprises a thermoplastic polymer.

Preferably, the at least one first connecting part and the second connecting part are part of at least two separate elements or pieces of the connecting system. There are many different alternative ways to construe and arrange the elements of the connecting system each comprising at least one of at least one first connecting part, at least one second connecting part or at least one first and one second
10 connecting part. Preferably, one element comprises only one kind of connecting parts. However, in an alternative embodiment, one element may comprise both types of connecting part, e.g. at least one first connecting part and at least one second connecting part.

If the connecting system just comprises 1 first connecting part and 1 second connecting part the first and second connecting parts are preferably connected to each other in an integral way in one element.

15 In this case the connecting system comprises only 1 piece or element for example in form of a frame which comprises the two connecting parts.

Preferably, the joint between the at least one first connecting part and the at least one second connecting part in the connecting system is a detachable joint. Detachable joint according to the invention means that the joint can be detached without destroying the shape and function of the
20 elements that had been joined. The detachable joint can preferably be detached by a force to separate the first connecting part from the second connecting part after they have been joined to provide the connecting system in the range of from 1 N to 2000 N, more preferable in the range of from 10 N to 500 N and most preferably in the range from 50 N to 400 N.

Preferably, the connecting system comprises a number of first connecting parts in a range of from 2 to
25 100, more preferably in a range of from 3 to 50, particularly preferably in a range of from 4 to 10.

Preferably, the connecting system comprises a number of second connecting parts in a range of from 2 to 100, more preferably in a range of from 3 to 50, particularly preferably in a range of from 4 to 10. If more than one first connecting part and more than one second connecting part are used to build the connecting system, the first and second connecting parts are preferably arranged in the connecting
30 system in an alternating manner.

Preferably, the connecting system comprises a similar number of first connecting parts and second connecting parts, both preferably in a range of from 1 to 100, more preferably in a range of from 3 to 50, particularly preferably in a range of from 4 to 10.

Preferably, the at least one first connecting part and the at least one second connecting part are joint to
35 each other in a way to build a frame. The connecting system preferably has a shape that is adapted to

provide a protective frame for fragile articles. Examples for fragile article are articles comprising brittle materials like glass, thin sheets of clay or stone, brittle plastics or the like. To provide a protective frame for the fragile article preferably more than one first connecting part are combined with more than one second connecting part.

- 5 The geometry and size of the connecting system may be adapted to the size and geometry of the fragile article. Preferably, the size of the connecting system is in the range of from 1 cm³ to 1000 m³, more preferably in a range of from 2 cm³ to 100 m³, more preferably in a range of from 5 cm³ to 10 m³, even more preferably in a range of from 10 cm³ to 1 m³. The connecting system preferably has a length in a range of from 1 cm to 1000 m, more preferably in a range of from 5 cm to 100 m, even
 10 more preferably in a range of from 10 cm to 5 m. The connecting system preferably has a width in a range of from 1 cm to 1000 m, more preferably in a range of from 5 cm to 100 m, even more preferably in a range of from 10 cm to 5 m. The connecting system preferably has a height in a range of from 1 mm to 10 m, more preferably in a range of from 5 mm to 5 m, even more preferably in a range of from 1 cm to 1 m, especially preferably in a range of from 3 cm to 20 cm.
- 15 Preferably, the size of the first connecting part is in the range of from 1 cm³ to 10 m³, more preferably in a range of from 2 cm³ to 1 m³, even more preferably in a range of from 10 cm³ to 0.1 m³. The first connecting part preferably has a length in a range of from 1 cm to 100 m, more preferably in a range of from 5 cm to 20 m, even more preferably in a range of from 10 cm to 2 m. The first connecting part preferably has a width in a range of from 0.5 cm to 10 m, more preferably in a range of from 1 cm to
 20 5 m, even more preferably in a range of from 2 cm to 0.5 m. The first connecting part preferably has a height in a range of from 0.5 cm to 10 m, more preferably in a range of from 1 cm to 5 m, even more preferably in a range of from 2 cm to 0.5 m.

- The first connecting part may comprise any material the skilled person would use for the first connecting part. Preferably, the material to build the first connecting part is selected from the group of
 25 metals, wood and polymer; however preferably the first connecting part comprises a polymer, more preferably a composite and most preferably a composite material comprising a thermoset polymer having a glass transition temperature T_g between 50 °C and 400 °C, and a fibrous filler with an aspect ratio of at least 5 and more. The aspect ratio of a fiber is defined as the result of the length of the fiber divided by the diameter of the fiber. Preferably, the material to build the first connecting part
 30 comprises the thermoset polymer in a range of from 1 to 50 wt.-%, more preferably in a range of from 5 to 40 wt.-%, more preferably in a range of from 10 to 30 wt.-%, referred to the total weight of the first connecting part. Preferably, the material to build the first connecting part comprises the fibrous filler in a range of from 40 to 95 wt.-%, more preferably in a range of from 50 to 80 wt.-%, more preferably in a range of from 60 to 70 wt.-%, referred to the total weight of the first connecting part.
- 35 The second connecting part may have any geometry that is suitable to interact with the first connecting part to form the connecting system. Preferably, the second connecting part provides a shape to enable

the second connecting part to interact with at least a part of a suitable first connecting part of the connecting system.

Preferably, the second connecting part comprises a polymer. The polymer is preferably selected from the group consisting of a thermoset and a thermoplastic polymer, particularly preferably a thermoplastic polymer. The polymer preferably comprises an engineering thermoplastic polymer selected from the group having a glass transition temperature T_g and/ or crystallization temperature T_c between 80 °C and 400 °C. The T_g and T_c can be measured for example by DSC (differential scanning calorimetry).

Preferably, the size of the second connecting part is in the range of from 0.1 cm³ to 1 m³, more preferably in a range of from 1 cm³ to 5000 cm³, even more preferably in a range of from 5 cm³ to 50 cm³. The second connecting part preferably has a length in a range of from 0.3 cm to 100 m, more preferably in a range of from 1 cm to 1 m, even more preferably in a range of from 1.5 cm to 20 cm. The second connecting part preferably has a width in a range of from 0.3 cm to 10 m, more preferably in a range of from 1 cm to 1 m, even more preferably in a range of from 1.5 cm to 20 cm. The second connecting part preferably has a height in a range of from 0.3 cm to 10 m, more preferably in a range of from 1 cm to 1 m, even more preferably in a range of from 1.5 cm to 20 cm.

The first connecting part may have any geometry that is suitable to interact with a second connecting part to form a connecting system. Preferably, the first connecting part provides a hollow section, for example in form of a cavity or recess, which is shaped in a way to interact with at least a part of a suitable second connecting part of the connecting system.

To arrange the first connecting part relative to the second connecting part in the connecting system in a way to be mechanically connectable to each other to build a detachable joint between the at least one first connecting part and the at least one second connecting part at least partly the shapes of the first connecting part and the second connecting part are adapted to each other at least partly. The adaptation of the first connecting part to the second connecting part to form together a connecting system is preferably selected from the group consisting of a lock-and-key principle, frictional connection and a snap lock or a combination of at least two thereof.

Preferably, the joint built between the at least one first connecting part and the at least one second connecting part is selected from the group consisting of a lock-and-key principle, a frictional connection and a snap lock or a combination of at least two thereof. Preferably, the joint between the first connecting part and the second connecting part is a frictional connection.

In a lock-and-key principle the first connecting part is arranged in a way to incorporate at least a part of the second connecting part in a way that the second connecting part fits into the body of the first connecting part in a first position. Having positioned the second connecting part positioned in the first position and then twisting the second connecting part inside the first connecting part the second

connecting part interlocks with the first connecting part to not fall out of the opening of the first connecting part again.

In a frictional connection the shape of the second connecting part is adapted to the first connecting part in a way that it only fits into a hole or cavity formed in the first connecting part by deforming at least a part of the second connecting part. The deformation of at least a part of the second connecting part leads to a relaxation of the form inside the first connecting part resulting in a friction of the surfaces of the second connecting part inside of the first connecting part.

In a preferred embodiment of the connecting system the at least one first connecting part and the at least one second connecting part are arranged in a way to be mechanically connectable to each other to build a joint between the at least one first connecting part and the at least one second connecting part by deforming at least a part of the second connecting part resulting in a frictional connection. Preferably, the force to separate the two connecting parts is in a range of from 1 N to 2000 N, more preferable in the range of from 10 N to 500 N and most preferably in the range from 50 N to 400 N.

In a snap lock principle the first connecting part is arranged in a way to incorporate at least a part of the second connecting part whereby the second connecting part has a profile to be squeezed into a gap of the first connecting part to get stuck to the first connecting part to not fall out of the opening of the first connecting part again.

Preferably, the joint between the first and second connecting part to form the connecting system is formed at a temperature in a range of from -20 to 100 °C, more preferably in a range of from -10 to 80 °C, most preferably in a range of from 0 to 40 °C.

In a preferred embodiment of the connecting system the at least second connecting part is arranged to be at least partly surrounded by at least a part of the first connecting part when joint to each other to build the connecting system. Preferably, the part of the second connecting part surrounded by at least a part of the first connecting part has physical contact to the first connecting part for example in the described principles selected of a lock-and-key principle, a frictional connection and a snap lock. Preferably, those parts of the first connecting part and the second connecting part which do not interact with each other to build the joint are arranged in a way that they build a part of a frame.

In a preferred embodiment of the connecting system the first connecting part or the second connecting part comprises a main body and at least one tongue on its outside. Preferably, the second connecting part comprises the at least one tongue which, when positioned inside the preferably hollow body of the first connecting part provides a friction force between the first connecting part and the second connecting part in a range as mentioned before. Preferably, after being positioned inside the hollow section of the first connecting part, the second connecting part cannot be pulled out of the first connecting part without deforming the tongue and thereby providing a resistance that hinders the second connecting part to fall out from the first connecting part on its own. Preferably, the force to

separate the first connecting part from the second connecting part after they have been joined to provide the connecting system is in the range of from 1 N to 2000 N, preferably in a range of from 10 N to 500 N, more preferably in a range of from 50 N to 400 N, most preferably in a range of from 50 N to 200 N.

- 5 Preferably, the connecting system provides at least one tongue, which is preferably positioned at the second connecting part, whereby the tongue has at least one of the following properties:
- a) a length in a range of from 1 mm to 50 cm, preferably from 5 mm to 20 cm, more preferably from 1 to 10 cm;
 - b) a flexural modulus in a range of 0.5 and 10 GPa, measured acc. to ISO 178;
 - 10 c) a nominal strain at break of $> 5\%$, measured acc. to ISO 527-1,-2;
 - d) an angle towards the virtual axis of the main body in a range of > 0 and ≤ 90 degree;
 - e) a density in a range of 500 and 3500 kg/m³, measured acc. to ISO 1183-1;
 - f) a thickness in a range of from 0.1 mm to 10 cm, preferably from 1 mm to 5 cm, more preferably from 5 mm to 1 cm;
 - 15 g) is manufactured by an additive manufacturing process or an injection molding process.

Preferably, the connecting system provides the feature combination selected from the group a) and b);

- a) and c); a) and d); a) and e); a) and f); a) and g); b) and c); b) and d); b) and e); b) and f); b) and g); c) and d); c) and e); c) and f); c) and g); d) and e); d) and f); d) and g); e) and f); e) and g); f) and g);
- 20 a), b) and c); a), b) and d); a), b) and e); a), b) and f); a), b) and g); b), c) and d); b), c) and e); b), c) and f); b), c) and g); c), d) and e); c), d) and f); c), d) and g); d), e) and f); d), e) and g); e), f) and g);
- a), b), c) and d); a), b), c) and e); a), b), c) and f); a), b), c) and g); b), c), d) and e); b), c), d) and f); b), c), d) and g); c), d), e) and f); c), d), e) and g); d), e), f) and g); a), b), c), d) and e); a), b), c), d) and f); a), b), c), d) and g); b), c), d), e) and f); b), c), d), e) and g); c), d), e), f) and g); a), b), c), d), e) and f);
- 25 a), b), c), d), e) and g); b), c), d), e), f) and g); a), b), c), d), e), f) and g).

- In a preferred embodiment of the connecting system an adhesive is applied between the at least one first connecting part and the at least one second connecting part so that the combined pull out force of the joint as a result of friction and adhesive interaction is at least 100 N, preferably at least 500 N, more preferably at least 1000 N and most preferably at least 2000 N. If an adhesive is applied between
- 30 the first and second connecting part the mechanical joint built between the first and second connecting part without the adhesive is preferably in a range of from 1 N to 2000 N, more preferably in a range of from 10 N to 500 N, most preferably in a range of from 50 N to 400 N. Preferably, the connecting system is heated to an elevated temperature after forming the joint between the first and second connecting part to form the connecting system, especially when an adhesive is applied between the

first and second connecting part. Preferably, the joint connecting system is heated to a temperature in a range of from 10 to 150 °C, more preferably in a range of from 20 to 100 °C, most preferably in a range of from 30 to 80 °C.

In a preferred embodiment the adhesive is cured at normal surrounding temperature, i.e. between 5 °C and 50 °C without special heating. The curing might be facilitated at least partly by water, for example by the moisture in the air.

In a preferred embodiment of the connecting system the joint between the at least one first connecting part and the at least one second connecting part provides a pull out friction force:

(1) Measured directly after having joined the first connecting part with the second connecting part to become the connecting system is at least 1 N, preferably at least 10 N, more preferably at least 100 N and most preferably at least 500 N; or

(2) Measured after at least 1 week after having joined the first connecting part with the second connecting part of at least 100 N, preferably at least 500 N, more preferably at least 1000 N, most preferably at least 2000 N.

“Measured directly after having joined” means according to the invention in a time frame of 0 to 10 minutes, preferably in a time frame of 1 sec to 5 minutes after the mechanical joint has been built.

The friction force is measured at 23 °C after establishing the lock by pulling in axial direction the first connecting part and the second connecting part in opposite directions using a force meter. In a preferred embodiment of the connecting system the thermoplastic polymer provides an E-modulus, measured according to DIN EN ISO 527 of ≥ 0.8 GPa, and is preferably selected from the group consisting of polyethylene, polypropylene, polyolefins, polycarbonate, polyamide, polyether-etherketone, polyphenylenesulfide, polyoxymethylene, polyethyleneterephthalate, polybutylene-terephthalate, polystyrene, polybutadiene, polyacrylnitrile, co-polymers based on styrene-, acrylonitrile- and/ or butadiene- monomer, thermoplastic polyurethane, polyimide, polylactic acid, polyvinylene chloride or a mixture of at least two thereof.

In a preferred embodiment of the connecting system the thermoplastic polymer comprises a filler material selected from the group consisting of glass fibers, carbon fibers, basalt fibers, talc, minerals, inorganic pigments, carbon black, silicon dioxide, alumina, magnesium oxide, inorganic oxides, carbonates and silicates or a mixture of at least two thereof. Preferably, the filler is selected from talc, glass fibers or carbon fibers or a mixture thereof.

In a preferred embodiment of the connecting system the thermoplastic polymer comprises the filler material in a range of from 5 to 90 wt.-%, preferably in a range of from 7 to 80 wt.-%, more preferably in a range of from 10 to 50 wt.-%, most preferably in a range of from 15 to 30 wt.-%, based on the total weight of the thermoplastic polymer.

In a preferred embodiment of the connecting system the first connecting part comprises a material, which is preferably a thermoset material, obtained by a polymerization of a resin selected from the group consisting of epoxy, vinylester, polyester, unsaturated polyester, polyisocyanate, polyurethane, polyisocyanurate, melamine, formaldehyde and silicone or a mixture of at least two thereof.

5 Preferably, the material from which the first connecting part is formed is a thermoset material with a Tg of at least 50 °C

Preferably, at least 50 wt.-% of the components utilized to compose the polymers which are used to build at least the first connecting part are originated from renewable sources.

10 Preferably, the first connecting part comprises a combination of thermoset resin material and fibrous filler material. Most preferably, the fibrous filler material is glass fiber.

Preferably, the first connecting part comprises glass fibers in a range of from 10 to 95 wt.-%, more preferably of from 25 to 90 wt.-% and most preferably of from 50 to 85 wt.-%, based on the total weight of the first connecting part.

15 In a preferred embodiment of the connecting system the connecting system also comprises a glass pane or a solar cell. The glass pane or the solar cell is preferably positioned in a frame built by at least one first connecting part and one second connecting part. The first and second connecting parts are shaped in a way to hold the glass pane or the solar cell at least at the edges.

20 A further aspect of the invention corresponds to a first connecting part or a second connecting part suitable for a connecting system according to the invention, wherein the first connecting part is shaped in a way to be able to build a mechanical joint to a corresponding first or second connecting part. The shape, size and other features of the first and second connecting parts are the same as described before in connection with the connecting system.

A further aspect of the invention corresponds to a process to produce a connecting system comprising at least the following steps:

25 (V1) providing a thermoplastic polymer;

(V2) optionally mixing the thermoplastic polymer with a filler material to receive a compound material;

30 (V3) forming the thermoplastic polymer of step (V1) or of step (V2) into at least one second connecting part, comprising at least partly a specific shape which is enabled to be mechanically connectable to at least one first connecting part;

(V4) forming at least one first connecting part, comprising at least partly a specific shape which is enabled to be mechanically connectable to the at least one second connecting part of the connecting system;

5 (V5) optionally sliding at least partly at least one second connecting part (V3) into at least one first connecting part (V4) in a way, that the second connecting part is at least partially surrounded by the at least one first connecting part;

to build the connecting system.

10 The providing of the thermoplastic polymer in step (V1) can be provided in any way the person skilled in the art would perform this step. Preferably, the providing is selected from the group consisting of providing in a vessel, a tank, a batch, a bag or the like, on a roll, on a tape, as powder or granule or a combination of at least two thereof.

15 The mixing of the thermoplastic polymer with a filler material to receive a compound material in step (V2) can be provided in any way the person skilled in the art would perform this step. Preferably, the mixing is performed in a static mixer, a speed mixer, a blender, an extruder, a kneader or a combination of at least two thereof.

20 The forming of the thermoplastic polymer (V1) or (V2) into at least one second connecting part in step (V3), comprising at least partly a specific shape which is enabled to be mechanically connectable to the at least one first connecting part, can be provided in any way the person skilled in the art would perform this step. Preferably, the forming is selected from the group consisting of injection molding, extruding, filament lay-up and melt-fusing, powder sintering, casting or a combination of at least two thereof. Step (V3) is preferably performed at elevated temperatures, preferably in the range of from 30 to 420 °C, more preferably of from 40 to 300 °C, most preferably of from 150 to 280 °C.

25 The forming of at least one first connecting part in step (V4), comprising at least partly a specific shape which is enabled to be mechanically connectable to at least one second connecting part of the connecting system, can be provided in any way the person skilled in the art would perform this step. The forming is selected from the group consisting of injection molding, extruding, pultruding, casting, filament winding or a combination of at least two thereof. Step (V4) is preferably performed at elevated temperatures, preferably in the range of from 30 to 1200 °C, more preferably of from 40 to 300 °C, most preferably of from 50 to 250 °C.

30 The sliding of at least a part of the at least one second connecting part of step (V3) into at least one first connecting part of step (V4) in a way, that the second connecting part is at least partially surrounded by the at least one first connecting part in step (V5) can be provided in any way the person

skilled in the art would perform this step. The sliding of the second connecting part into at least one first connecting part in step (V5) is preferably performed manually.

The features, especially the shape, size, geometry, composition and interaction of the first connecting part and the second connecting part described in connection with the connecting system according to the invention above are also applicable to these elements in the context of the process according to the invention. Preferably, the first connecting part received in step (V4) provides means to interact with the second connecting part received in step (V3). As mentioned in context of the connecting system according to the invention these means are preferably selected from the group consisting of tongues, keys for a key lock connection and snaps for a snap lock connection or a combination of at least two thereof.

Preferably, the second connecting part received in step (V3) provides means to interact with the first connecting part received in step (V4). As mentioned in context of the connecting system according to the invention these means are preferably selected from the group consisting of holes e.g. in form of a cavity, locks for a key lock connection, locks for a snap lock connection or a combination of at least two thereof.

In a preferred embodiment of the process step (V5) is done in an automated way after having established steps (V3) and (V4). The person skilled in the art knows how to establish the automation of such assembling processes.

In a preferred embodiment of the process at least a part of step (V3) or (V4) are established by at least one of the following processes:

- i. an additive manufacturing process;
- ii. an injection molding process;
- iii. a screen printing process;
- iv. a pultrusion process.

The additive manufacturing process in step i. can be provided in any way the person skilled in the art would perform this step. Preferably the step i. is selected from melt layering (fused filament fabrication, FFF), ink-jet-printing, photopolymer jetting, stereo lithography, selective laser sintering, digital-light-processing-based additive manufacturing system, continuous liquid interface production, selective laser melting, binder-jetting-based additive manufacturing, multijet-fusion-based additive manufacturing, high-speed sintering process and laminated object modelling or a combination of at least two thereof.

The injection molding process in step ii. can be provided in any way the person skilled in the art would perform this step. All injection molding processes known in the prior art are applicable for step ii.

The screen printing process in step iii. can be provided in any way the person skilled in the art would perform this step. Screen printing processes are well known in the prior art.

The pultrusion process in step iv. can be provided in any way the person skilled in the art would perform this step. Pultrusion processes are well known in the prior art.

- 5 A further aspect of the invention corresponds to a solar panel, a glass pane or a window comprising a connecting system according to the invention or produced by a process according to the invention, or a connecting part according to the invention.

10 The features, especially the shape, size, geometry, composition and interaction of the first connecting part and the second connecting part described in connection with the connecting system according to the invention above are also applicable to these elements in the context of the process according to the invention.

The solar panel could be any solar panel preferably comprises a solar cell. Systems of solar panels are known in the prior art.

A further aspect of the invention is related to a kit of parts comprising at least

- 15 A1) at least one first connecting part and
A2) at least one second connecting part

wherein the at least one first connecting part and the at least one second connecting part are arranged in a way to be mechanically connectable to each other to build a preferably detachable joint between the at least one first connecting part and the at least one second connecting part at least partly, wherein
20 at least one of the at least one first connecting part or the at least one second connecting part comprises a thermoplastic polymer. The first connecting part and the second connecting part are selected from the same.

25 The features, especially the shape, size, geometry, composition and interaction of the first connecting part and the second connecting part described in connection with the connecting system according to the invention above are also applicable to these elements in the context of the process according to the invention.

The invention is illustrated in the following figures without being bound to details described in connection with the drawings.

FIG. 1: illustrative view of a first preferred embodiment of a first connecting part

- 30 FIG. 2: illustrative view of a first preferred embodiment of a second connecting part with a rectangular main body and several squeezable tongues

FIG. 3: illustrative view of a further preferred embodiment of a second connecting part with a small main body expanding into squeezable tongues

FIG. 4a: illustrative view of a further preferred embodiment of a second connecting part with an L-shaped main body and several squeezable tongues

5 FIG. 4b: illustrative view of a further preferred embodiment of a second connecting part with an Y-shaped main body and several squeezable tongues

FIG. 5: illustrative view of a connecting system comprising two different first connecting part and a second connecting part with a rectangular main body and several squeezable tongues

10 FIG. 6: illustrative view of a connecting system comprising a first connecting and a second connecting part with several squeezable tongues extending into the first connecting part

FIG. 7: illustrative view of a solar panel comprising a frame with a connecting system comprising a first connecting part and a second connecting part

In Figure 1 a first preferred embodiment of a first connecting part 10 is shown. The first connecting part 10 has a frame 12 with a hole 14 with two openings 16 which is able to interact with at least one
15 second connecting part 20 of the connecting system 100 as shown in Figures 5 to 7. The hole 14 could be formed as a blind hole or as shown in Figure 1 as an end-to-end hole 14, which connects the two openings 16 of the two sides of the first connecting part 10. Thus, the hole 14 may be formed as a hollow section which expands only partly in the connecting part 10 or as a hollow core which expands through the whole length of the connecting part 10. By having two holes 14 this example of a first
20 connecting part 10 is able to interact with two different second connecting parts 20 to build a connecting system 100 as shown in Figure 5. The first connecting part 10 may expand in different directions in for example an L-shape or a Y-shape which are then interconnectable with more than two second connecting parts 20.

In Figure 2 a preferred embodiment of a second connecting part 20 with a rectangular main body 24 and several squeezable tongues 22 is shown. The squeezable tongues 22 can expand to different
25 directions of the main body 24. As described before the material of the main body 24 and the tongues 22 may comprise the same thermoplastic material or different thermoplastic material. Preferably, the main body 24 is massive; however it could also be formed with a hollow core or at least a hollow section. To build a connecting system 100 the second connecting part 20 of figure 2 may be pressed
30 into one of the openings of the hole 14 of the first connecting part 10. The tongues 22 will be pressed together and alter their shape by this pressure. By being pressed against the walls of hole 14 of the first connecting part 10 the tongues form a resistance when pulling the second connecting part 20 out of the hole 14 of the first connecting part 10.

In Figure 3 a further preferred embodiment of a second connecting part 20 with a small main body 24, confined by the dotted lines is shown. The main body 24 is expanding into squeezable tongues 22. To build a connecting system 100 the tongues 22 of the second connecting part 20 as illustrated in figure 3 have to be squeezed together at the ends 28 to be pressed into one of the openings of the hole 14 of the first connecting part 10. By doing this the tongues 22 of the second connecting part 20 of Figure 3 will try to expand into the opposite direction as illustrated by the arrows 30.

The second connecting part 20 may have different shapes as illustrated in Figures 4a and Figure 4b. As examples in Figure 4a a second connecting part 20 is shown with an L-shaped main body and several squeezable tongues 22 expanding therefrom in different directions.

In Figure 4b a further preferred embodiment of a second connecting part 20 with a Y-shaped main body 24 and several squeezable tongues 22 is shown. By these different shapes of second connecting parts 20 as illustrated in Figures 2, 3, 4a and 4b many different shapes of connecting systems 100 can be provided.

In Figure 5 a connecting system 100 comprising two different first connecting parts 10 (of which only a part is shown) and a second connecting part 20 with a rectangular main body 24 and several squeezable tongues 22 is shown. The two different connecting parts 10a and 10b may have different shapes of their frames 12a, 12b as illustrated by different frame thicknesses of frame 12a and 12b. The second connecting part 20 is pushed into the openings 16 of each of the two connecting parts 10a and 10b and fills at least partly the hole 14 which is partly built by the two first connecting parts 10a and 10b. The tongues 22 hereby are pushed against the inner wall 13 of the first connecting parts 10a and 10b to provide a frictional interaction between the first connecting parts 10a and 10b with the second connecting part 20.

In Figure 6 a connecting system 100 comprising a first connecting part 10 (of which only a part is shown) and a second connecting part 20 with several squeezable tongues 22 extending into the hole 14 of the first connecting part 10. The shape of the tongues 22 is adapted to the frame 12 of the first connecting part 10 in a way that the tongues 22 interact with the surface of the frame 12 of the first connecting part 10.

Figure 7 shows a solar panel 300 comprising a frame 40 comprising a connecting system 100 comprising two first connecting parts 10a and 10b connected by at least one second connecting part 20. By the frame 40 a solar cell 200 is fixed. The interaction of the tongues 22 of the second connecting part 20 with the first connecting part 10 is the same as described in connection with Figure 5.

Example 1*First connecting part*

A first connecting part was formed in shape of a profile by pultrusion process analogously to WO2018/054776A1 using a material combination and process as described in inventive example 5.

5

Preparation of catalyst:

Potassium acetate (50.0 g) was stirred in the PEG 400 (950.0 g) at room temperature ($RT = 23^{\circ}\text{C} \pm 1^{\circ}\text{C}$) until all of it had dissolved. In this way, a 5% by weight solution of potassium acetate in PEG 400 was obtained and was used as catalyst without further treatment.

10

Preparation of resin mixture:

A resin mixture composed of the isocyanate Desmodur N 3600 (18.70 kg), the catalyst mixture (0.80 kg) and INT- 1940RTM demoulding agent (0.40 kg) and also zinc stearate (0.1 kg) was prepared as follows: The isocyanate Desmodur N 3600 was initially charged in an open vessel at room temperature and stirred by means of a Dispermat and dissolver disc at 100 revolutions per minute (rpm) for 1 minute. Subsequently, first the separating agent and then the catalyst were added, the stirrer speed was increased to 300 rpm and the whole mixture was stirred for a further 10 min, so as to form a homogeneous mixture. This mixture was used without further treatment for the pultrusion.

15

For pultrusion the glass fibre bundles were oriented and guided by means of a deflection through an open impregnation bath. The bath temperature was about 25°C . The impregnated glass fibres were pulled directly into the heated mould. The temperature zones during pultrusion were $H1 = 180^{\circ}\text{C}$, $H2 = 220^{\circ}\text{C}$, $H3 = 200^{\circ}\text{C}$ and $H4 = 180^{\circ}\text{C}$. The pulling speed was 0.5 m/min and the tensile forces were 0.2-0.6 t. By this pultrusion process 150 m of profile were produced. Excess reactive resin mixture that had been stripped off was recycled continuously into the impregnation bath via a channel and used again. The receiving cavity was of rectangular shape with width $W = 24.0\text{ mm}$ and thickness $T = 8.0\text{ mm}$.

20

25

Second connecting part

A second connecting part was produced by additive manufacturing (fused filament fabrication) using as machine RAISE3D Pro2 from RAISE3D Inc. and as material PolyMaxTM PC from Polymaker (China). The part had a rectangular shape with length $L = 80.0\text{ mm}$, width $W = 24.5\text{ mm}$ and thickness $T = 7.0\text{ mm}$. In the middle of the part a cut with a length of 25 mm and a width of 3 mm was formed so that 2 tongues with a geometry as shown in figure 3 were formed.

30

Making a connecting system

The second connecting part was slidden into the cavity of the first connecting part by applying pushing force so that a connecting system med. The overlap was partially so that 10 mm on one side and 15 mm on the other side of the second connecting part were surrounded by the first connecting part.

Measuring pull out friction force

- 5 The first connecting part of the connecting system was fixed and a dynamometer (force meter) WeiHeng[®] was attached on the second connecting part. The applied force was measured when the joint between the second connecting part and the first connecting part was detached by pulling along in axial direction. The measurement was repeated 3 times and the average pull out force was calculated using the highest (initial) force. An overlap of 10 mm resulted in 75 N and an overlap of 15
- 10 mm in 165 N.

Claims

1. A connecting system (100) comprising:

A1) at least one first connecting part (10) and

A2) at least one second connecting part (20)

5 wherein the at least one first connecting part (10) and the at least one second connecting part (20) are arranged in a way to be mechanically connectable to each other to build a joint between the at least one first connecting part (10) and the at least one second connecting part (20),

wherein at least one of the at least one first connecting part (10) or the at least one second connecting part (20) comprises a thermoplastic polymer.

10 2. The connecting system (100) according to claim 1, wherein the joint between the at least one first connecting part (10) and the at least one second connecting part (20) is built by deforming at least a part of the second connecting part resulting in a frictional connection.

3. The connecting system (100) according to any of the preceding claims, wherein the at least one second connecting part (20) is arranged to be at least partly surrounded by at least a part of the first connecting part (10) when joint to each other.

4. The connecting system (100) according to any of the preceding claims, wherein the first connecting part (10) or the second connecting part (20) comprises a main body and at least one tongue (22) on its outside.

5. The connecting system (100) according to any of the preceding claims, wherein an adhesive is applied between the at least one first connecting part (10) and the at least one second connecting part (20) before building the joint so that the combined pull out force of the joint as a result of friction and adhesive interaction is at least 100 N, preferably at least 500 N, more preferably at least 1000 N and most preferably at least 2000 N.

6. The connecting system (100) according to any of the preceding claims, wherein the joint between the at least one first connecting part (10) and the at least one second connecting part (20) provides a pull out friction force:

(1) Measured directly after having joined the first connecting part (10) with the second connecting part (20) of at least 1 N, preferably at least 10 N, more preferably at least 100 N and most preferably at least 500 N; or

(2) Measured after at least 1 week after having joined the first connecting part (10) with the second connecting part (20) of at least 100 N, preferably at least 500 N, more preferably at least 1000 N, most preferably at least 2000 N.

7. The connecting system (100) according to any of the preceding claims, wherein the thermoplastic polymer provides an E-modulus, measured according to DIN EN ISO 527 of ≥ 0.8 GPa, and is preferably selected from the group consisting of polyethylene, polypropylene, polyolefins, polycarbonate, polyamide, polyetheretherketone, polyphenylenesulfide, polyoxymethylene, polyethyleneterephthalate, polybutyleneterephthalate, polystyrene, polybutadiene, polyacrylonitrile, co-polymers based on styrene-, acrylonitrile- and/ or butadiene- monomer, thermoplastic polyurethane, polyimide, polylactic acid, polyvinylene chloride or a mixture of at least two thereof.
8. The connecting system (100) according to any of the preceding claims, wherein the thermoplastic polymer comprises a filler material selected from the group consisting of glass fibers, carbon fibers, basalt fibers, talc, minerals, inorganic pigments, carbon black, silicon dioxide, alumina, magnesium oxide, inorganic oxides, carbonates and silicates or a mixture of at least two thereof.
9. The connecting system (100) according to any of the preceding claims, wherein the connecting system also comprises a glass pane or a solar cell (200).
10. A first connecting part (10) or a second connecting part (20) suitable for a connecting system (100) according to one of claims 1 to 10, wherein the connecting part (10, 20) is shaped in a way to be able to build a mechanical joint to a corresponding first connecting part (10) or second connecting part (20).
11. A process to produce a connecting system (100) comprising at least the following steps:
 - (V1) providing a thermoplastic polymer;
 - (V2) optionally mixing the thermoplastic polymer with a filler material to receive a compound material;
 - (V3) forming the thermoplastic polymer of step (V1) or of step (V2) into at least one second connecting part, comprising at least partly a specific shape which is enabled to be mechanically connectable to at least one first connecting part;
 - (V4) forming at least one first connecting part, comprising at least partly a specific shape which is enabled to be mechanically connectable to the at least one second connecting part of the connecting system;
 - (V5) optionally sliding at least partly at least one second connecting part (V3) into at least one first connecting part (V4) in a way, that the second connecting part is at least partially surrounded by the at least one first connecting part;
 to build the connecting system (100).

12. The process according to claim 11, wherein step (V5) is done in an automated way after having established steps (V3) and (V4).

13. The process according to any of claims 11 or 12, wherein at least a part of step (V3) or (V4) are established by at least one of the following processes:

- 5
- i. an additive manufacturing process;
 - ii. an injection molding process;
 - iii. a screen printing process;
 - iv. a pultrusion process.

10 14. A solar panel (300) comprising a connecting system (100) according to any of claims 1 to 9 or produced by a process according to any of claims 11 to 13, or a connecting part (10, 20) according to claim 10.

15. A kit of parts comprising at least:

- A1) at least one first connecting part and
- A2) at least one second connecting part

15 wherein the at least one first connecting part and the at least one second connecting part are arranged in a way to be mechanically connectable to each other to build a joint between the at least one first connecting part and the at least one second connecting part at least partly, wherein at least one of the at least one first connecting part or the at least one second connecting part comprises a thermoplastic polymer.

20

Figures

Figure 1

5

10

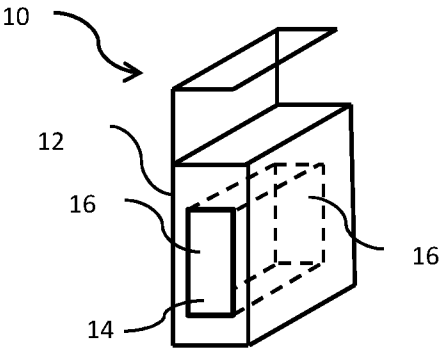


Figure 2

15

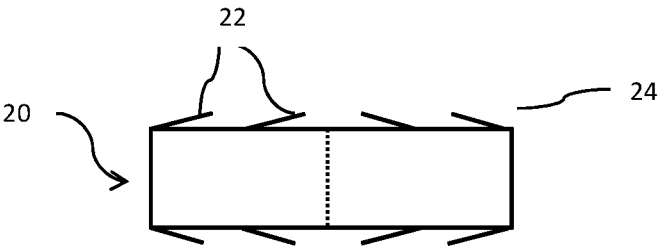


Figure 3

20

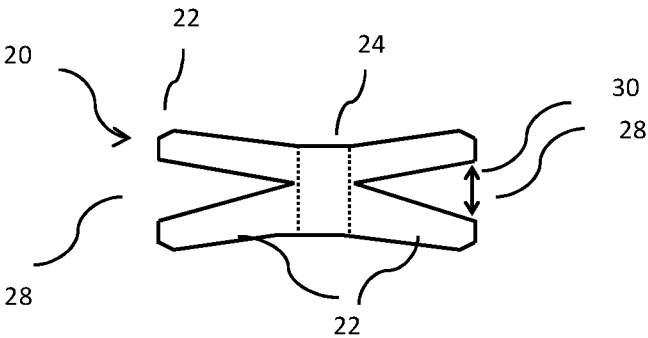


Figure 4a

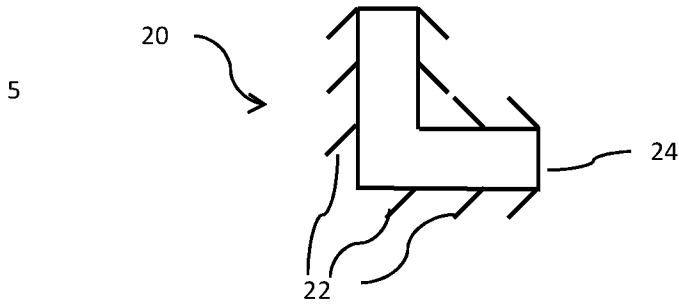


Figure 4b

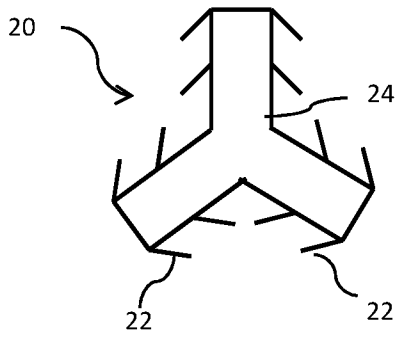


Figure 5

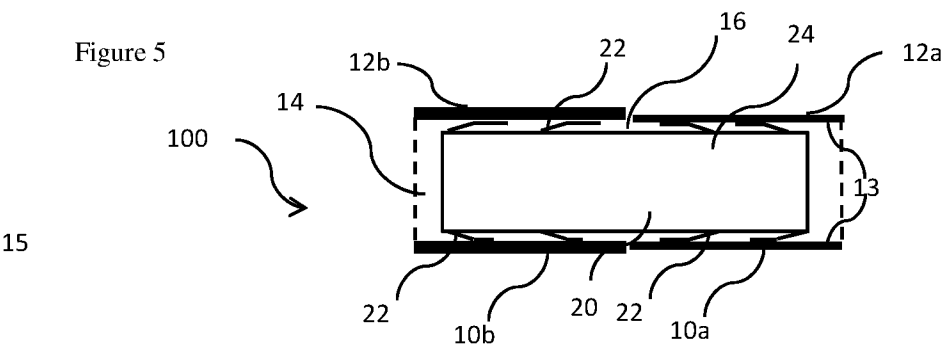


Figure 6

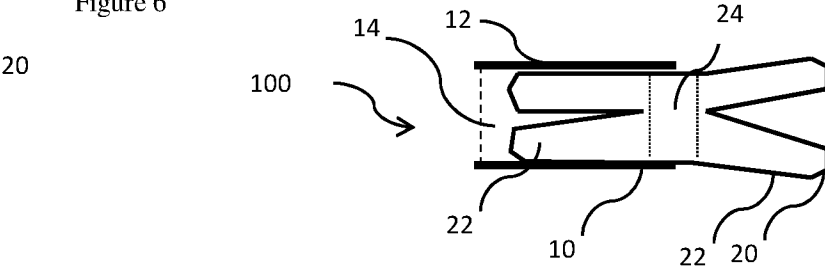
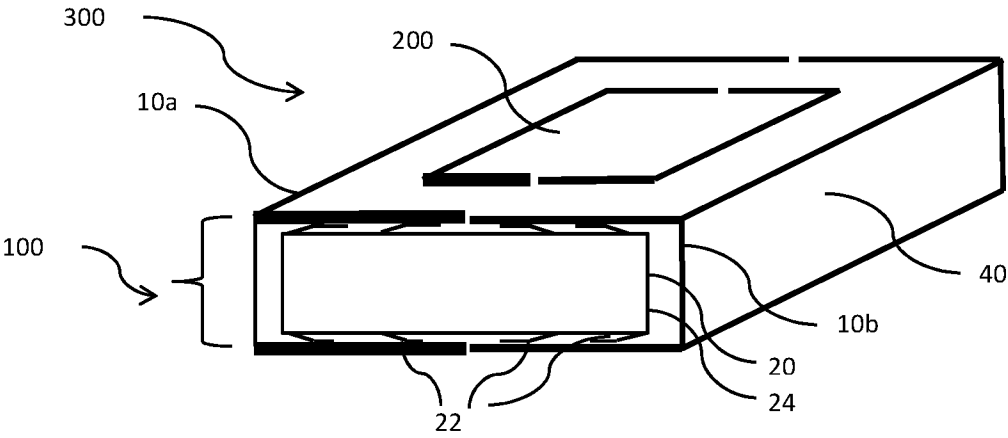


Figure 7



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/065409

A. CLASSIFICATION OF SUBJECT MATTER INV. F24S25/65 F24S25/67 F24S25/634 ADD. F24S25/60 F24S80/00		
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) F24S		
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	US 2012/174981 A1 (KARG FRANZ [DE] ET AL) 12 July 2012 (2012-07-12)	1-3,5-15
Y	paragraph [0043]; figures 3,4 paragraph [0047]; figure 4 paragraph [0034]; figure 1 -----	4
X	DE 10 2008 027452 A1 (SOLAR WERKE GMBH & CO KG DEUTS [DE]) 15 October 2009 (2009-10-15)	1,3,7, 9-11,14, 15
Y	paragraph [0013] - paragraph [0014]; figures 1,2 -----	4
Y	EP 2 903 035 A1 (SANYO ELECTRIC CO [JP]) 5 August 2015 (2015-08-05) paragraph [0032] - paragraph [0033]; figure 3 ----- -/-	4
☒ 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 "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 17 August 2020		Date of mailing of the international search report 01/09/2020
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Mendão, João

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2020/065409

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 2009/086239 A2 (DU PONT [US]; KINARD RICHARD DALE [US]; MC QUADE MICHAEL ROBERT [US]) 9 July 2009 (2009-07-09) page 15, line 24 - page 16, line 3 page 20, line 1 - line 8; figure 2D -----	1,10,11, 14,15
X	US 2013/220395 A1 (BABINEAU JR FRANCIS JOHN [US] ET AL) 29 August 2013 (2013-08-29) paragraph [0031] - paragraph [0033]; figures 1A-1C -----	1,10,11, 14,15
X	WO 2010/019742 A2 (DU PONT [US]; ASHMEAD JAMES WILLIAM [US]; MC QUADE MICHAEL ROBERT [US]) 18 February 2010 (2010-02-18) page 15, line 27 - page 16, line 2; figure 1C page 32, line 16 - line 26 -----	1
A	DE 20 2015 102043 U1 (TAIWAN CARBON NANOTUBE TECHNOLOGY CORP [TW]) 27 May 2015 (2015-05-27) figure 1 -----	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2020/065409

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012174981 A1	12-07-2012	CN 202957264 U	29-05-2013
		CN 202993633 U	12-06-2013
		DE 212010000121 U1	05-06-2012
		DE 212010000122 U1	11-04-2012
		FR 2949494 A1	04-03-2011
		FR 2949548 A1	04-03-2011
		KR 20120003444 U	17-05-2012
		KR 20120004267 U	14-06-2012
		US 2012174968 A1	12-07-2012
		US 2012174981 A1	12-07-2012
		WO 2011023902 A2	03-03-2011
		WO 2011023903 A2	03-03-2011

DE 102008027452 A1	15-10-2009	NONE	

EP 2903035 A1	05-08-2015	CN 104508835 A	08-04-2015
		EP 2903035 A1	05-08-2015
		JP WO2014050087 A1	22-08-2016
		US 2015222219 A1	06-08-2015
		WO 2014050087 A1	03-04-2014

WO 2009086239 A2	09-07-2009	US 2010269891 A1	28-10-2010
		WO 2009086239 A2	09-07-2009

US 2013220395 A1	29-08-2013	NONE	

WO 2010019742 A2	18-02-2010	WO 2010019742 A2	18-02-2010
		WO 2010019745 A2	18-02-2010
		WO 2010019749 A2	18-02-2010
		WO 2010019754 A2	18-02-2010

DE 202015102043 U1	27-05-2015	CN 204498060 U	22-07-2015
		DE 202015102043 U1	27-05-2015
		JP 3198764 U	23-07-2015
		TW M498861 U	11-04-2015
