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(71) Applicant: **VKR HOLDING A/S** [DK/DK]; Breeltevej 18, DK-2970 Hørsholm (DK).

(72) Inventor: **LYHNE, Dennis**; Solbakken 55, DK-6710 Esbjerg V (DK).

(74) Agent: **PATENTGRUPPEN A/S**; Aaboulevarden 31, 4th floor, DK-8000 Aarhus C (DK).

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(54) **Title**: PULTRUDED FIBRE REINFORCED POLYURETHANE COMPONENTS FOR EXTERIOR APPLICATIONS

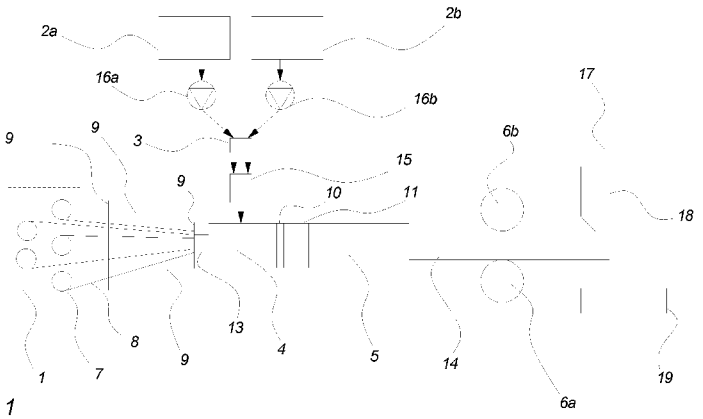

Fig. 1

(57) **Abstract**: The invention relates to a process for manufacturing frames orsashes for windows or doors, the windows and doors comprising pultruded fibrereinforced polyurethane elements which are powder coated with UV-curing polyester powder.

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PULTRUDED FIBRE REINFORCED POLYURETHANE COMPONENTS FOR EXTERIOR APPLICATIONS

FIELD OF THE INVENTION

The invention relates to pultruded fibre reinforced polyurethane components, their surface treatment and the manufacturing of windows and doors using these components.

BACKGROUND OF THE INVENTION

Pultrusion is a well-established continuous process for manufacturing fibre reinforced plastic parts or components, also called composite materials, which may be used for a variety of purposes. Depending on the resinous material used to wet and bind together the reinforcing fibres in the pultrusion process, the use of the pultruded parts or profiles is restricted due to e.g. temperature constraints, durability and/or visual appearance.

Conventional methods to improve e.g. the visual appearance of pultruded parts include coating the surface of the pultruded parts with a suitable organic coating such as wet paint. A problem relating to such paints is the often relatively poor finish and durability.

A need remains to improve the durability and visual appearance of pultruded components.

SUMMARY OF THE INVENTION

The present invention relates to a process for manufacturing a frame or a sash for a window or door comprising frame members and sash members, said process comprising the steps of:

a) providing one or more pultruded components comprising reinforcing fibres and polyurethane resin,

b) coating said one or more pultruded components with a powder coating comprising polyester resin,

c) curing the powder coating with UV-radiation to form a coated surface on the one or more pultruded components,

d) assembling a frame or a sash for a window or door, one or more of the frame members or sash members comprising one or more of the coated pultruded components.

According to the present invention it is possible to obtain fibre reinforced polyurethane pultruded parts for window- and door assemblies which are robust with regards to appearance of the surface and the complete assembly as such. The established surface is of exceptionally good quality, both with respect to wear and visual appearance. It has been found that a coating system comprising UV-curing polyester powder coatings and pultruded fibre reinforced polyurethane parts achieves surprisingly good properties and overall mechanical stability of sash- and frame members for windows and doors. By curing the powder coating with UV-radiation at comparatively low temperatures, the dimensional stability of the powder coated pultruded components is not compromised and, at the same time, durable coated surfaces are achieved. While the surface of the pultruded part will deteriorate rather quickly when e.g. exposed to sunlight, the same surface coated with the UV-curing polyester powder coating can withstand e.g. exposure to sunlight for years. The results obtained by the present inventors on a substrate of pultruded fibre reinforced polyurethane are unexpected for several reasons. Firstly, an excellent adhesion between the coating and the substrate is obtained, despite the UV-curing process and the somewhat inhomogeneous substrate surface.

Secondly, the excellent finish conferred to the pultruded fibre reinforced polyurethane part by the UV-curing powder coating allows for use of the finished part, where visual appearance is important.

Furthermore, it has been found by the present inventors that contrary to expectations, the surprisingly good resistance towards stress and wear during use of the assembly includes a good retention of finish which is of particular importance on window- and door sashes or frames making up a considerable part of the looks of a building. Customer demands for high durability and low maintenance of doors and windows have for the first time been met with the substrate – and coating combination of the present invention.

It should also be noted, that the assembly of the windows or doors according to the provisions of the invention may be significantly improved due to the fact that logistics may be arranged with less restrictions than previously required. This is due to the fact that the individual pultruded components are quite robust after they have been coated and may therefore be coated with powder coating at one location and transported to a

second location for assembly, whereby the damage to the components during transportation may be minimized when compared to e.g. the same components coated with a conventional wet coating.

In an embodiment of the invention the part of the frame or sash for a window or door facing the exterior environment in a final window or door assembly, when the window or door assembly is mounted in a building, comprises the coated surface of the one or more pultruded components.

According to the present invention powder coatings suitable for outdoor use can be achieved on fibre reinforced polyurethane pultruded parts for window- and door assemblies. Restrictions regarding the temperature stability of such pultruded substrates demand a powder coating that can be cured at temperatures not substantially above the glass transition temperature of the polyurethane resin. It has been found by the present inventors that a coating system comprising UV-curing polyester powder coatings and pultruded fibre reinforced polyurethane parts achieves surprisingly good weatherability of the resulting coated surface. By curing the powder coating with UV-radiation, the dimensional stability of the powder coated pultruded components is not compromised, and at the same time, durable coated surfaces are achieved that can withstand outdoor applications for a long time without coating failure. This may partly be due to the surprisingly excellent compatibility of the substrate polyurethane/fibre surface and the powder coating. The combination of the fibre reinforced polyurethane pultruded surface with a UV-curing polyester powder coating greatly enhances the durability of the resulting coated surface when exposed to outdoor conditions and compared to the pultruded surface alone. While the surface of the pultruded part will deteriorate rather quickly when e.g. exposed to sunlight, the same surface coated with the UV-curing polyester powder coating can withstand exposure to sunlight for many years. This is indeed surprising since it is a part of common general knowledge within the coating art that powder coatings curable with UV-radiation are primarily suitable for indoor use only in less demanding applications, especially when such coatings are applied to plastic substrates.

Therefore, the results obtained by the present inventors on a substrate of pultruded fibre reinforced polyurethane are unexpected for several reasons. Firstly, an excellent adhesion between the coating and the substrate is obtained, despite the UV-curing process and the somewhat inhomogeneous substrate surface.

Secondly, the excellent finish conferred to the pultruded fibre reinforced polyurethane part by the UV-curing powder coating allows for use of the finished part, where visual appearance is important.

Furthermore, it has been found by the present inventors that contrary to expectations, the surprisingly good resistance towards exterior climate includes a good retention of finish which is of particular importance on window- and door frames making up a considerable part of the looks of a building. While the surface of the pultruded part will deteriorate rather quickly when e.g. exposed to sunlight, the same surface coated with the UV-curing polyester powder coating can withstand e.g. exposure to sunlight for many years. Customer demands for high durability and low maintenance of door- and window frames may for the first time be met with the substrate – and coating combination of the present invention.

The components from the process of the present may, in advantageous embodiments, be subjected to exterior conditions. The surprisingly good performance of sash – or frame members mounted so that the UV powder coated surface is subjected to the exterior environment allows for window and door constructions that are light, having good insulating properties and preserving good appearance for prolonged periods.

In some embodiments of the present invention, different exterior and interior finishes are desirable. For example sashes or frames comprised of combinations of different materials are possible, e.g. tree for the interior side and pultruded polyurethane composite for the exterior side.

In an embodiment of the invention the sash for a window or for a door is completely formed by pultruded components having a coated surface.

In preferred embodiments of the invention, the complete sash is formed by components produced according to the process of the present invention. In this respect it is important

to note that the obtainable finish of the components is equally suited for the side of the sash facing the interior when the window or door is closed.

In an embodiment of the invention the frame for a window or for a door is completely formed by pultruded components having a coated surface.

In preferred embodiments of the invention, the complete frame is formed by components produced according to the process of the present invention. In this respect it is important to note that the obtainable finish of the components is equally suited for the side of the frame facing the interior of the building.

In an embodiment of the inventin the assembling of a frame or sash for a window or door is partly or fully performed before coating said one or more pultruded components with a powder coating comprising polyester resin and

curing the powder coating with UV-radiation to form a coated surface on the one or more pultruded components.

In advantageous embodiments of the invention the frame and/or sash for a window or door is partly or fully assembled before coating. In this way, damage of the coating due to steps in the assembly procedure may be completely avoided. Also, this procedure may save coating powder since excess profile cut away before assembly of the frame will not be coated. Furthermore, slight color variations due to coating process variations will not occur on the same frame, making such variations less critical. Furthermore the flexibility of the whole coating operation may be greatly improved, because no stock of different profiles in several colors is needed for later frame assembly, whereby logistics may be considerably simplified.

In an embodiment of the invention the polyurethane resin has a glass transition temperature in the range from 100 °C to 150 °C, preferably in the range from 110 °C to 135 °C.

The glass transition temperature, Tg, of the polyurethane resin indicates the temperature at which the resin starts softening and even flowing. This means that during the coating process, the temperature should not exceed Tg for prolonged periods. By using UV-

radiation to cure the coating, the process temperature in the coating process can be kept comparatively low, whereby the dimensional stability of the pultruded fibre reinforced polyurethane component is not compromised. It may be advantageous according to embodiments of the present to use a polyurethane resin with a Tg of about 110 °C, such as 115 °C or 120 °C, since these resins have a good impact resistance and flexibility. These resins are particularly suitable for use in the process of the present invention.

In an embodiment of the invention the one or more pultruded components comprises reinforcing fibres in an amount of between 70 and 90% by weight of the pultruded components, preferably between 75 and 85% by weight of the pultruded components.

The reinforcing fibres give the necessary strength to the pultruded component and in that respect it may be desirable to have relatively high fibre content in the pultruded component. If the fibre content gets too high, individual fibres or bundles of fibres may extend from the surface of the pultruded component. This will make it difficult to achieve a good finish of the applied powder coating. Surprisingly it has been found by the present inventors that it is possible to achieve good finish even with a relatively high amount of fibres in the pultruded component by using polyurethane resin and a UV-curing powder coating comprising polyester resin. High content of reinforcing fibres also may create problems in the pultrusion process, since the wetting of the fibres with polyurethane resin may become insufficient. Thereby, also the strength of the profile may be compromised.

In an embodiment of the invention the surface of the one or more pultruded components is cleaned before coating the pultruded components.
It may be necessary to remove dirt, grease, oils, mould release agents and the like from the pultruded component, to achieve superior and consisting coating results with respect to e.g. finish and/or adhesion. Any known cleaning process may be used. Examples of suitable processes include washing with water/detergent, sanding, corona- or plasma treatment, cleaning with carbon dioxide or even combinations of suitable cleaning processes. A preferred process is the abrasive blasting with corundum-containing minerals.

Preferably the surface energy of the pultruded component prior to powder coating should be above 35 J/m^2, whereby good wetting of the pultruded component by any optional primer and the powder coating may be achieved. A suitable surface energy e.g. 37 J/m^2 or higher may be achieved by various methods, including the abrasive blasting with corundum-containing minerals.

In an embodiment of the invention the coated surface of the pultruded components withstand QUV B weathering conditions according to the standard requirement of GSB AL 631, preferably the master requirement of GSB AL 631.

A preferred way to assess the weathering properties of the coated surface of pultruded components is the standardized weathering test described in GSB International, Edition 05/2011, *International Quality Regulations for the Coating of Aluminium Building Components*, GSB AL 631.

The requirements for powder coating materials are listed in Sect. 1.6.1 and the accelerated weathering QUV-B is described in sect. 9.22.1. Gloss measurements are described in sect. 9.21 and color measurements in sect. 9.20.

According to embodiments of the present invention, the coated pultruded component is complying with the standard requirement of GSB AL 631, corresponding to 300 hours of accelerated weathering (Cycle: 4 h Dewing at about 40 °C and 4 h of UVB-radiation (313 nm, 0.75 $(W/m^2)/nm$) at about 50 °C, at least 50% residual gloss).

In preferred embodiments of the present invention, the coated pultruded component is complying with the master requirement of GSB AL 631, corresponding to 600 hours of accelerated weathering, the weathering cycle being as described above.

In an embodiment of the invention the powder coating is applied on the pultruded component to a coating thickness of between 40 and 120 micrometer, preferably between 70 and 100 micrometer.

The coating thickness of the applied UV-curing polyester powder coating is important e.g. for the ability to mask imperfections on the fibre reinforced polyurethane composite substrate. Also, a thicker coating layer may be expected to be more resistant to wear. It has surprisingly been found that comparatively thick coating layers, such as 90

micrometers of coating or 110 micrometers of coating, can be fully cured using UV radiation, despite the fact that the coating comprises e.g. pigments that may absorb substantial amounts of the UV-energy supplied by a UV lamp, whereby less UV energy becomes available for the curing process. Contrary to expectations, a wide range of colors can be applied according to embodiments of the present invention, still obtaining excellent overall mechanical, chemical and visual properties.

In an embodiment of the invention wherein the powder coating after application on the pultruded component is melted in an oven comprising IR-heaters, the surface temperature of the coated pultruded component being kept at a temperature of between 80 and 120 °C, preferably between 90 and 110 °C, for 1 to 12 minutes, preferably for 3 to 10 minutes.

The powder coating may be melted prior to curing by heating means, such as a convection oven.

A preferred way of melting the powder coating after application on the pultruded component is by applying infrared radiation (IR). Thereby, only the surface of the pultruded component may be heated to melt the powder. This may reduce the energy needed in the melting process, because the bulk portion of the pultruded component does not need to achieve the temperature needed for melting the powder. Control of the surface temperature may be achieved by conventional temperature sensors, e.g. infrared thermometers or thermocouples, which may be connected to the power control of the heating means.

It may be advantageous to apply convection heat, e.g. from a gas-fired oven, to melt the powder on the pultruded component before curing the melted powder with UV-radiation.

It is also possible to combine IR-heating with convection heating.

In an embodiment of the invention the powder coating is cured irradiating the powder coating with UV-radiation from one or more UV-lamps for between 5 seconds and 4 minutes, preferably between 30 seconds and 3 minutes.

The UV-energy required to cure the powder coating may vary, depending on color, the unsaturated polyester resins used and the particular photoinitiator types, concentrations

in the powder coating and the UV-intensity emitted by the lamp or lamps. According to the present invention, it has been realized that a wide variety of colors and finishes can be UV-cured to obtain coatings on pultruded components having exterior durability suitable for frames and sashes for windows and/or doors.

In an embodiment of the invention the time from powder coating the one or more pultruded components until a cured powder coated surface on the pultruded component is achieved is less than 20 minutes, preferably less than 15 minutes, most preferably less than 10 minutes.

It has been found by the present inventors that the process time required to cure the UV-curing powder may be exceptionally low, without compromising the finish, durability and chemical/mechanical properties of the frame- or sash members and/or the complete sash and frame. Eventually, this short process time for the curing process among other things saves both floor area and energy, or allows for higher line-speeds, whereby the productivity is increased. Furthermore, the time span, during which the coated parts carry uncured powder coating and therefore are vulnerable to dust inclusions and the like, is exceptionally short. Unlike many thermal curing processes, the curing by UV radiation is essentially complete when the coated components leave the UV oven and thereby the full mechanical properties of the coated parts are achieved immediately after leaving the curing zone. Thermally curing coatings often require considerable extra time after leaving the thermal oven, before they are fully cured and can be handled accordingly.

The invention further relates to a frame member or a sash member for a window or door frame comprising one or more pultruded components comprising reinforcing fibres and polyurethane resin, said one or more pultruded components being coated with a powder coating comprising polyester resin,
said powder coating being cured with UV-radiation to form a coated surface on the one or more pultruded components.

According to preferred embodiments of the present invention, frame- and/or sash members for window- and door frames are obtained from polyurethane fibre reinforced components that are powder coated with an UV-curing polyester powder.

The reinforcement fibres are preferably glass fibres, but could also be selected from the group consisting of carbon fibres, aramide fibres, basalt and natural fibres.

The combination of polyurethane resin and glass fibres in the pultrusion process according to preferred embodiments of the present invention produces a particularly fine surface finish on the pultruded components, whereby a synergy with the powder coating process is obtained.

The reinforcing fibres will, according to preferred embodiments, substantially run along the longitudinal axis of the pultruded components. In certain cases, it may also be desirable to have reinforcing fibres extending in other directions at an angle with respect to the longitudinal axis.

In an embodiment of the invention the part of said frame- or sash member for a window or door, facing the exterior environment in a final window or door assembly, when the window or door assembly is mounted in a building, comprises the coated surface of the one or more pultruded components.

According to the present invention powder coatings suitable for outdoor use can be achieved on fibre reinforced polyurethane pultruded parts for window- and door assemblies. Restrictions regarding the temperature stability of such pultruded substrates demand a powder coating that can be cured at temperatures not substantially above the glass transition temperature of the polyurethane resin. It has been found by the present inventors that a coating system comprising UV-curing polyester powder coatings and pultruded fibre reinforced polyurethane parts achieves surprisingly good weatherability of the resulting coated surface. By curing the powder coating with UV-radiation, the dimensional stability of the powder coated pultruded components is not compromised, and, at the same time, durable coated surfaces are achieved that can withstand outdoor applications for a long time without coating failure. This may partly be due to the surprisingly excellent compatibility of the substrate polyurethane/fibre surface and the powder coating. The combination of the fibre reinforced polyurethane pultruded surface with a UV-curing polyester powder coating greatly enhances the durability of the resulting coated surface when exposed to outdoor conditions and compared to the pultruded surface alone. While the surface of the pultruded part will deteriorate rather quickly when e.g. exposed to sunlight, the same surface coated with the UV-curing

polyester powder coating can withstand exposure to sunlight for many years. This is indeed surprising since it is a part of common general knowledge within the coating art that powder coatings curable with UV-radiation are primarily suitable for indoor use only in less demanding applications, especially when such coatings are applied to plastic substrates.

Therefore, the results obtained by the present inventors on a substrate of pultruded fibre reinforced polyurethane are unexpected for several reasons. Firstly, an excellent adhesion between the coating and the substrate is obtained, despite the UV-curing process and the somewhat inhomogeneous substrate surface.

Secondly, the excellent finish conferred to the pultruded fibre reinforced polyurethane part by the UV-curing powder coating allows for use of the finished part, where visual appearance is important.

Furthermore, it has been found by the present inventors that contrary to expectations, the surprisingly good resistance towards exterior climate includes a good retention of finish which is of particular importance on window- and door frames making up a considerable part of the looks of a building. While the surface of the pultruded part will deteriorate rather quickly when e.g. exposed to sunlight, the same surface coated with the UV-curing polyester powder coating can withstand e.g. exposure to sunlight for many years. Customer demands for high durability and low maintenance of door- and window frames may for the first time be met with the substrate – and coating combination of the present invention.

The invention also relates to a frame or a sash for a window or door manufactured according to the process of claim 1.

The frame- or sash members are finally assembled to a window frame or door frame or a window sash or door sash. These frames have an increased thermal resistance compared to many other conventional window- or door construction materials, making these frames and sashes particularly useful in buildings were heating is required from time to time.

The invention further relates to the use of one or more pultruded components comprising reinforcing fibres and polyurethane resin,

said one or more pultruded components being coated with a powder coating comprising polyester resin,

said powder coating being cured with UV-radiation to form a coated surface on the one or more pultruded components,

for the manufacture of a frame or a sash for a window or door.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic representation of a pultrusion apparatus suitable for producing pultruded components.

Fig. 2 is a schematic representation of a sash and a frame for a window.

DESCRIPTION

Components or profiles obtained from the pultrusion process are currently used in a variety of applications such as engineering, aerospace and construction.

In particular the use of pultruded components for the manufacturing of doors and windows has attracted some attention recently due to the fact that composite materials may have good insulating properties and also poses the necessary mechanical strength.

Figure 1 schematically represents a pultrusion apparatus in accordance with an embodiment of the invention for manufacturing a profile. Here the fibre supply 1 is a magazine having a large number of fibre spools 7 (only 5 spools shown in the figure). From each of the fibre spools 7, a fibre material 8 runs off and extends through a number of pre-form plates 9.

Typically the fibre material is provided in a pre-defined form. Further, the pre-defined form in which the fibre material is provided typically depends on special properties/characteristics associated with the desired profile corresponding to an application area. Various examples of the pre-defined form include, but are not limited to, single fibres, tows, rovings and mats.

One or more pre-form plates 9 may be used to guide individual fibre bundles 8 between the fibre spools 7 and the injection box 4. These pre-form plates 9 typically comprise a number of holes corresponding to approximately the number of fibre spools 7 in use or less. With further pre-form plates 9, the holes in these are brought closer together as the fibres are approaching the injection box 4.

In an embodiment of the invention, one pre-form plate 9 may be mounted directly onto the injection box 4. This pre-form plate 9 may comprise at least one hole for guiding a number of fibre bundles or a number of holes for controlling individual fibre bundles.

Hereby the fibres 13 are brought into close proximity to each other and continue into the injection box 4 where they are being impregnated by the resin being supplied from a resin mixing chamber 15. Thereafter the impregnated fibres enter the guide plate 10,

further enter the replaceable inlet section 11 before entering the heated pultrusion die 5 for curing the resin.

After the curing process, a conventional pulling mechanism e.g. in the form of a roller 6a and a roller 6b is used to grip and pull a cured profile 14 out of the pultrusion die 5. The cured profile 14 is therefore a continuous pultruded profile with a selected shape, defined by the interior shape of the pultrusion die.

Thereafter, the cured profile 14 is advanced to a cutting station 17. At the cutting station 17, the continuously pultruded cured profile 14 is cut with a saw 18 at a pre-determined length to obtain the final profile 19.

As mentioned above, the resin is supplied to the injection box 4 through a mixing chamber 15. According to the present invention the resin is a polyurethane comprising at least two reactive resin components, e.g. polyols and isocyanates, being stored in separate containers 2a, 2b from which they are pumped by means of separate pumps 16a, 16b through optional separate heaters 3, and thereafter the two resin components are mixed in the mixing chamber 15 and introduced into the injection box 4.

The described pultrusion process using polyurethane resins provides profile surfaces that are very well suited for the coating with UV-curing polyester powder according to the process of the present invention.

The profiles obtainable may have a relatively simple form but can also have a more complicated cross section. In this context it is important to note that the term “surface” herein is to be understood in a straightforward way. For example, the surface of a pultruded component/profile is the outer boundary of that profile. UV powder coating of a pultruded component therefore normally implies that the whole circumference of the component is covered by coating. In the coating process it is always the goal to provide the pultruded component with a uniform coating thickness. Depending on the exact geometry of the part, some variations may occur across the surface, e.g. in recesses. Nevertheless, the coating process described herein is equally suitable for simple and complex shapes because of the electrostatic spray method used. This method provides an comparatively even distribution of powder on the part even on complex shapes.

It has surprisingly been realized that even complex powder coated shapes can be fully UV-cured. This may require carful design of the UV-oven and optimizations regarding the type of UV-source used. For pigmented coatings it may be beneficial to apply Ga-

doped mercury lamps, whereby the output from the lamp is shifted to longer wavelengths.

Although the preferred embodiments are coated on the whole surface of the pultruded component it may of course be anticipated that for certain reasons, specific parts of the surface are not coated or masked to achieve certain advantages, e.g. an exact geometry, not altered by the coating. Also, if the pultruded component is cut into shorter length after the coating process, the cut surface will not always be coated.

It should be understood that the part of the surface of the pultruded component facing the exterior environment must always be coated with the UV-curing polyester powder coating to withstand outdoor conditions for prolonged periods of time. In this context, exterior environment is to be understood as the conditions outside the building having mounted windows and/or doors made according to embodiments of the present invention.

It could also be appreciated within the scope of the present invention that the inside and outside of a frame or sash have different colours and/or finishes.

Figure 2 schematically shows a window frame connected to a window sash through hinges. The frame 1 and sash 2 in this case have four frame members 3 and four sash members 4 respectively. For simplicity, no details of the actual geometrical shape of the members are shown, but it may med appreciated by those skilled in the art that many geometric features may be incorporated into the pultruded components of the frame or sash.

The following examples further illustrate the claimed invention.

Example 1. Coating of pultruded profiles

Pultruded profiles were coated with UV-curing polyester powder.

The powder coating procedure was as follows:

A number of pultruded profiles comprising polyurethane resin having a glass transition temperature between 107 and 125 °C, and about 80% by weight reinforcing glass fibres, were blasted with corundum-containing mineral particles. The surface energy of the profiles was measured using a series of liquids having well defined and increasing surface tensions. The liquids are applied to a small area of the blasted profile and the

liquid with the highest surface tension still fully wetting the profile surface determines the surface energy of the profile.

The surface energies measured were always 35 J/m^2 or higher.

The profiles were cut into pieces of about 55 cm length for easy handling.

The cleaned surface was coated with a layer of conductive primer, about 20 µm in wet thickness. After drying the primer at about 20 °C for about 10 minutes, the polyester powder was electrostatically applied with conventional powder coating equipment to form a layer of about 70 – 100 µm. The powder applied to the profile surface was then melted at a temperature of about 110 °C in an oven providing both IR-heating and convection heating. The coated surface of the pultruded profile was kept at this temperature for about 8 to 15 minutes.

The surface temperature of the profiles were monitored using a thermocouple.

The coating was then cured with UV-radiation. The parts were irradiated for 1-3 minutes under a Ga-doped mercury lamp. The UV dosage could be adjusted by altering the conveyor speed under the lamp.

The UV intensity and UV dosage may be measured with a radiometer.

The adhesion of the UV-cured powder coating to the pultruded glass fibre reinforced polyurethane corresponded to 0 or 1 according to DIN EN ISO 2409.

Example 2. Weathering of coated profiles.

The profile samples from Example 1 were subjected to a QUV B (313 nm) test according to GSB AL 631 (Edition 05/2011).

Initially, the gloss is measured on the coated parts at a radiation angle of 60 °, as described in GSB Al 631.

This accelerated weathering test uses a UV-source with an emission of 0.75 $W/m^2/nm$ in the UV-B region to which suitable pieces of the coated profiles are subjected in a weathering chamber. The conditions in the chamber cycle between 4 h of dewing at 40 °C +/- 2 °C and 4 h of radiation at 50 °C +/- 2 °C.

At different hours of weathering as described, the gloss is measured at a radiation angle of 60 ° on the pieces of coated profile.

The result of weathering tests on representative profiles manufactured according to

Example are given in Tables 1 and 2:

High Gloss (77) RAL 9010

ASSAY HOURS	GLOSS (60°)	GLOSS RETENTION %	COLOUR (DE*)	COMMENTS
0	77.6	100	0	
143	74	95.36	1.32	
229	66.3	85.44	1.79	Light yellowing
301	65.7	84.66	1.1	
373	57.7	74.36	0.87	
490	59.7	76.93	1.38	
637	56.3	72.55	0.93	
703	55.9	72.04	0.97	

Table 1: Results from QUV B weathering test according to GSB AL 631 on profiles according to Example 1 for a high gloss white.

Granite 80

ASSAY HOURS	GLOSS (60°)	GLOSS RETENTION %	COLOUR (DE*)	COMMENTS
0	16.6	100	0	
143	19.7	118.67	0.29	
229	18.9	113.86	0.38	
301	16.8	101.20	0.2	
373	18.55	111.75	0.59	Softly lightened
490	16.8	101.20	0.74	Softly lightened
637	15.5	93.37	0.59	Softly lightened
703	14.95	90.06	0.815	Softly lightened

Table 2: Results from QUV B weathering test according to GSB AL 631 on profiles according to Example 1 for a structured dark color (Granite 80).

It may be seen from the tables that after 703 hours of testing, the gloss retention is well within the 50% demand of the test (72.04%, Table 1, and 90.06%, Table 2). It is also evident that the color is not altered too much since the total color deviation Delta E (DE*) is within the limit of less than 2 in both tables after 703 hours of testing.

It can be concluded that the Master requirement according to GSB AL 63 is fulfilled for both samples.

CLAIMS

1. Process for manufacturing a frame or a sash for a window or door comprising frame members and sash members, said process comprising the steps of:

a) providing one or more pultruded components comprising reinforcing fibres and polyurethane resin,

b) coating said one or more pultruded components with a powder coating comprising polyester resin,

c) curing the powder coating with UV-radiation to form a coated surface on the one or more pultruded components,

d) assembling a frame or a sash for a window or door, one or more of the frame members or sash members comprising one or more of the coated pultruded components.

2. Process according to claim 1,

wherein the part of the frame or sash for a window or door facing the exterior environment in a final window or door assembly, when the window or door assembly is mounted in a building, comprises the coated surface of the one or more pultruded components.

3. Process according to claim 1 or 2,

wherein the sash for a window or for a door is completely formed by pultruded components having a coated surface.

4. Process according to any of the claims 1 to 3,

wherein the frame for a window or for a door is completely formed by pultruded components having a coated surface.

5. Process according to any of the claims 1 to 4,

wherein the assembling of a frame or sash for a window or door is partly or fully performed before coating said one or more pultruded components with a powder coating comprising polyester resin and

curing the powder coating with UV-radiation to form a coated surface on the one or more pultruded components.

6. Process according to any of the claims 1 to 5,
wherein the polyurethane resin has a glass transition temperature in the range from 100 °C to 150 °C, preferably in the range from 110 °C to 135 °C.

7. Process according to any of the claims 1 to 6,
wherein the one or more pultruded components comprises reinforcing fibres in an amount of between 70 and 90% by weight of the pultruded components, preferably between 75 and 85% by weight of the pultruded components.

8. Process according to any of the claims 1 to 7,
wherein the surface of the one or more pultruded components is cleaned before coating the pultruded components.

9. Process according to any of the claims 1 to 8,
wherein the coated surface of the pultruded components withstand QUV B weathering conditions according to the standard requirement of GSB AL 631, preferably the master requirement of GSB AL 631.

10. Process according to any of the claims 1 to 9,
wherein the powder coating is applied on the pultruded component to a coating thickness of between 40 and 120 micrometer, preferably between 70 and 100 micrometer.

11. Process according to any of the claims 1 to 10,
wherein the powder coating after application on the pultruded component is melted in an oven comprising IR-heaters, the surface temperature of the coated pultruded component being kept at a temperature of between 80 and 120 °C, preferably between 90 and 110 °C, for 1 to 12 minutes, preferably for 3 to 10 minutes.

12. Process according to any of the claims 1 to 11,
wherein the powder coating is cured irradiating the powder coating with UV-radiation from one or more UV-lamps for between 5 seconds and 4 minutes, preferably between 30 seconds and 3 minutes.

13. Process according to any of the claims 1 to 12,
wherein the time from powder coating the one or more pultruded components until a cured powder coated surface on the pultruded component is achieved is less than 20 minutes, preferably less than 15 minutes, most preferably less than 10 minutes.

14. Frame member or sash member for a window or door frame comprising one or more pultruded components comprising reinforcing fibres and polyurethane resin,
said one or more pultruded components being coated with a powder coating comprising polyester resin,
said powder coating being cured with UV-radiation to form a coated surface on the one or more pultruded components.

15. Frame- or sash member according to claim 14,
wherein the part of said frame member or sash member for a window or door, facing the exterior environment in a final window or door assembly, when the window or door assembly is mounted in a building, comprises the coated surface of the one or more pultruded components.

16. Frame or sash for a window or door manufactured according to the process of claim 1.

17. Use of one or more pultruded components comprising reinforcing fibres and polyurethane resin,
said one or more pultruded components being coated with a powder coating comprising polyester resin,
said powder coating being cured with UV-radiation to form a coated surface on the one or more pultruded components,

for the manufacture of a frame or a sash for a window or door.

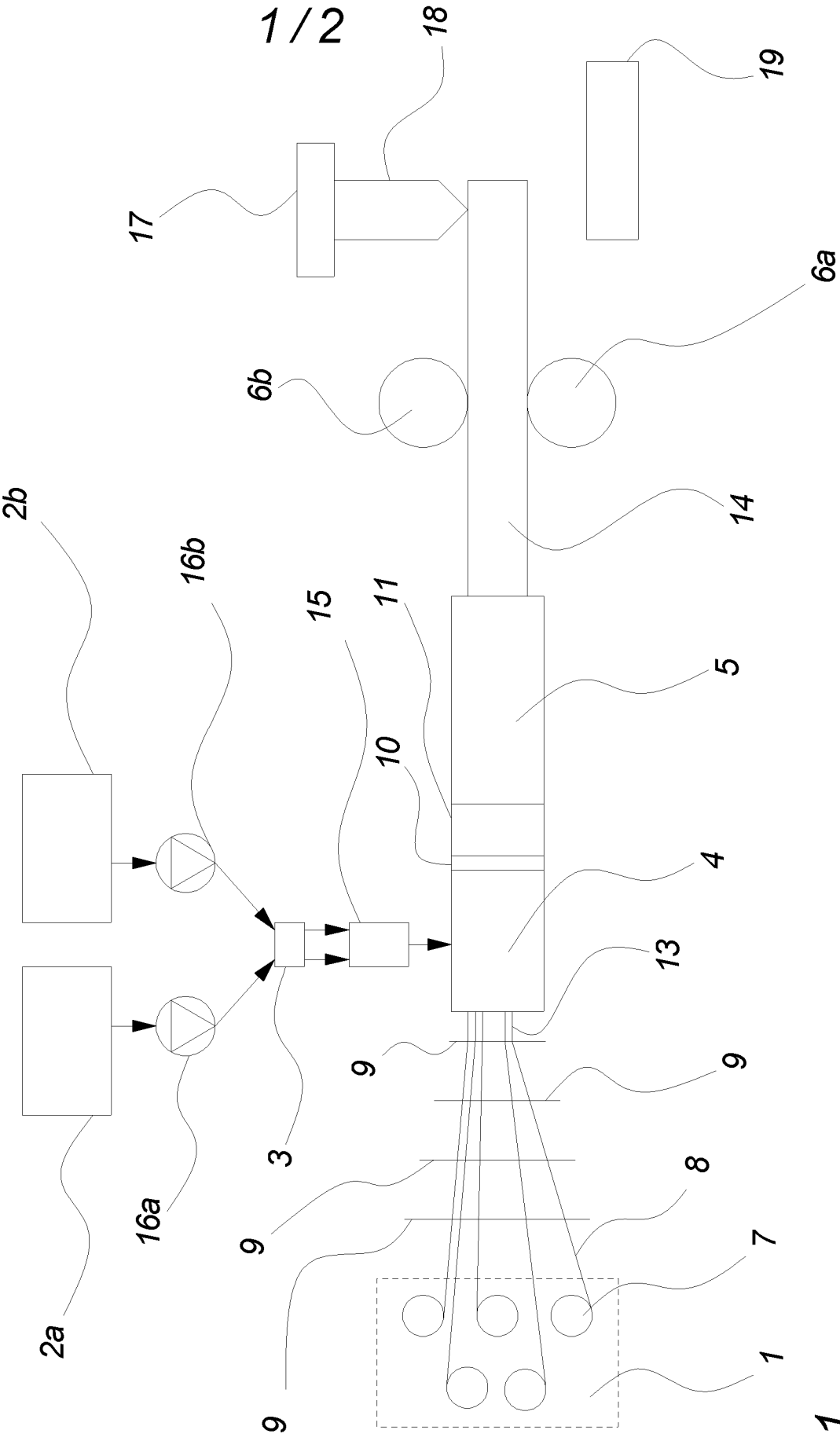

Fig. 1

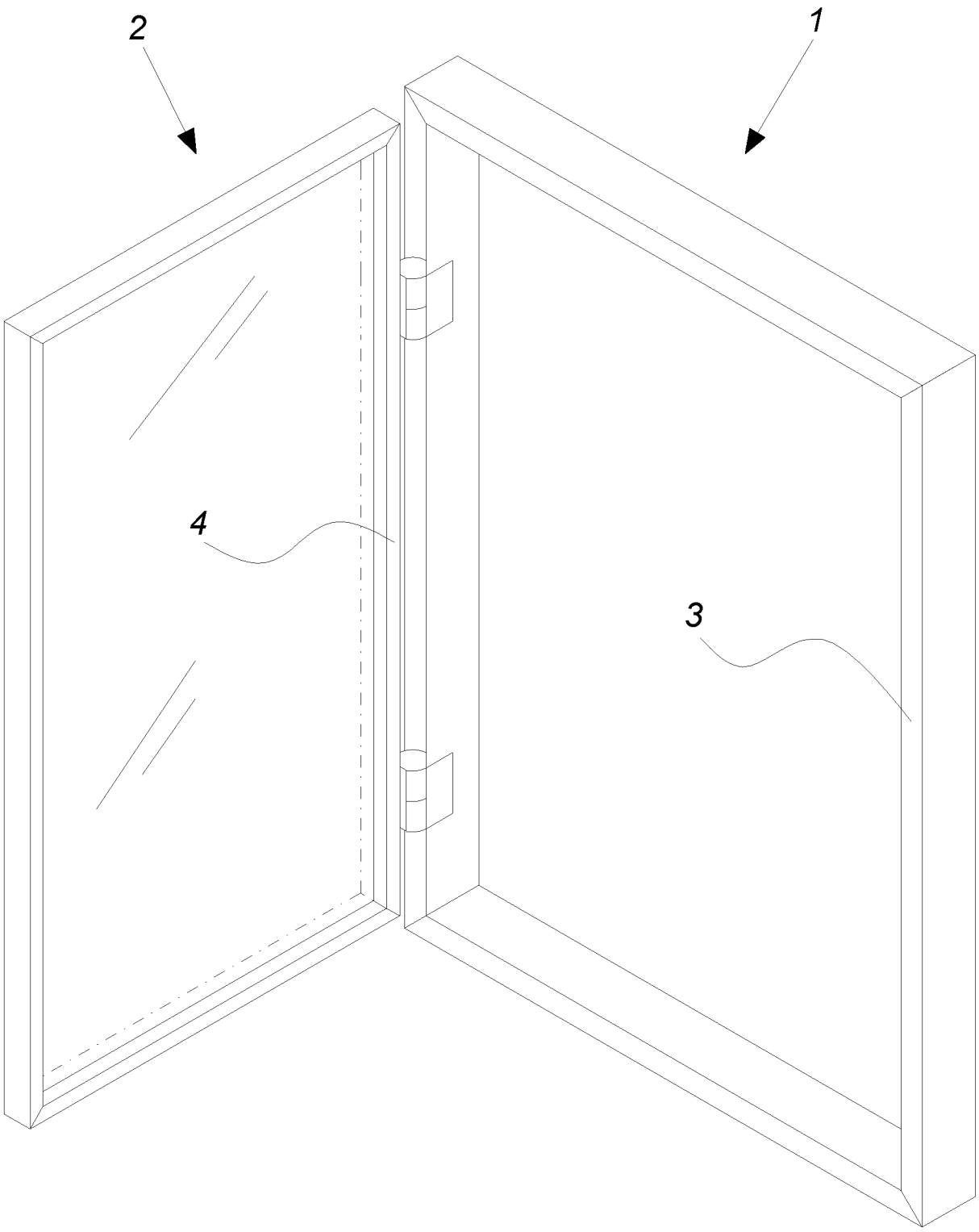

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/DK2013/050085

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C70/52 B29C39/00
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)
B29C B29L B29K C09D

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Michael Connolly, Dan Heberer: "Advances in Urethane Pultrusion", Composites 2012 , 21 February 2012 (2012-02-21), XP002700390, Retrieved from the Internet: URL:http://old.acmanet.org/meetings/2012_composites/tuesday/148-Connolly-Michael-.pdf [retrieved on 2013-07-09] pages 4-6	1-17
Y	US 2004/068027 A1 (DALY ANDREW T [US] ET AL) 8 April 2004 (2004-04-08) paragraphs [0054], [0058]	1

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[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
10 July 2013	30/07/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Van Wallene, Allard

INTERNATIONAL SEARCH REPORT

International application No
PCT/DK2013/050085

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/DK2013/050085

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