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(54) Title: FLUOROPOLYMER COMPOSITION COMPRISING CALCIUM OXIDE OR CALCIUM CARBONATE FOR THERMOFORMED WINDOW SHADES

(57) Abstract: The present invention pertains to a fluoropolymer composition (C) comprising a polymer (A) of ethylene and tetrafluoroethylene and/or chlorotrifluoroethylene, and a certain amount of specific acid scavenger (AS), optionally a colorant, and to the use thereof for the preparation of sheets for thermoformed or injection moulded window shades and other body panels for use in vehicles, e.g., airplanes, trains, buses or the like.



Description

FLUOROPOLYMER COMPOSITION COMPRISING CALCIUM OXIDE OR CALCIUM CARBONATE FOR THERMOFORMED WINDOW SHADES

Related applications

[0001] This application claims priority to U.S. provisional application No. 62/413,353 - filed October 26, 2016 and to European application No. 17153294.8 - filed January 26, 2017, the whole content of each of these applications being incorporated herein by reference for all purposes.

Technical Field

[0002] The present invention pertains to a fluoropolymer composition (C) comprising at least one polymer of ethylene and tetrafluoroethylene and/or chlorotrifluoroethylene, and a certain amount of specific acid scavenger (AS), optionally colorants. The present invention also relates to the use of the composition (C) for the preparation of sheets for thermoformed or injection molded window shades and other body panels. These articles or parts can be used in vehicles, e.g. airplanes, trains, buses or the like.

Background Art

[0003] Current window shades in commercial passenger vehicles, aircrafts in particular, are extremely complex thermoformed laminates of polyvinylfluoride (PVF) and polyaryletherketoneketone (PEKK).

[0004] **US5304413** (DU PONT DE NEMOURS) 19/4/1994 discloses laminar structures of PVF/PEKK which can be shaped into their final desired configuration, such as structures for aircraft interiors, and backfilled with a moulding resin.

[0005] However, said laminates suffer from high manufacturing costs, multiple process steps, low yields, and color shifts in processing from exposing the low temperature PVF to the processing temperature of PEKK.

[0006] As an alternative to PVF/PEKK laminates, thermoformable monolayer fluoromaterial sheets of appropriate thickness would be considered as suitable candidates for the preparation of window shades, eliminating the

need for adhesives and limiting the risks of colour shift during exposure to high temperature.

- [0007] ECTFE and ETFE have been extensively employed in several fields of use, thanks to their chemical resistance, wide continuous usage temperature range and thermal ageing resistance, good fire resistance with high limiting oxygen index, very low small molecules permeation, and excellent corrosion resistance.
- [0008] Nevertheless, exposure to harsh thermal conditions during processing in the molten state, such as during extrusion, or during thermoforming might lead to thermal decomposition of ECTFE and ETFE.
- [0009] It is generally understood that the mechanism of decomposition involves both radical generation and direct dehydrohalogenation, both of which might finally generate HF and also HCl in the case of ECTFE. As a whole, the result of thermal instability leads to poor processability, yellow to brownish color in the material and bubbles and gels in films and sheets.
- [0010] To address the thermal instability of ECTFE and ETFE, particularly when intended to be processed in the molten state, stabilizers are added to the materials before they are extruded and converted to films.
- [0011] Thus, **US 5328948** (AUSIMONT, USA, INC.) 7/12/1994 pertains to the stabilization of ethylene/chlorotrifluoroethylene copolymers using a combination of an effective amount of a ionomer, and of an antioxidant selected from notably phosphate derivatives. As ionomers, an ethylene-acrylic acid copolymer metal salt, notably commercially available from Allied-Signal as Aclyn® grade, or styrene/sulfonated styrene copolymer in its salified form were employed in preferred embodiments.
- [0012] **WO2014/187758** (SOLVAY SPECIALTY POLYMERS ITALY) 27/11/2014 discloses a stabilizer package comprising an antioxidant and a polyelectrolyte, preferably selected from the group consisting of poly(meth)acrylic acid metal or ammonium salts, which can improve the properties of ECTFE when melt processed at high temperatures.
- [0013] Nevertheless, the addition of acid scavengers to fluoropolymers can cause quality issues in the materials when melt processed at high temperatures

for preparing films of sheets, such as uneven distribution of the material, generation of holes, surface and texture imperfections.

[0014] Moreover, the materials to be used in vehicle interiors have to fulfil certain specific requirements in terms of flammability and smoke emissions when exposed to a flame.

[0015] There accordingly remains a continuing need in the art for materials useful in manufacture of articles that have a low release of gases on combustion and that have combustion products with low toxicity. In addition, it would be advantageous if manufacture of thermoformable articles is made efficient and economical.

Summary of invention

[0016] It is an object of the invention a fluoropolymer composition (C) comprising:

- at least one polymer (A) comprising recurring units derived from ethylene (E) and at least one of chlorotrifluoroethylene (CTFE) and tetrafluoroethylene (TFE) ;
- from 10 to 40 wt.%, based on the weight of polymer (A), of at least one acid scavenger (AS) selected from the group consisting of calcium carbonate and calcium oxide.

[0017] The fluoropolymer composition (C) of the present invention presents the ability to be processed into extruded thermoformable or injection molded articles having excellent surface properties and reduced smoke toxicity, which makes the composition (C) well-suited for window shades to be used in vehicles, for example aircrafts. The composition also presents an advantageous set of properties, including chemical, UV, mechanical and flammability resistance performances.

[0018] The combination of the polymer (A) and at least one acid scavenger (AS) allows obtaining sheets of high quality, in terms of thickness, homogeneity and texture.

[0019] The invention further pertains to a method of making a sheet (S) from the fluoropolymer composition (C) comprising a step of extruding the fluoropolymer composition (C) by means of an extruder.

[0020] Still another object of the present invention is a method for making a shaped article including using the sheet (S) made from a fluoropolymer composition (C), said method comprising thermoforming or injection moulding a sheet (S) made from the fluoropolymer composition (C).

Description of embodiments

[0021] Embodiments wherein polymer (A) essentially consists of recurring units (a), (b) and optionally (c), and preferably of recurring units (a) and (b), as above detailed, are generally preferred. End chain, defects and minor amounts of monomer impurities leading to recurring units different from those above mentioned (typically, <0.1 % moles, with respect to the total amount of recurring units) may be tolerated, without these substantially affecting the properties of polymer (A).

[0022] Polymer (A) of the fluoropolymer composition (C) of the invention comprises:

(a) recurring units derived from ethylene (E) in an amount ranging from 45 to 55 mol. %, preferably from 47 to 53 mol. %;

(b) recurring units derived from at least one of chlorotrifluoroethylene (CTFE), tetrafluoroethylene (TFE) or mixture thereof, in an amount ranging from 55 to 45 mol.%, preferably from 53 to 47 mol. %,

(c) optionally, recurring units derived from one or more fluorinated and/or hydrogenated comonomer(s), in an up to 3 mol.%, preferably up to 2 mol. %

the total amount of recurring units (a), (b) and (c) being equal to 100 mol.%, based on the total number of moles of recurring units of said polymer (A).

[0023] According to a preferred embodiment, the polymer (A) consists essentially in recurring units (a), (b) and optionally (c). According to a most preferred embodiment, the polymer (A) consist essentially in recurring units (a) and (b). End chain, defects and minor amounts of monomer impurities leading to recurring units different from those above mentioned (for example < 0.1 mol %, with respect to the total amount of recurring units) may be

tolerated, without these substantially affecting the properties of polymer (A).

- [0024] When the polymer (A) comprises recurring units (c), the comonomer is generally a hydrogenated comonomer selected from the group of the (meth)acrylic monomers. More preferably, the hydrogenated comonomer is selected from the group of the hydroxyalkylacrylate comonomers, such as hydroxyethylacrylate, hydroxypropylacrylate and (hydroxy)ethylhexylacrylate, and alkyl acrylate comonomers, such as n-butyl acrylate.
- [0025] According to an embodiment, the polymer (A) suitable in the fluoropolymer composition of the invention presents a melting temperature T_m greater than 220°C, preferably greater than 225°C, even greater than 230°C, preferably greater than 235°C. The melting temperature (T_m) of the polymer (A) can for example be determined by Differential Scanning Calorimetry (DSC) at a heating rate of 10°C/min, according to ASTM D 3418.
- [0026] According to an embodiment, the polymer (A) suitable in the fluoropolymer composition of the invention presents a heat of fusion of at least 35 J/g, preferably of at least 37 J/g, more preferably of at least 40 J/g, as determined by Differential Scanning Calorimetry (DSC) at a heating rate of 10°C/min, according to ASTM D 3418.
- [0027] According to another embodiment, the polymer (A) suitable in the fluoropolymer composition of the invention presents a heat of fusion of at most 55 J/g, preferably of at most 53 J/g, more preferably of at most 50 J/g, as determined by Differential Scanning Calorimetry (DSC) at a heating rate of 10°C/min, according to ASTM D 3418.
- [0028] According to another embodiment, the polymer (A) suitable in the fluoropolymer composition of the invention presents a melt flow rate ranging from 0.1 to 35 g/10 min, as measured according to ASTM D 3275-81 at 275°C and 2.16 Kg, .
- [0029] In a preferred embodiment, the melt flow rate of the polymer (A), as measured according to ASTM D 3275-08 at 275°C and 2.16 Kg, ranges from 15 to 27 g/10 min.

- [0030] In another preferred embodiment, the melt flow rate of the polymer (A), as measured according to ASTM D 3275-08 at 275°C and 2.16 Kg, ranges from 0.2 to 2 g/10 min.
- [0031] Among polymers (A), ECTFE copolymers, i.e. copolymers of ethylene and CTFE and optionally a third monomer (c) are preferred.
ECTFE copolymers which have been found to give particularly good results are those consisting essentially of:
- (a) recurring units derived from ethylene (E) in an amount of 47 to 53 mol. %;
 - (b) recurring units derived from chlorotrifluoroethylene (CTFE) in an amount of 53 to 47 mol. %, the amount of recurring units (a) and (b) being equal to 100 mol. %, based on the total number of moles of recurring units of the polymer (A).
- [0032] Polymer (A) may comprise additional optional ingredients, such as ionomers, polyelectrolytes and antioxidants, as for example the ones described in **WO 2014/187758** and **US 5328948**, incorporated herein by reference.
- [0033] The fluoropolymer composition (C) of the invention comprises at least one acid scavenger (AS) selected from the group consisting of calcium carbonate and calcium oxide.
- [0034] The acid scavenger (AS) is present in the fluoropolymer composition (C) in an amount of from 10 to 40 wt. %, preferably of from 11 to 25 wt. %, and more preferably 12 to 16 wt. %, based on the weight of polymer (A).
- [0035] The addition of calcium carbonate and/or calcium oxide to the polymer (A) in the amount as above detailed has the beneficial effect of providing compositions that can be converted by extrusion to high quality sheets, which have homogeneous structure and texture, having at most very few imperfections, which represents an important feature of this invention.
- [0036] According to one aspect of the present invention, the fluoropolymer composition (C) further comprises at least one colorant (COL).
- [0037] According to a preferred embodiment, the colorant (COL) is a white pigment, more preferably TiO₂.

- [0038] The amount of colorant (COL) in the fluoropolymer composition (C), based on the total weight of polymer (A), may be of from 2 to 20 wt. %, more preferably from 10 to 16 wt. %.
- [0039] TiO_2 may be mixed with any conventional colorant such as a pigment, dye or a dispersed dye to impart the required color to the fluoropolymer composition.
- [0040] The addition of a colorant (COL) to the fluoropolymer composition (C) present the technical effect of providing opacity, even at a low sheet thickness. In other words, no light is transmitted through the material when a colorant is used.
- [0041] In a preferred embodiment, the present invention relates to a fluoropolymer composition (C) comprising:
- at least one polymer (A) comprising recurring units derived from ethylene and at least one of chlorotrifluoroethylene (CTFE) and tetrafluoroethylene (TFE) ;
 - from 10 to 40 wt. %, based on the weight of polymer (A), of at least one acid scavenger (AS) selected from the group consisting of calcium carbonate and calcium oxide; and
 - at least one colorant (COL), preferably being a white pigment, more preferably being TiO_2 .
- [0042] The invention further pertains to a process for manufacturing the fluoropolymer composition (C) as above described, the process comprising mixing the at least one polymer (A), the at least one acid scavenger (AS) and optionally the at least one the colorant (COL).
- [0043] The composition of the invention is particularly suitable for manufacturing films, sheets or other finished articles.
- [0044] The fluoropolymer composition (C) according to the invention as above detailed can be processed by all the conventional techniques for the conversion in the molten state.
- [0045] The invention thus further pertains to a method of making a sheet (S) from the fluoropolymer composition (C) as above detailed, said method comprising processing the composition (C) in the molten state, preferably by extrusion.

- [0046] The sheet (S) made from the fluoropolymer composition (C) of the present invention is characterized by improved thermal stability and reduced production of gases generated by combustion, as measured according to BSS7239 (test method for toxic gas generation by materials on combustion). BSS7239 is a standard procedure established by Boeing for measuring the amount of gases generated in a specified, calibrated smoke chamber during standard rate of smoke generation testing (ASTM E 662), in both flaming combustion and non-flaming pyrolytic decomposition test modes. The amount of the following gases is measured in this procedure: CO (carbon monoxide), HF (hydrogen fluoride), HCl (hydrogen chloride), NO_x (nitrogen oxides - both NO, nitric oxide, and NO₂, nitrogen dioxide, are detected), SO₂ (sulfur dioxide) and HCN (hydrogen cyanide).
- [0047] Moreover, the sheet (S) obtained from a fluoropolymer composition (C) of the invention is characterized by an improved thermal stability, having a degradation temperature, measured by TGA (ASTM E1131-08) with a ramp of 20° C/min in N₂, which is higher than that of polymers (A) stabilized with different acid scavengers.
- [0048] The thickness of the sheet (S) obtained from a fluoropolymer composition (C) of the invention may range from 0.5 to 2.5 mm, preferably from 0.8 to 1.8 mm, more preferably from 1 to 1.5 mm.
- [0049] Still another object of the present invention is a method for making a shaped article including thermoforming or injection moulding the sheet (S) made from a fluoropolymer composition (C) according to the invention.
- [0050] It is generally noted that the term "thermoforming" is used to describe a method that comprises the sequential or simultaneous heating and forming of a material onto a mold, wherein the material is originally in the form of a sheet (e.g., film, layer, and the like) and is formed into a desired shape. Once the desired shape has been obtained, the formed article (e.g., window shade) is cooled below its glass transition temperature.
- [0051] The term "injection moulding" is defined as a conventional injection moulding process involving the rapid injection of a moldable material into a cavity formed by at least a pair of closed mold members.

- [0052] All the features described above for components polymer (A), acid scavenger (AS) and colorant (COL) of the fluoropolymer composition (C) are also applicable here as preferred embodiments of the sheet made from the fluoropolymer composition (C) and the article made from the sheet (S).
- [0053] It has been found that the article so obtained advantageously exhibits outstanding mechanical properties, while ensuring outstanding opacity, superior thermal stability and reduced smoke toxicity.
- [0054] The article of the invention is particularly suitable for use in various applications such as in window shades and other body panels for use in vehicles, e.g., airplanes, trains, buses or the like.
- [0055] Should the disclosure of any patents, patent applications, and publications which are incorporated herein by reference conflict with the description of the present application to the extent that it may render a term unclear, the present description shall take precedence.
- [0056] The invention will be now described with reference to the following examples, whose purpose is merely illustrative and not intended to limit scope of the invention.

[0057] **EXAMPLES**

[0058] **RAW MATERIALS**

Polymer (A1): HALAR® 500 LC, a ECTFE polymer, 50/50 molar ratio E/CTFE with melting temperature of 242 °C and heat of fusion of 42 J/g commercially available from Solvay Specialty Polymers

CaCO₃ (Calcium carbonate): Hubercarb® W3N available from J. M. Huber Corp

CaO (Calcium oxide), pulverized (BET surface area of 2.0 m²/g) available from Mississippi Lime Company

ZnO (Zinc oxide): Zoco 102 available from Zochem

CaSiO₃ (Wollastonite): Wollastonite Nyad 400 from Imerys.

NW-2200, Aluminium magnesium carbonate eptahydroxide (CH₇AlMgO). available from Kyowa Chemical Industry Co.

KenReact TTS/H, available from Kenrich Petrochemicals

TiO₂ Ti-Pure R-350 titanium dioxide available from Chemours

TiO₂ Ti-Pure R-105 titanium dioxide available from Chemours

[0059] GENERAL PROCEDURE FOR PREPARING COMPOSITIONS

Examples 1 and 2 and comparative examples C.1, C.2, C.3, C.4, C.5 and C.6 were prepared by melt blending the ingredients listed in Table 1 in a twin screw extruder. The barrel temperatures were about 250° C and screw speed was 250 rpm. Upon exiting the extruder, the molten compound was quenched in a water bath and pelletized.

Table 1

COMPOSITION	1	2	C. 1	C. 2	C. 3	C. 4	C. 5	C. 6
polymer (A1)	73	70	73	92	95	72.6	73	74
CaCO ₃	14							
CaO		15						
ZnO			14	8		1	1	8.5
CaSiO ₃						13		
NW-2200							13	4.5
KenReact TTS/H						0.4		
TiO ₂ R350	13	15			5	13	13	13
TiO ₂ R105			13					

Values are reported as percentages by weight (wt. %).

[0060] GENERAL PROCEDURE FOR PREPARING SHEETS

Films were prepared on a Brabender Intelli-torque 19 mm single screw extruder with a 100 mm ribbon die for appearance evaluations. Melt temperatures were in the range of 240 to 260 °C, screw speed was set at 50 rpm and puller roll speed adjusted from 40 to 60% in order to obtain a 50 micron thick film.

[0061] FILM PROPERTIES OF THE COMPOSITIONS

Compositions 1 and 2 and comparative compositions C.1 to C.6 were converted to films of 0.002 inch thickness (0.050 mm) by extrusion according to the method above detailed.

The quality of the films so obtained was evaluated visually in terms of color (white, off white, beige), of opacity (clear, opaque, translucent) and of presence of imperfections and rated 0 to 3, where 0 is bad overall quality and 3 is good overall quality).

The table 2 herein below summarizes the data obtained.

Table 2

COMPOSITION	SHEET QUALITY RATE
1	2
2	2
C.1	2
C.2	1
C.3	2
C.4	0
C.5	0
C.6	1

Sheets prepared from compositions according to the invention, as well as sheets containing ZnO as acid scavenger resulted in quite good quality extruded sheets, while the compositions including the ECTFE polymer and other acid scavengers did not meet the quality requirements.

[0062] SMOKE TOXICITY OF THE COMPOSITIONS

Compositions 1 and 2 and comparative compositions C.1 to C.3 were compression moulded into 1.0 mm plaques for smoke toxicity testing according to Boeing BSS7239 method, flaming mode.

The results in ppm are summarized in table 3 here below.

Table 3

COMPOSITION	1	2	C.1	C.2	C.3
HCN	<1	<1	<1	<1	<1

CO (1)	752	444	1017	490	474
CO (2)	657	479	647		451
NO/NO ₂	1	1	3	1	2
SO ₂	<1	<1	<1	<1	<1
HCl (1)	395	250	450	>500	>500
HCl (2)	400	275	450	>500	>500
HCl (3)	400	275	475		
HF (1)	60	49	243	201	17
HF (2)	59	48	240		49

The results demonstrate that the compositions comprising ECTFE polymer, titanium dioxide and calcium carbonate or calcium oxide have an overall emission of the toxic gases HCl and HF which is much lower than that of comparative compositions which include ZnO as acid scavenger, with or without TiO₂ (C.1 and C.2, respectively) or of comparative composition C.3 which includes only the ECTFE polymer and TiO₂.

[0063] DEGRADATION TEMPERATURE OF THE COMPOSITIONS

The thermal degradation temperatures of samples of compositions 1 and 2 and of the comparative compositions C.1 to C.3 were determined by a Thermogravimetric Analysis instrument (TGA).

Thermogravimetric analysis (TGA) is often used to determine thermal stability by means of weight-loss decomposition profiles as a function of temperature. This was carried out using a TA instruments TGA Q500, ramp: 10° C./min, max temp: 800° C, in nitrogen.

The results are summarized in table 4 here below.

Table 4

COMPOSITION	1	2	C.1	C.2	C.3
Degradation Temperature	417	421	399	399	382

The results demonstrate that the compositions according to the present invention have a higher degradation temperature in comparison with compositions including the acid scavenger ZnO or including only the

ECTFE polymer and TiO_2 .

Claims

- Claim 1. A fluoropolymer composition (C) comprising:
- at least one polymer (A) comprising recurring units derived from ethylene (E) and at least one of chlorotrifluoroethylene (CTFE) and tetrafluoroethylene (TFE) ;
 - from 10 to 40 wt. %, based on the weight of polymer (A), of at least one acid scavenger (AS) selected from the group consisting of calcium carbonate and calcium oxide.
- Claim 2. The fluoropolymer composition (C) of claim 1, wherein the polymer (A) comprise:
- (a) 45 to 55 mol.% of recurring units derived from of ethylene (E) , preferably from 47 to 53 mol. %;
 - (b) 45 to 55 mol.% of recurring units derived from at least one of chlorotrifluoroethylene (CTFE), tetrafluoroethylene (TFE) or mixture thereof, preferably from 53 to 47 mol. % ,
 - (c) 0 to 3 mol. % of recurring units derived from at least one fluorinated and/or hydrogenated monomer, preferably from 0 to 2 mol. %, the total amount of recurring units (a), (b) and (c) being equal to 100 mol. %, based on the total number of moles of recurring units of polymer (A).
- Claim 3. The fluoropolymer composition (C) of claim 2, wherein the polymer (A) comprises recurring units derived from (meth)acrylic monomers as recurring units (c).
- Claim 4. The fluoropolymer composition (C) of claim 2, wherein polymer (A) consists essentially in:
- (a) 47 to 53 mol. % of recurring units derived from ethylene (E);
 - (b) 53 to 47 mol. % of recurring units derived from chlorotrifluoroethylene (CTFE),
- the total amount of recurring units (a) and (b) being equal to 100 mol.%, based on the total number of moles of recurring units of said polymer (A).
- Claim 5. The fluoropolymer composition (C) of any one of the preceding claims, wherein the melting temperature of polymer (A), as measured by Differential Scanning Calorimetry (DSC) at a heating rate of 10°C/min, according to ASTM D 3418, is greater than 220°C, preferably greater than 225

°C, more preferably greater than 230°C, still more preferably greater than 235°C.

- Claim 6. The fluoropolymer composition (C) of any one of the preceding claims, wherein the heat of fusion of at least of polymer (A), as measured by Differential Scanning Calorimetry (DSC) at a heating rate of 10°C/min, according to ASTM D 3418, is greater than 35 J/g, preferably greater than 37 J/g, more preferably greater than 40 J/g.
- Claim 7. The fluoropolymer composition (C) of any one of the preceding claims, wherein the melt flow rate of the ECTFE polymer, as measured according to the procedure of ASTM 3275-81 at 230°C, ranges from 0.1 to 35 g/10 min, preferably from 15 to 27 g/10 min or of from 0.2 to 2 g/10 min.
- Claim 8. The fluoropolymer composition (C) of any one of the preceding claims, wherein the acid scavenger (AS) is present in the fluoropolymer composition (C) in an amount ranging from 11 to 25 wt.%, more preferably ranging from 12 to 16 wt.%, based on the weight of polymer (A).
- Claim 9. The fluoropolymer composition (C) of any one of the preceding claims further comprising at least one colorant (COL).
- Claim 10. The fluoropolymer composition (C) of claim 9, wherein the colorant (COL) is a white pigment, preferably TiO₂.
- Claim 11. The fluoropolymer composition (C) of anyone of claims 9 or 10, wherein the amount of colorant (COL) in the fluoropolymer composition (C), based on the total weight of polymer (A), ranges from 2 to 20 wt. %, preferably of from 10 to 16 wt.%.
- Claim 12. A method of making a sheet (S) from the fluoropolymer composition (C) of any one of claims 1-11, wherein the method comprises a step of extruding the fluoropolymer composition (C) by means of an extruder.
- Claim 13. A method for making a shaped article including thermoforming or injection moulding the sheet (S) of claim 12.
- Claim 14. A shaped article comprising a thermoformed or injection moulded sheet (S) of claim 13.
- Claim 15. The shaped article of claim 14 that is a window shade.
- Claim 16. A vehicle comprising the shaped article of claims 14 or 15.
- Claim 17. The vehicle of claim 16 wherein the vehicle is an airplane.

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/077343

A. CLASSIFICATION OF SUBJECT MATTER INV. C08J5/18 C08K3/22 C08K3/26 B60J1/20 B64C1/14 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) B60J C08J C08K B64C		
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, CHEM ABS Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 105 566 737 A (WUHU JIAHONG NEW MAT CO LTD) 11 May 2016 (2016-05-11) *"Embodiment" on page 5*	1-17
X	EP 1 674 503 A1 (FREUDENBERG CARL KG [DE]) 28 June 2006 (2006-06-28) examples 6a, 10a, 12a, 15a, 19a paragraph [0061] paragraph [0097] paragraph [0104]	1-17
A	WO 2016/128315 A1 (SOLVAY SPECIALTY POLYMERS IT [IT]) 18 August 2016 (2016-08-18) claims	1-17
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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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 Gerber, Myriam

INTERNATIONAL SEARCH REPORT

Information on patent family members

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