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(54) Title: LIGHT DIFFUSING ARTICLE

(57) Abstract: The invention relates to a light diffusing article comprising a composition comprising (A) a heterophasic propylene copolymer and (B) a particulate material, wherein the amount of the particulate material is from 0.01 to 1 wt% of the total composition, wherein the heterophasic propylene copolymer consists of (a) a propylene-based matrix, wherein the propylene-based matrix consists of a propylene homopolymer and/or a copolymer of propylene and ethylene or a-olefin consisting of at least 95 wt% of propylene and at most 5 wt% of a-olefin, based on the total weight of the propylene-based matrix and wherein the propylene-based matrix is present in an amount of 65 to 85 wt% based on the total heterophasic propylene copolymer and (b) a dispersed ethylene-a-olefin copolymer, wherein the amount of ethylene in the dispersed ethylene-a-olefin copolymer is at least 40 wt%, wherein the dispersed ethylene-a-olefin copolymer is present in an amount of 35 to 15 wt% based on the total heterophasic propylene copolymer and wherein the sum of the total amount of propylene-based matrix and total amount of the dispersed ethylene-a-olefin copolymer in the heterophasic propylene copolymer is 100 wt% of the heterophasic propylene copolymer, wherein a sheet having a thickness of 1 mm made of the composition has a degree of light dispersion  $DLD_T$  and a haze  $H_T$  and a sheet having a thickness of 1 mm made of the heterophasic propylene copolymer has a degree of light dispersion  $DLD_R$  and a haze  $H_R$ , wherein  $(H_T - H_R)/H_R$  is at most 2% and  $(DLD_T - DLD_R)/DLD_R$  is at least 10%, preferably at least 100%, more preferably at least 400%.



## LIGHT DIFFUSING ARTICLE

The present invention relates to a light diffusing article and a lighting device comprising  
5 such light diffusing article.

Materials prepared by dispersing an organic or inorganic light diffusing agent in a  
transparent resin have been widely used in application fields in which light diffusion  
property is required. The application fields include lighting covers, displays, car meters  
10 and face plates. Typical transparent resins are aromatic polycarbonate resin, acrylic  
resin and styrene resin. Among these transparent resins, aromatic polycarbonate  
resins are widely used as they have good mechanical properties, heat resistance and  
weatherability and high light transmittance. For example, EP2829574 discloses a light-  
diffusing resin composition comprising a polycarbonate.

15 It is known to use organic particles having a crosslinked structure as a light diffusing  
agent, and examples thereof include crosslinked acrylic particles, crosslinked silicone-  
based particles and crosslinked styrene-based particles. Further, inorganic particles  
such as calcium carbonate, barium sulfate, aluminum hydroxide, silicon dioxide,  
20 titanium oxide and calcium fluoride, and inorganic fibers such as glass short fibers are  
also used.

Use of polypropylene for making a light diffusion plate is also known. For example,  
WO2010074312 discloses a light diffusion plate comprising a polypropylene resin and  
25 a hindered amine light stabilizer having a specific chemical structure. WO2010074312  
mentions that the light diffusion plate preferably further comprises light diffusing  
particles and/or a nucleating agent. The nucleating agent is sorbitol-based nucleating  
agents, organic phosphate-based nucleating agents, nucleating agents of metal salts of  
carboxylic acid and rosin-based nucleating agents.

30 It is desirable for light diffusing sheets and tubes to have good optical properties as well  
as good mechanical properties such as impact strength especially when they are used  
in outdoor lighting applications.

There is a need in the industry for a light diffusing article which has a high diffusing property and a high light transmittance and has good mechanical properties. Further, it is desirable that the manufacturing of the light diffusing article is simple.

- 5 It is an objective of the present invention to solve the above-mentioned and/or other needs.

Accordingly, the invention provides a light diffusing article comprising a composition comprising (A) a heterophasic propylene copolymer and (B) a particulate material,  
10 wherein the amount of the particulate material is from 0.01 to 1 wt% of the total composition,  
wherein the heterophasic propylene copolymer consists of  
(a) a propylene-based matrix,  
wherein the propylene-based matrix consists of a propylene homopolymer and/or a  
15 copolymer of propylene and ethylene or  $\alpha$ -olefin consisting of at least 95 wt% of propylene and at most 5 wt% of  $\alpha$ -olefin, based on the total weight of the propylene-based matrix and  
wherein the propylene-based matrix is present in an amount of 65 to 85 wt% based on the total heterophasic propylene copolymer and  
20 (b) a dispersed ethylene- $\alpha$ -olefin copolymer,  
wherein the amount of ethylene in the dispersed ethylene- $\alpha$ -olefin copolymer is at least 40 wt%,  
wherein the dispersed ethylene- $\alpha$ -olefin copolymer is present in an amount of 35 to 15 wt% based on the total heterophasic propylene copolymer and  
25 wherein the sum of the total amount of propylene-based matrix and total amount of the dispersed ethylene- $\alpha$ -olefin copolymer in the heterophasic propylene copolymer is 100 wt% of the heterophasic propylene copolymer,  
wherein a sheet having a thickness of 1 mm made of the composition has a degree of light dispersion  $DLD_T$  and a haze  $H_T$  and  
30 a sheet having a thickness of 1 mm made of the heterophasic propylene copolymer has a degree of light dispersion  $DLD_R$  and a haze  $H_R$ ,  
wherein  $(H_T - H_R)/H_R$  is at most 2%, preferably at most 1%, and  $(DLD_T - DLD_R)/DLD_R$  is at least 10%, preferably at least 100%, more preferably at least 400% .

- 35 It was surprisingly found that a light diffusing article can be produced from a composition comprising a heterophasic propylene copolymer with a large increase in the degree of light dispersion without a large change in the haze by the addition of a

particulate material. The light diffusing article also has good mechanical properties such as flexural modulus.

It is noted that US2003/0175499 discloses a method for imparting a translucent optical  
5 effect to transparent thermoplastic polymers by addition of a particulate, light diffusing material having an average maximum particle size of 0.1 microns to 200 microns. US2003/0175499 does not disclose a heterophasic propylene copolymer. US2003/0175499 mentions that the resulting translucent polymer products comprising 0.01 to 15 parts by weight of the particulate material exhibit a haze that is about 900%  
10 to about 11,400% higher than the haze of a polymer part comprising the polymer alone. The light diffusing article according to the invention shows little difference in the haze compared to the composition without the particulate material.

#### Light diffusing article

15 The light diffusing article according to the invention has a small thickness for transmitting the light from the light source, as generally understood in the art. The light diffusing article according to the invention may have any shape, but typical examples include a light diffusing sheet, a light diffusing tube and a light diffusing lightbulb.

20 Typically, the thickness of article is 0.2 to 10 mm, for example 0.2 to 5 mm, 0.5 to 5 mm or 0.8 to 3 mm.

The term 'sheet' is herein understood to mean an article having a small thickness and extending in two dimensions perpendicular to the thickness direction. When the  
25 thickness of the sheet is small, e.g. smaller than 0.25 mm, the sheet may also be called a film.

The term 'tube' is herein understood to mean an article having a shape of a hollow cylinder, having a small thickness perpendicular to the axis direction.

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The term 'lightbulb' is generally understood in the art, i.e. a housing of a light source such as an LED lamp.

#### Properties

35 In the context of the present invention, the light diffusion property is represented by a degree of light dispersion (DLD), wherein the DLD is defined as the receiving angle that obtains a luminous intensity which equals to the half of a luminous intensity of the

vertically transmitted light. The luminous intensity may be measured by a goniophotometer, for example GP200 in transmission mode.

In the context of the present invention, the light transmittance and the haze are  
5 measured according to ASTM D1003.

In the context of the present invention, the flexural modulus is measured according to ISO 178 (test geometry: 3.2 mm thickness according to ISO37/2, parallel orientation.

10 According to the invention, a sheet having a thickness of 1 mm made of the composition has a degree of light dispersion  $DLD_T$  and a haze  $H_T$  and a sheet having a thickness of 1 mm made of the heterophasic propylene copolymer has a degree of light dispersion  $DLD_R$  and a haze  $H_R$ .

15  $(H_T - H_R)/H_R$  is at most 2%, preferably at most 1%, more preferably at most 0.5%. The difference in the haze between a sheet made of the composition and a sheet made of the heterophasic propylene copolymer is very small.

Preferably,  $H_T - H_R$  is at most 1%, preferably at most 0.5%.  $H_T$  may e.g. be 80-99%,  
20 preferably 90-99%.  $H_R$  may e.g. be 79-98%, preferably 89-98%, more preferably 90-98%.

$(DLD_T - DLD_R)/DLD_R$  is at least 10%, preferably at least 100%, more preferably at least 400%. Preferably,  $DLD_T - DLD_R$  is at least 4, preferably at least 5, more preferably at  
25 least 8, more preferably at least 10. Preferably,  $DLD_T$  is at least 8, more preferably at least 10, more preferably at least 15, more preferably at least 20, more preferably at least 30, more preferably at least 35. The difference in DLD between a sheet made of the composition and a sheet made of the heterophasic propylene copolymer is large.

30 Preferably, the polypropylene composition in the light diffusion article according to the invention has a melt flow index of at least 0.1 dg/min, at least 0.2 dg/min, at least 0.3 dg/min, at least 0.5 dg/min, at least 1 dg/min at least 1.5 dg/min, at least 5 dg/min or at least 10 dg/min, and/or for example at most 100 dg/min, at most 50 dg/min, at most 40 dg/min, at most 30 dg/min, at most 25 dg/min, at most 20 dg/min or at most 10 dg/min,  
35 measured according to ISO1133 (2.16 kg/230°C).

In some embodiments, the MFI of the heterophasic propylene copolymer may be in the range of 15 to 100 dg/min, measured according to ISO1133 (2.16 kg/230 °C). In some embodiments, the composition has a melt flow index of 15 to 100 dg/min as determined according to ISO1133 at 230 °C and 2.16 kg and  $DLD_T$  is at least 35.

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In some embodiments, the MFI of the heterophasic propylene copolymer may be in the range of 1 to 10 dg/min, measured according to ISO1133 (2.16 kg/230 °C). In some embodiments, the composition has a melt flow index of 1 to 10 dg/min as determined according to ISO1133 at 230 °C and 2.16 kg and  $DLD_T$  is at least 5.

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Preferably, the composition according to the invention has a flexural modulus measured according to ISO 178 (test geometry: 3.2 mm thickness according to ISO37/2, parallel orientation) of at least 1180 N/mm<sup>2</sup>.

#### 15 (A) Heterophasic propylene copolymer

Heterophasic propylene copolymers are generally prepared in one or more reactors, by polymerization of propylene in the presence of a catalyst and subsequent polymerization of a propylene- $\alpha$ -olefin mixture. The resulting polymeric materials are heterophasic, but the specific morphology usually depends on the preparation method and monomer ratios used.

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The heterophasic propylene copolymers employed in the process according to present invention can be produced using any conventional technique known to the skilled person, for example multistage process polymerization, such as bulk polymerization, gas phase polymerization, slurry polymerization, solution polymerization or any combinations thereof. Any conventional catalyst systems, for example, Ziegler-Natta or metallocene may be used. Such techniques and catalysts are described, for example, in WO06/010414; *Polypropylene and other Polyolefins*, by Ser van der Ven, Studies in Polymer Science 7, Elsevier 1990; WO06/010414, US4399054 and US4472524.

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30 Preferably, the heterophasic propylene copolymer is made using Ziegler-Natta catalyst.

The heterophasic propylene copolymer may be prepared by a process comprising

- polymerizing propylene and optionally  $\alpha$ -olefin in the presence of a catalyst system to obtain the propylene-based matrix and
- 35 - subsequently polymerizing ethylene and  $\alpha$ -olefin in the propylene-based matrix in the presence of a catalyst system to obtain the dispersed ethylene- $\alpha$  olefin copolymer.

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These steps are preferably performed in different reactors. The catalyst systems for the first step and for the second step may be different or same.

5 The heterophasic propylene copolymer of the composition of the invention consists of a propylene-based matrix and a dispersed ethylene- $\alpha$ -olefin copolymer. The propylene-based matrix typically forms the continuous phase in the heterophasic propylene copolymer. The amounts of the propylene-based matrix and the dispersed ethylene- $\alpha$ -olefin copolymer may be determined by  $^{13}\text{C}$ -NMR, as well known in the art.

10 The propylene-based matrix consists of a propylene homopolymer and/or a propylene- $\alpha$ -olefin copolymer consisting of at least 95 wt% of propylene and up to 5 wt% of  $\alpha$ -olefin, for example ethylene, based on the total weight of the propylene-based matrix.

15 Preferably, the  $\alpha$ -olefin in the propylene-  $\alpha$ -olefin copolymer is selected from the group of  $\alpha$ -olefins having 2 or 4 to 10 carbon atoms, for example ethylene, 1-butene, 1-pentene, 4-methyl-1-pentene, 1-hexen, 1-heptene or 1-octene, and is preferably ethylene.

20 Preferably, the propylene-based matrix consists of a propylene homopolymer. The fact that the propylene-based matrix consists of a propylene homopolymer is advantageous in that a higher stiffness is obtained compared to the case where the propylene-based matrix is a propylene- $\alpha$ -olefin copolymer.

25 The melt flow index (MFI) of the propylene-based matrix (before the heterophasic propylene copolymer is mixed into the composition of the invention),  $\text{MFI}_{\text{PP}}$ , may be for example at least 0.1 dg/min, at least 0.2 dg/min, at least 0.3 dg/min, at least 0.5 dg/min, at least 1 dg/min, at least 1.5 dg/min, and/or for example at most 50 dg/min, at most 40 dg/min, at most 30 dg/min, at most 25 dg/min, at most 20 dg/min, measured according to ISO1133 (2.16 kg/230 °C). The  $\text{MFI}_{\text{PP}}$  may be in the range of for example  
30 0.1 to 50 dg/min, for example from 0.2 to 40 dg/min, for example 0.3 to 30 dg/min, for example 0.5 to 25 dg/min, for example from 1 to 20 dg/min, for example from 1.5 to 10 dg/min, measured according to ISO1133 (2.16 kg/230 °C).

35 The propylene-based matrix is present in an amount of 65 to 85 wt%. Preferably, the propylene-based matrix is present in an amount of at least 70 wt% and/or at most 80 wt% or at most 78 wt%, based on the total heterophasic propylene copolymer.

The propylene-based matrix is preferably semi-crystalline, that is it is not 100% amorphous, nor is it 100% crystalline. For example, the propylene-based matrix is at least 40% crystalline, for example at least 50%, for example at least 60% crystalline and/or for example at most 80% crystalline, for example at most 70% crystalline. For example, the propylene-based matrix has a crystallinity of 60 to 70%. For purpose of the invention, the degree of crystallinity of the propylene-based matrix is measured using differential scanning calorimetry (DSC) according to ISO11357-1 and ISO11357-3 of 1997, using a scan rate of 10 °C/min, a sample of 5mg and the second heating curve using as a theoretical standard for a 100% crystalline material 207.1 J/g.

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Besides the propylene-based matrix, the heterophasic propylene copolymer also comprises a dispersed ethylene- $\alpha$ -olefin copolymer. The dispersed ethylene- $\alpha$ -olefin copolymer is also referred to herein as the 'dispersed phase'. The dispersed phase is embedded in the heterophasic propylene copolymer in a discontinuous form. The particle size of the dispersed phase is typically in the range of 0.05 to 2.0 microns, as may be determined by transmission electron microscopy (TEM). The amount of the dispersed ethylene- $\alpha$ -olefin copolymer in the heterophasic propylene copolymer may herein be sometimes referred as RC.

The amount of ethylene in the ethylene- $\alpha$ -olefin copolymer is at least 40 wt%, for example at least 45 wt% or at least 50 wt%, and/or at most 60 wt% or at most 55 wt%. The amount of ethylene in the dispersed ethylene- $\alpha$ -olefin copolymer in the heterophasic propylene copolymer may herein be sometimes referred as RCC2.

The  $\alpha$ -olefin in the ethylene- $\alpha$ -olefin copolymer is preferably chosen from the group of  $\alpha$ -olefins having 3 to 8 carbon atoms. Examples of suitable  $\alpha$ -olefins having 3 to 8 carbon atoms include but are not limited to propylene, 1-butene, 1-pentene, 4-methyl-1-pentene, 1-hexen, 1-heptene and 1-octene. More preferably, the  $\alpha$ -olefin in the ethylene- $\alpha$ -olefin copolymer is chosen from the group of  $\alpha$ -olefins having 3 to 4 carbon atoms and any mixture thereof, more preferably the  $\alpha$ -olefin is propylene, in which case the ethylene- $\alpha$ -olefin copolymer is ethylene-propylene copolymer.

The MFI of the dispersed ethylene  $\alpha$ -olefin copolymer (before the heterophasic propylene copolymer is mixed into the composition of the invention),  $MFI_{EPR}$ , may be for example at least 0.001 dg/min, at least 0.01 dg/min, at least 0.1 dg/min, at least 0.3 dg/min, at least 0.7 dg/min, at least 1 dg/min, and/or for example at most 30 dg/min, at most 20 dg/min, at most 15 dg/min at most 10 dg/min, at most 5 dg/min or at most 3

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dg/min. The  $MFI_{EPR}$  may be in the range for example from 0.001 to 30 dg/min, for example from 0.01 to 20 dg/min, for example 0.1 to 15 dg/min, for example 0.3 to 10 dg/min, for example from 0.7 to 5 dg/min, for example from 1 to 3 dg/min.  $MFI_{EPR}$  is calculated taking into account the MFI of the propylene-based matrix ( $MFI_{PP}$ ) measured according to ISO1133 (2.16 kg/230 °C), the MFI of the heterophasic propylene copolymer ( $MFI_{heterophasic}$ ) measured according to ISO1133 (2.16 kg/230 °C) and the amount of the propylene-based matrix in the heterophasic propylene copolymer (matrix content) and the amount of the dispersed phase in the heterophasic propylene copolymer (rubber content (RC)) according to the following formula:

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$$MFI_{EPR} = 10^{\left(\frac{\text{Log } MFI_{heterophasic} - \text{matrix content} * \text{Log } MFI_{PP}}{\text{rubber content}}\right)}$$

The dispersed ethylene- $\alpha$ -olefin copolymer is present in an amount of 35 to 15 wt%. Preferably, the dispersed ethylene- $\alpha$ -olefin copolymer is present in an amount of at least 20 wt% and/or at most 30 wt% based on the total heterophasic propylene copolymer.

In the heterophasic propylene copolymer in the composition of the invention, the sum of the total weight of the propylene-based matrix and the total weight of the dispersed ethylene- $\alpha$ -olefin copolymer is 100 wt% of the heterophasic propylene copolymer.

Preferably, the heterophasic propylene copolymer has a fraction soluble in p-xylene at 25 °C (CXS) measured according to ISO 16152:2005 of 35 to 20 wt%. More preferably, the heterophasic propylene copolymer has CXS of at least 22 wt% and/or at most 30 wt%.

Preferably, the amount of ethylene in the heterophasic propylene copolymer (sometimes referred as TC2) is in the range of 15 to 35 wt% based on the heterophasic propylene copolymer.

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The MFI of the heterophasic propylene copolymer may be for example at least 0.1 dg/min, at least 0.2 dg/min, at least 0.3 dg/min, at least 0.5 dg/min, at least 1 dg/min at least 1.5 dg/min, at least 5 dg/min or at least 10 dg/min, and/or for example at most 100 dg/min, at most 50 dg/min, at most 40 dg/min, at most 30 dg/min, at most 25 dg/min, at most 20 dg/min or at most 10 dg/min, measured according to ISO1133 (2.16

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kg/230 °C). The MFI of the heterophasic propylene copolymer may be in the range of for example 0.1 to 50 dg/min, for example from 0.2 to 40 dg/min, for example 0.3 to 30 dg/min, for example 0.5 to 25 dg/min, for example from 1 to 20 dg/min, for example from 1.5 to 10 dg/min, measured according to ISO1133 (2.16 kg/230 °C). In some  
5 embodiments, the MFI of the heterophasic propylene copolymer may be in the range of 10-100 dg/min, measured according to ISO1133 (2.16 kg/230 °C). Such a range of MFI is suitable for injection moulding.

The values of the MFI of the propylene-based matrix (MFI<sub>PP</sub>) and the MFI of the  
10 dispersed ethylene- $\alpha$ -olefin elastomer (MFI<sub>EPR</sub>) mentioned herein are understood as the values before the heterophasic propylene copolymer is mixed with component (B) and optional component(s) to obtain the composition according to the invention. The value of the MFI of the heterophasic propylene copolymer (MFI heterophasic) refers to the final MFI of the heterophasic propylene copolymer. To exemplify this:

15 In case the heterophasic propylene copolymer is not subjected to vis-breaking or shifting by melt-mixing with a peroxide, the MFI heterophasic is the original MFI value of the heterophasic propylene copolymer. In case the heterophasic propylene copolymer is subjected to vis-breaking or shifting by melt-mixing with a peroxide, the MFI heterophasic is the value of the heterophasic propylene copolymer after such vis-  
20 breaking or shifting.

Preferably, in the heterophasic propylene copolymer according to the invention, the  $\alpha$ -olefin in the propylene-  $\alpha$ -olefin copolymer is selected from the group of  $\alpha$ -olefins having 2 or 4 to 10 carbon atoms and  
25 the  $\alpha$ -olefin in the ethylene- $\alpha$ -olefin copolymer is selected from the group of  $\alpha$ -olefins having 3 to 8 carbon atoms.

#### (B) particulate material

The particulate material may be in the form of, for example, powders, flakes, platelets,  
30 fibers, whiskers, aggregates, agglomerates and mixtures of these.

Preferably, the particulate material is talc.

Talc is a relatively abundant, inexpensive, highly hydrophobic and generally unreactive mineral. It can be categorized as a hydrated magnesium silicate and its main  
35 components can be represented by, inter alia, one or more of the formulas (Si<sub>2</sub>O<sub>5</sub>)<sub>2</sub>Mg<sub>3</sub>(OH)<sub>2</sub>, Si<sub>8</sub>Mg<sub>6</sub>O<sub>20</sub>(OH)<sub>4</sub> or Mg<sub>12</sub>Si<sub>16</sub>O<sub>40</sub>(OH)<sub>8</sub>.

Preferably, the particulate material is an untreated talc having an average particle diameter  $d_{50}$  of 0.5 to 5  $\mu\text{m}$ . An untreated talc is herein understood to mean that the talc is not coated by a surface modifier, such as silanes, amines, glycols, stearates, sorbates and titanates. A treated talc as opposed to an untreated talc is also commonly referred as surface-modified talc, surface-treated talc or surface coated talc.

Exemplary suitable particles for use in the invention are talc commercially available from Hansheng and AH5000. An example of the talc from Hansheng has  $d_{50}$  of 2.75  $\mu\text{m}$ . AH5000 has  $d_{50}$  of 1.1  $\mu\text{m}$ .

The amount of the particulate material is from 0.01 to 1 wt% of the total composition, for example 0.05 to 0.5 wt%.

#### Additives

The composition according to the invention may optionally comprise at least one further component such as additives. The amount of the optional component is typically 0 to 30 wt% of the total of the composition.

It will be appreciated that the optional components are used to the extent that they do not interfere with obtaining the desired properties of the light diffusion article.

The additives may include stabilisers, e.g. heat stabilisers, anti-oxidants, UV stabilizers; colorants, like pigments and dyes; clarifiers; surface tension modifiers; lubricants; flame-retardants; mould-release agents; flow improving agents; plasticizers; anti-static agents; external elastomeric impact modifiers; blowing agents; inorganic fillers and reinforcing agents; and/or components that enhance interfacial bonding between polymer and filler, such as a maleated polypropylene.

The skilled person can readily select any suitable combination of additives and additive amounts without undue experimentation. The amount of the additives depends on their type and function and typically is of from 0 to about 30 wt%. The amount of the additives may e.g. be from about 1 to about 20 wt%; from about 2 to about 10 wt% or of from 3 to about 5 wt% based on the total composition.

The sum of all components added in the process of the invention to form the composition comprising the propylene-based polymer, the particulate material and the optional components should add up to 100% by weight of the total composition.

Preferably, the total of the propylene-based polymer and the particulate material is at least 70 wt%, at least 80 wt%, at least 90 wt%, at least 95 wt%, at least 97 wt%, at least 98 wt%, at least 99 wt%, at least 99.5 wt%, at least 99.9 wt% or 100 wt% of the total composition.

#### Process for making composition

The composition of the invention may be obtained by a process comprising melt-mixing (A) the heterophasic propylene copolymer, (B) the particulate material and (C) the optional component by using any suitable means. Accordingly, the invention further relates to a process for the preparation of the composition according to the invention comprising melt mixing (A) and (B) and optionally (C). Preferably, the composition of the invention is made in a form that allows easy processing into a shaped article in a subsequent step, like in pellet or granular form. The composition can be a mixture of different particles or pellets; like a blend of the heterophasic propylene copolymer and a masterbatch of additives. Preferably, the composition of the invention is in pellet or granular form as obtained by mixing all components in an apparatus like an extruder; the advantage being a composition with homogeneous and well-defined concentrations of the additives.

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With melt-mixing is meant that the components (B) and optionally (C) are mixed with the heterophasic propylene copolymer at a temperature that exceeds the melting point of the heterophasic propylene copolymer. Melt-mixing may be done using techniques known to the skilled person, for example in an extruder. Generally, in the process of the invention, melt-mixing is performed at a temperature in the range from 2-300 °C.

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Suitable conditions for melt-mixing, such as temperature, pressure, amount of shear, screw speed and screw design when an extruder is used are known to the skilled person.

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When using an extruder, a conventional extruder such as a twin-screw extruder may be used. The temperature can vary through the different zones of the extruder as required. For example, the temperature may vary from 100 °C in the feed zone to 300 °C at the die. Preferably, the temperature in the extruder varies from 200 to 265 °C; lower temperatures may impede reactions between the peroxide and an optional co-agent, for example polyfunctional monomers such as BDDMA and, as a consequence, compositions with the desired melt flow index may not be obtained; too high

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temperatures may induce undesired degradation processes, which may for example result in compositions having poor mechanical properties. Likewise, the screw speed of the extruder may be varied as needed. Typical screw speed is in the range from about 100rpm to about 400rpm.

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further aspects

The invention further provides a process for the preparation of the light diffusion article according to the invention, comprising melt mixing the heterophasic propylene copolymer and the particulate material to obtain the composition and forming the  
10 composition into the light diffusion article.

The invention further relates to use of a composition comprising (A) a heterophasic propylene copolymer and (B) a particulate material for making a light diffusing article, wherein the amount of the particulate material is from 0.01 to 1 wt% of the total  
15 composition,

wherein the heterophasic propylene copolymer consists of

(a) a propylene-based matrix,

wherein the propylene-based matrix consists of a propylene homopolymer and/or a copolymer of propylene and ethylene or  $\alpha$ -olefin consisting of at least 95 wt% of  
20 propylene and at most 5 wt% of  $\alpha$ -olefin, based on the total weight of the propylene-based matrix and

wherein the propylene-based matrix is present in an amount of 65 to 85 wt% based on the total heterophasic propylene copolymer and

(b) a dispersed ethylene- $\alpha$ -olefin copolymer,

25 wherein the amount of ethylene in the dispersed ethylene- $\alpha$ -olefin copolymer is at least 40 wt%,

wherein the dispersed ethylene- $\alpha$ -olefin copolymer is present in an amount of 35 to 15 wt% based on the total heterophasic propylene copolymer and

wherein the sum of the total amount of propylene-based matrix and total amount of the dispersed ethylene- $\alpha$ -olefin copolymer in the heterophasic propylene copolymer is 100  
30 wt% of the heterophasic propylene copolymer,

wherein a sheet having a thickness of 1 mm made of the composition has a degree of light dispersion  $DLD_T$  and a haze  $H_T$  and

a sheet having a thickness of 1 mm made of the heterophasic propylene copolymer  
35 has a degree of light dispersion  $DLD_R$  and a haze  $H_R$ ,

wherein  $(H_T - H_R)/H_R$  is at most 2% and  $(DLD_T - DLD_R)/DLD_R$  is at least 10%, preferably at least 100%, more preferably at least 400%.

The invention further relates to use of the light diffusing article according to the invention for diffusing light.

- 5 The invention further relates to a lighting device comprising a housing containing a light source and the light diffusing article according to the invention, said article being positioned relative to the light source such that it diffuses at least part of the light coming from said light source. Preferably, the light source is a LED lamp.
- 10 Although the invention has been described in detail for purposes of illustration, it is understood that such detail is solely for that purpose and variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention as defined in the claims.
- 15 It is further noted that the invention relates to all possible combinations of features described herein, preferred in particular are those combinations of features that are present in the claims. It will therefore be appreciated that all combinations of features relating to the composition according to the invention; all combinations of features relating to the process according to the invention and all combinations of features
- 20 relating to the composition according to the invention and features relating to the process according to the invention are described herein.

It is further noted that the term 'comprising' does not exclude the presence of other elements. However, it is also to be understood that a description on a

25 product/composition comprising certain components also discloses a product/composition consisting of these components. The product/composition consisting of these components may be advantageous in that it offers a simpler, more economical process for the preparation of the product/composition. Similarly, it is also to be understood that a description on a process comprising certain steps also

30 discloses a process consisting of these steps. The process consisting of these steps may be advantageous in that it offers a simpler, more economical process.

The invention is now elucidated by way of the following examples, without however being limited thereto.

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### Experiments

Polymer 1, 2 and 3 are a heterophasic propylene copolymer comprising a matrix phase of a propylene homopolymer and a dispersed phase of propylene-ethylene copolymer.

	polymer 1	polymer 2	polymer 3
RC: amount of dispersed phase (w%)	20.3	21.7	22.3
RCC2: amount of ethylene in dispersed phase (w%)	48.23	51.25	54.28
T2: amount of ethylene in polymer (w%)	9.79	11.12	12.10
MFI (g/10min)	37.73	4.12	3.8

- 5 MFI is measured according to ISO 1133, 230 °C, 2.16 kg.

talc 1: Hansheng talc: untreated talc having d50 of 2.75 µm

talc 2: AH5000 talc: untreated talc having d50 of 1.1 µm

- 10 The heterophasic propylene copolymer (and antioxidants and acid scavenger of 500 to 1000 ppm) was pre-blended with talc. Subsequently the pre-blended powder was extruded using a twin extruder. The pellets were dried at 100 °C for 2 h and injection molded using FANUC injection molding machine (S-2000i) to prepare the parts for test.

### 15 **Equipment and Procedures**

For the optical properties measurements, a sheet having a thickness of 1 mm was used. Transmittance data were obtained on a Hazegard II with standard D65 lamp following ASTM D1003 protocol (uncompensated mode). Degree of light dispersion (DLD) was measured by Goniophotometer GP-200 in transmission mode. The

- 20 maximum DLD is 60 degree based on Lambert's law.

The flexural modulus was measured according to ISO 178 (test geometry: 3.2 mm thickness according to ISO37/2, parallel orientation).

The heat deflection temperature (HDT) was measured according to ISO 75 (load at 0.45 MPa).

- 25 The compositions and test results are shown in Tables 1-5.

In all three types of heterophasic propylene copolymer, the addition of either types of talc led to a large increase in DLD with little change in the haze. In addition, the composition of the light diffusing article according to the invention, also increases the HDT, which is beneficial as the light diffusing article needs to be able to withstand the

- 30 heat from the lighting source.

Table 1

	polymer 1			
	CEx 1	Ex 1	Ex 2	Ex 3
talca 1 (wt% in total composition)	0	0.1	0.2	0.5
Haze @ 1mm	97.8	98	98.1	98
T @ 1mm	72.7	70.7	67.9	66.8
DLD @ 1mm	30.8	38	41.7	44.5
MFI	37.73	35.82	36.07	34.95
Flex modulus (N/mm <sup>2</sup> )	1162	1220.42	1286.08	1320.32
HDT at 0.45 MPa	85.8	91.7	97.8	103.7

Table 2

	polymer 2				
	CEx 2	Ex 4	Ex 5	Ex 6	Ex 7
talca 1 (wt% in total composition)	0	0.05	0.1	0.2	0.5
Haze @ 1mm	90.9	91	90.9	90.9	91
T @ 1mm	69.3	69.1	68.8	68.6	67.8
DLD @ 1mm	5.6	14.9	15.4	19	20
MFI	4.12	4.05	4.11	4.03	3.96
Flex modulus (N/mm <sup>2</sup> )	1174	1198	1228	1258	1296
HDT at 0.45 MPa	75.2	79.0	82.1	88.6	91.9

Table 3

	polymer 2				
	CEx 2	Ex 8	Ex 9	Ex 10	Ex 11
talc 2 (wt% in total composition)	0	0.05	0.1	0.2	0.5
Haze @ 1mm	90.9	90.9	90.9	91	91
T @ 1mm	69.3	68.9	67.5	68.3	67.2
DLD @ 1mm	5.6	10.5	12.2	16.2	16.9
MFI	4.12	4.05	4.12	4.03	4.04
Flex modulus (N/mm <sup>2</sup> )	1174	1222	1232	1266	1278
HDT at 0.45 MPa	75.2	79.3	82.5	89.7	92.3

Table 4

	polymer 3				
	CEx 3	Ex 8	Ex 9	Ex 10	Ex 11
talc 1 (wt% in total composition)	0	0.05	0.1	0.2	0.5
Haze @ 1mm	98	98	98	98.1	98.1
T @ 1mm	71.9	71.5	71.3	71.2	70.2
DLD @ 1mm	4.2	8.7	12.9	16.3	16.5
MFI	3.8	3.74	3.76	3.75	3.8
Flex modulus (N/mm <sup>2</sup> )	1158	1192	1224	1232	1258
HDT at 0.45 MPa	72.4	75.7	80.0	85.1	89.8

Table 5

	polymer 3				
	CEx 3	Ex 8	Ex 9	Ex 10	Ex 11
talc 2 (wt% in total composition)	0	0.05	0.1	0.2	0.5
Haze @ 1mm (%)	98	98	98	98.1	98.1
T @ 1mm (%)	71.9	71.1	70.9	70.9	70.4
DLD @ 1mm	4.2	11	11.7	16.8	19.3
MFI (dg/min)	3.8	3.73	3.82	3.79	3.82
Flex modulus (N/mm <sup>2</sup> )	1158	1202	1208	1230	1312
HDT at 0.45 MPa	72.4	76.6	80.4	84.4	89.2

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## CLAIMS

1. A light diffusing article comprising a composition comprising (A) a heterophasic  
5 propylene copolymer and (B) a particulate material, wherein the amount of the  
particulate material is from 0.01 to 1 wt% of the total composition,  
wherein the heterophasic propylene copolymer consists of  
(a) a propylene-based matrix,  
wherein the propylene-based matrix consists of a propylene homopolymer and/or a  
10 copolymer of propylene and ethylene or  $\alpha$ -olefin consisting of at least 95 wt% of  
propylene and at most 5 wt% of  $\alpha$ -olefin, based on the total weight of the propylene-  
based matrix and  
wherein the propylene-based matrix is present in an amount of 65 to 85 wt% based on  
the total heterophasic propylene copolymer and  
15 (b) a dispersed ethylene- $\alpha$ -olefin copolymer,  
wherein the amount of ethylene in the dispersed ethylene- $\alpha$ -olefin copolymer is at least  
40 wt%,  
wherein the dispersed ethylene- $\alpha$ -olefin copolymer is present in an amount of 35 to 15  
wt% based on the total heterophasic propylene copolymer and  
20 wherein the sum of the total amount of propylene-based matrix and total amount of the  
dispersed ethylene- $\alpha$ -olefin copolymer in the heterophasic propylene copolymer is 100  
wt%,  
wherein a sheet having a thickness of 1 mm made of the composition has a degree of  
light dispersion  $DLD_T$  and a haze  $H_T$  and  
25 a sheet having a thickness of 1 mm made of the heterophasic propylene copolymer  
has a degree of light dispersion  $DLD_R$  and a haze  $H_R$ ,  
wherein  $(H_T - H_R)/H_R$  is at most 2% and  $(DLD_T - DLD_R)/DLD_R$  is at least 10%, preferably at  
least 100%, more preferably at least 400%.
- 30 2. The light diffusing article according to claim 1, wherein  $H_T$  is 80-99%.
3. The light diffusing article according to any one of claims 1-2, wherein the  
composition has a melt flow index of 15 to 100 dg/min as determined according to  
ISO1133 at 230 °C and 2.16 kg and  $DLD_T$  is at least 20, preferably at least 35.

4. The light diffusing article according to any one of claims 1-2, wherein the composition has a melt flow index of 1 to 10 dg/min as determined according to ISO1133 at 230 °C and 2.16 kg and  $DLD_T$  is at least 5.
- 5 5. The light diffusing article according to any one of the preceding claims, wherein  $H_R$  is 90 to 98%.
6. The light diffusing article according to any one of the preceding claims, wherein the particulate material is talc.
- 10 7. The light diffusing article according to any one of the preceding claims, wherein the particulate material is an untreated talc having an average particle diameter  $d_{50}$  of 0.5 to 5  $\mu\text{m}$ .
- 15 8. A process for the preparation of the light diffusing article according to any one of the preceding claims, comprising melt mixing (A) and (B) to obtain the composition and shaping the composition into the light diffusing article.
- 20 9. Use of a composition comprising (A) a heterophasic propylene copolymer and (B) a particulate material for making a light diffusing article, wherein the amount of the particulate material is from 0.01 to 1 wt% of the total composition, wherein the heterophasic propylene copolymer consists of
- (a) a propylene-based matrix,
- 25 wherein the propylene-based matrix consists of a propylene homopolymer and/or a copolymer of propylene and ethylene or  $\alpha$ -olefin consisting of at least 95 wt% of propylene and at most 5 wt% of  $\alpha$ -olefin, based on the total weight of the propylene-based matrix and
- wherein the propylene-based matrix is present in an amount of 65 to 85 wt% based on the total heterophasic propylene copolymer and
- 30 (b) a dispersed ethylene- $\alpha$ -olefin copolymer,
- wherein the amount of ethylene in the dispersed ethylene- $\alpha$ -olefin copolymer is at least 40 wt%,
- wherein the dispersed ethylene- $\alpha$ -olefin copolymer is present in an amount of 35 to 15 wt% based on the total heterophasic propylene copolymer and
- 35 wherein the sum of the total amount of propylene-based matrix and total amount of the dispersed ethylene- $\alpha$ -olefin copolymer in the heterophasic propylene copolymer is 100 wt% of the heterophasic propylene copolymer,

wherein a sheet having a thickness of 1 mm made of the composition has a degree of light dispersion  $DLD_T$  and a haze  $H_T$  and

a sheet having a thickness of 1 mm made of the heterophasic propylene copolymer has a degree of light dispersion  $DLD_R$  and a haze  $H_R$ ,

5 wherein  $(H_T - H_R)/H_R$  is at most 2% and  $(DLD_T - DLD_R)/DLD_R$  is at least 10%, preferably at least 100%, more preferably at least 400%

10. A lighting device comprising a housing containing a light source and the light diffusing sheet according to any one of claims 1 to 7, said sheet being positioned  
10 relative to the light source such that it diffuses at least part of the light coming from said light source.

11. The lighting device of claim 10, wherein the light source is a LED lamp

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/EP2017/068634

**A. CLASSIFICATION OF SUBJECT MATTER**  
INV. C08L23/12  
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)  
C08L

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
EPO-Internal, WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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A	WO 2006/114357 A1 (BASELL POLIOLEFINE SRL [IT]; CAGNANI CAMILLO [IT]; CAVALIERI CLAUDIO []) 2 November 2006 (2006-11-02) the whole document -----	1-11
A	WO 2008/020925 A1 (EXXONMOBIL CHEM PATENTS INC [US]; CHAPMAN BRYAN R [US]; VALENTAGE JEFF) 21 February 2008 (2008-02-21) the whole document -----	1-11

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	"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
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"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  28 August 2017	Date of mailing of the international search report  25/09/2017
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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  Ritter, Nicola
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