

(19)



(11)

EP 3 109 355 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:

28.12.2016 Bulletin 2016/52

(51) Int Cl.:

D04H 1/4291 ^(2012.01)

D04H 1/56 ^(2006.01)

D04H 3/007 ^(2012.01)

D04H 3/16 ^(2006.01)

(21) Application number: **15173655.0**

C08L 23/08 ^(2006.01)

C08F 210/02 ^(2006.01)

(22) Date of filing: **24.06.2015**

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA ME

Designated Validation States:

MA

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(54) **NONWOVEN MELT-BLOWN WEBS MADE FROM METALLOCENE CATALYZED ETHYLENE BASED PLASTOMER**

(57) New soft nonwoven melt-blown webs based on melt-blown fibers comprising metallocene catalyzed ethylene based plastomer and to articles made therefrom, in particular hygiene products, such as sanitary wipes, baby diapers, adult incontinence products and feminine hygiene products, or protective films or articles for medical/surgical applications.

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Description

[0001] The present invention is directed to new soft nonwoven melt-blown webs based on melt-blown fibers comprising metallocene catalyzed ethylene based plastomer and to articles made therefrom, in particular hygiene products, such as sanitary wipes, baby diapers, adult incontinence products and feminine hygiene products, or protective films or articles for medical/surgical applications.

[0002] A melt-blown web, being a non-woven structure consisting of melt-blown fibers, is typically made in a one-step process in which high-velocity air blows a molten thermoplastic resin from an extruder die tip onto a conveyor belt or take-up screen to form a fine fibered self-bonding web.

The melt-blowing process is amenable to a wide range of polymers in terms of viscosities and blends. The type of polymer or resin used defines the elasticity, softness, wetability, dyeability, chemical resistance and other related properties of formed webs. Some polymers, which can be used for the formation of melt-blown webs, are listed as polypropylene (PP), polyethylene (PE), polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polyamide (PA) and polylactic acid (PLA). Polypropylene (PP) is the most widely used polymer for melt-blowing process, because it has a low viscosity, a low melting point and is easy to draw into fibers. Furthermore it is known that polyethylene (PE) is more difficult to melt-blow into fine fibrous webs than is polypropylene.

[0003] But as polypropylene (PP) melt-blown fabrics are not as soft as polyethylene (PE) fabrics and further lack elasticity, there were several attempts to use polyethylene (PE) instead of polypropylene (PP) in order to increase the softness and elasticity of the webs, as especially softness is becoming more and more important.

Especially in hygiene applications, such as for example such as sanitary wipes, baby diapers, adult incontinence products and feminine hygiene products, there is growing trend for more soft touch, meaning also improved comfort to wear.

Also for protective films, which are i.a. used to protect new cars or boats, etc. during transportation, softness and elasticity are desired properties.

Additionally polypropylene (PP) melt-blown fabrics are not suitable for sterilization by e.g. γ -radiation.

[0004] EP 1097185 B1 for example describes the use of a metallocene-polyethylene nonwoven as backing material, especially as plaster backings, which should give a pleasant wear comfort in use. The polymer employed is a copolymer of ethylene and an α -olefin having a carbon number from C_4 to C_{10} , it being possible for the polyolefin to have a melt index of between 1 and 50 g/10min and a density of from 860 to 900 kg/m³. According to the Examples, the used ethylene-octene copolymers had a melt index of 30 g/10min. As will be shown in the Experimental part, such metallocene-polyethylenes are not suitable for being used in the present invention.

[0005] In EP 1085980 B1 it is stated that the use of 100% metallocene-catalyzed polymers in the melt-blowing process often results in poor web formation and that due in part to the high viscosity and quenching problems, nonwoven webs formed from only elastomeric olefins, such as metallocene-catalyzed polyethylene, may be open or splotchy. In addition it is stated that the higher the viscosity of the polymer, the more difficult it is to produce small diameter microfibers which are necessary to achieve good web formation and coverage.

Therefore EP 1085980 suggests the use of a polymeric composition comprising at least one elastomeric polyolefin and at least one non-elastomeric polyolefin for preparing an elastic nonwoven web that is suited for use in applications requiring increased tensile strength, decreased viscosity, and improved web formation.

The elastomeric polyolefins are especially narrow molecular weight distribution polyolefins such as a metallocene-catalyzed polyethylene, a metallocene-catalyzed polypropylene, other metallocene-catalyzed α -olefins, or various single-site catalyzed polyolefins and constrained geometry catalyzed polyolefins having a density of less than about 0.885 g/cm³. Examples mentioned in EP 1085980 are a metallocene-catalyzed polyethylene sold by Dow under the product designation DOWXU58200.02., having a density of about 0.870 grams/cubic centimeter (g/cm³), a melt index of about 30 grams/10 minutes, and a peak melting point of about 140°F (60°C) and a elastomeric plastomer sold by Dupont Dow Elastomers, LLC. Under the trademarks ENGAGE 8100 and ENGAGE 8200 which is claimed by the manufacturer to be an ethylene/1-octene copolymer. Some of the ENGAGE plastomers may have density ranges of from about 0.865 to about 0.899 g/cm³, a melt index of approximately 0.5 grams/10 minutes to about 30 grams/10 minutes, and a peak melting point range of about 120° to about 185°F (about 49° to about 85°C). Other suitable plastomers mentioned are available from Exxon Chemical Americas, Polymer Group under the trademark EXACT. The EXACT plastomers, according to Exxon, have density and peak melting point ranges that are similar to the ENGAGE and AFFINITY plastomers.

[0006] EP 1709117 B1 also suggests the use of a polymeric blend, whereby the polymeric blend comprising at least:

- (a) a first polyethylene with a density ρ_1 , and a melt index MI1; and
- (b) a second polyethylene with a density ρ_2 and a melt index MI2.

In this case the first polyethylene has a density ρ_1 , between 0.900 g/cm³ and 0.935 g/cm³ and a melt index MI1 between 5 to 25 g/10 minutes and the second polyethylene has a density ρ_2 between 0.935 g/cm³ and 0.965 g/cm³ and a melt

index MI2, between 30 g/10 minutes and 45 g/10 minutes.

It is stated that nonwoven materials comprising fibers made from the polymeric blend, have superior performance with regard to extensibility, softness and abrasion resistance compared to fibers produced from other polyethylenes, such as LLDPE blends, using resins having a density and a melt index outside the ranges specified herein for the first and second polyethylenes.

[0007] EP 989222 again suggests the use of a polymer blend, the blend being composed of a polyolefin-based elastomer and a propylene-based polymer for forming a melt-blown nonwoven fabric. The melt-blown nonwoven fabric is laminated to a spunbonded nonwoven fabric to provide soft nonwoven fabric laminates.

[0008] In addition to softness, often the performance requirements of the product demand a composite nonwoven fabric having elasticity. For example, in certain disposable diaper designs it is desired to impart elastic properties to the waist and/or to the leg cuff areas.

[0009] Another desirable attribute for non-woven melt-blown webs, besides softness and elasticity, is a high opacity. The higher the opacity, the more closed the fabric is, thus providing better barrier properties, coverage and visual aesthetics.

[0010] A further desired property for non-woven melt-blown webs is stability during sterilization using e.g. γ -radiation. This property is essential, if the non-woven melt-blown webs are to be used in medical/surgical applications, which require a sterilization step.

[0011] None of the solutions provided until today provides non-woven melt-blown webs made from ethylene based polymers with a satisfactory combination of softness, elasticity and opacity and furthermore stability during sterilization steps.

[0012] Therefore, there is still a need to improve the properties of non-woven melt-blown webs made from ethylene based polymers.

[0013] The inventors of the present invention have surprisingly found that the use of a specific class of metallocene catalyzed ethylene based plastomers provides non-woven melt-blown webs with high softness, high opacity and high elasticity, without the need of any polymer blend partner. Additionally such webs are stable during sterilization, especially by using γ -radiation.

[0014] Thus, the present invention is related to a soft non-woven melt-blown web comprising a metallocene catalyzed ethylene based plastomer being a copolymer of ethylene and a C_4 to C_{10} alpha olefin with a density according to ISO 1183 in the range of 860 to 900 kg/m³ and an MFR₂ according to ISO 1133 (190°C, 2.16kg) in the range of 55 to 100 g/10 min as the sole polymer component.

[0015] The webs according to the invention are characterized by a soft and elastic feeling with hand touch determined by a panel test and high opacity.

[0016] The present invention is further directed to articles comprising the above defined non-woven melt-blown web, wherein said article is selected from hygiene products, such as sanitary wipes, baby diapers, adult incontinence products and feminine hygiene products, as well as protective films or articles for medical/surgical applications, like medical packaging, sterilization wraps, surgical gowns, wound care, like plasters, etc..

[0017] In a further embodiment the present invention is related to a process for producing the above defined non-woven melt-blown web.

[0018] In the following the invention is described in more detail.

[0019] The non-woven melt-blown webs according to the present invention comprise a specific class of metallocene catalyzed ethylene based plastomers.

[0020] Such metallocene catalyzed ethylene based plastomers are copolymers of ethylene and a C_4 to C_{10} alpha olefin being produced with a metallocene catalyst and having specific density and MFR₂ ranges.

[0021] Suitable C_4 - C_{10} alpha-olefin include 1-butene, 1-hexene and 1-octene, preferably 1-butene or 1-octene and more preferably 1-octene.

Preferably copolymers of ethylene and 1-octene are used.

[0022] Suitable ethylene based plastomers have a density (ISO 1183) in the range of 860 - 900 kg/m³, preferably in the range of 870 to 895 kg/m³ and more preferably in the range of 875 to 890 kg/m³.

[0023] The MFR₂ (ISO 1133; 190°C; 2.16kg) of suitable ethylene based plastomers is in the range of 55 - 100 g/10 min, preferably in the range of 65 - 95 g/10 min and more preferably in the range of 75 - 90 g/min.

[0024] The melting points (measured with DSC according to ISO 11357-1) of suitable ethylene based plastomers are below 100°C, preferably below 90°C and more preferably below 80°C.

[0025] Suitable copolymers of ethylene and a C_4 - C_{10} alpha olefin have an ethylene content from 60 to 95 wt%, preferably from 65 to 90 wt% and more preferably from 70 to 88 wt%.

[0026] The molecular mass distribution Mw/Mn of suitable ethylene based plastomers is below 4.0, such as 3.8 or below, but is at least 1.7. It is preferably between 3.5 and 1.8.

[0027] These ethylene based plastomers can be prepared by known processes, in a one stage or two stage polymerization process, comprising solution polymerization, slurry polymerization, gas phase polymerization or combinations

therefrom, in the presence of suitable metallocene catalysts, known to the art skilled persons.

[0028] Preferably these ethylene based plastomers are prepared by a one stage or two stage solution polymerization process, especially by high temperature solution polymerization process at temperatures higher than 100°C.

[0029] Such process is essentially based on polymerizing the monomer and a suitable comonomer in a liquid hydrocarbon solvent in which the resulting polymer is soluble. The polymerization is carried out at a temperature above the melting point of the polymer, as a result of which a polymer solution is obtained. This solution is flashed in order to separate the polymer from the unreacted monomer and the solvent. The solvent is then recovered and recycled in the process.

[0030] Preferably the solution polymerization process is a high temperature solution polymerization process, using a polymerization temperature of higher than 100°C. Preferably the polymerization temperature is at least 110°, more preferably at least 150°C. The polymerization temperature can be up to 250°C.

[0031] The pressure in such a solution polymerization process is preferably in a range of 10 to 100 bar, preferably 15 to 100 bar and more preferably 20 to 100 bar.

[0032] The liquid hydrocarbon solvent used is preferably a C₅₋₁₂-hydrocarbon which may be unsubstituted or substituted by C₁₋₄ alkyl group such as pentane, methyl pentane, hexane, heptane, octane, cyclohexane, methylcyclohexane and hydrogenated naphtha. More preferably unsubstituted C₆₋₁₀-hydrocarbon solvents are used.

[0033] A known solution technology suitable for the process according to the invention is the COMPACT technology.

[0034] The metallocene catalyzed ethylene based plastomer used according to the present invention are first converted into melt-blown fibers.

[0035] Melt-blown fibers differ essentially from other fibers, in particular from those produced by spunbond technique.

[0036] Processes and apparatuses employed for producing melt-blown fibers and the resulting nonwoven webs are well known in the art. Melt-blowing technology is used for producing light fiber webs directly from polymers.

Melt-blown fibers are fibers formed by extruding a molten polymeric material through a plurality of fine, usually circular, die capillaries as molten threads or filaments into converging, usually hot and high velocity, gas (e.g. air) streams to attenuate the filaments of molten material and form fibers. During the melt blowing process, the diameters of the molten filaments are reduced by the drawing air to a desired size. Thereafter, the melt-blown fibers are carried by the high velocity gas stream and are deposited on a collecting surface (conveying belt or take-up screen) to form a web of randomly disbursed melt-blown fibers.

In the process metering pumps are used to pump the molten polymeric material to the distribution system, i.e. the die capillaries.

[0037] The principal advantage of the melt-blown process is that one can make very fine fibers and very lightweight melt-blown webs with excellent uniformity. The result is a soft melt-blown web with excellent barrier properties, meaning effective filtration characteristics and resistance to penetration by aqueous liquids. In other words the process features "melt-blown" distinguishes such produced fibers from fibers produced by different technology. More precisely "melt-blown fibers" are very thin having diameters not accomplished with other fiber processes. Furthermore, webs made out of such melt-blown fibers are softer and have lower weight compared to webs of the same thickness but produced by other technologies, like the spunbond process.

[0038] Accordingly, the melt-blown fiber according to the present invention preferably has an average diameter measured with scanning electron microscopy (SEM) of not more than 50 µm, like below 40 µm, more preferably of not more than 35 µm.

Although the melt-blown fibers according to the present invention have a higher average diameter compared to, e.g. polypropylene (PP) based fibers, webs produced therefrom are much softer than PP based webs, which can be seen in the Experimental Part.

[0039] One specific requirement of the present invention is that the melt-blown fiber comprises the metallocene catalyzed ethylene based plastomer. Preferably the melt-blown fiber comprises at least 90 wt%, more preferably at least 95 wt%, like at least 98 wt% of the metallocene catalyzed ethylene based plastomer, based on the total weight of the melt-blown fiber. Accordingly, it is in particular appreciated that the melt-blown fiber may comprise in addition to the metallocene catalyzed ethylene based plastomer typical additives, like antioxidants stabilizers, fillers, colorants or nucleating agents.

[0040] The amount of such additives however shall preferably not exceed 10 wt%, more preferably not more than 5 wt%, based on the total weight of the melt-blown fiber and/or web comprising the melt-blown fiber. Accordingly, the melt-blown fiber and/or the web comprising the melt-blown fiber may contain additives, in particular those as stated in this paragraph, but no other polymers. Thus, the metallocene catalyzed ethylene based plastomer is the only polymer within the melt-blown fiber and/or web comprising the melt-blown fiber.

[0041] The melt-blown fibers are provided in the form of a melt-blown web.

[0042] Additionally, the melt-blown web is a nonwoven web. The term "nonwoven web" in the meaning of the present invention refers to a web comprising individual melt-blown fiber that have been formed into a web and bonded together by any means such as by chemical, mechanical, heat and/or solvent treatment, but not by weaving or knitting.

[0043] The melt-blown web according to the instant invention can be produced as single layer or as one part of a multi-layer construction, like an SMS-web comprising, preferably consisting of, a spunbonded web layer, a melt-blown web layer and another spunbonded web layer. Alternatively, the multi-layer construction can also include a multiplicity of melt-blown web layers and spunbonded web layers, such as a SSMMS construction.

[0044] The basis weight of the melt-blown web being part of the composite material depends very much on the end use, however it is preferred that the melt-blown web has a basis weight of at least 15 g/m² if it is produced as single layer. Preferably, the melt-blown web of the present invention, if used as single layer, has a basis weight of at least 15 g/m² and more preferably at least 25 g/m². Accordingly, the melt-blown web of the present invention has a basis weight of between 15 g/m² and 200 g/m², preferably between 20 g/m² and 100 g/m², and more preferably between 25 g/m² and 70 g/m².

[0045] In case the melt-blown web according to the instant invention is produced as one part of a multi-layer construction, like an SMS-web comprising, preferably consisting of, a spunbonded web layer, a melt-blown web layer and another spunbonded web layer, the melt-blown web has a weight per unit area of at least 1 g/m², more preferably of at least 5 g/m², yet more preferably in the range of 5 to 80 g/m², still more preferably in the range of 5 to 50 g/m².

[0046] The webs according to the invention are characterized by a soft and elastic feeling with hand touch determined by a panel test and high opacity.

[0047] Due to this advantageous combination of softness, elasticity and opacity, the webs according to the invention are suitable for producing articles, especially for producing hygiene products, protective films or articles for medical/surgical applications.

[0048] The present invention is therefore further directed to articles comprising the above defined non-woven melt-blown web, wherein said article is selected from hygiene products, such as sanitary wipes, baby diapers, adult incontinence products and feminine hygiene products; as well as protective films for transportation of new cars, boats and the like or articles for medical/surgical applications, like medical packaging, sterilization wraps, surgical gowns, wound care, like plasters, etc..

[0049] In addition to polymer properties, the melt-blown process parameters are crucial in production of melt-blown and corresponding end products.

The properties of the melt-blown webs are affected by various production parameters including air temperature, die to collector distance (DCD), collector (conveying belt) speed, polymer throughput, air volume and die hole size and hole density.

[0050] All of these affect the final properties of the nonwoven web. In the present case it has been found out, that when using the specific class of metallocene catalyzed ethylene based plastomers, as described above, especially the ratio of the polymer throughput [kg/h]/ conveying belt speed [m/min] as well as the ratio of polymer throughput per meter die [kg/h/m]/ conveying belt speed [m/min] play an important role on the final appearance of the produced webs. Furthermore the hole density of the die, i.e. the number of holes per cm or per inch of the die, has a big influence.

[0051] In the melt-blown fiber process the metallocene catalyzed ethylene based plastomer is used in pellet, chips or granule form. The polymer is introduced into an extruder with a metering pump. The extruder has at least two up to five temperature zones, preferably with three to four temperature zones and the molten polymer is moved to the die.

A typical die will have holes with 0.3 to 0.5 mm diameter, preferably 0.4 mm diameter and holes spaced at 25 to 60 per inch.

[0052] The die tip is designed in such a way that the holes are in a straight line with high-velocity air impinging from each side.

The impinging high-velocity hot air attenuates the filaments and forms the desired fibers. Immediately below or adjacent to the die, a large amount of ambient air is drawn into the hot air stream containing the fibers which cools the hot gas and solidifies the fibers onto the conveying belt that is typically moving in such a manner as to create a continually renewed surface for the fibers to contact and form a web.

[0053] The air temperature is in the range of 160°C to 350°C, preferably in the range of 200°C to 300°C and the air volume is in the range of 50 to 550 m³/h, preferably in the range of 100 to 200 m³/h.

[0054] The die to collector distance (DCD) is in the range of 30 to 500 mm, preferably in the range of 300 to 500 mm.

[0055] In the present case the ratio of polymer throughput [kg/h]/ conveying belt speed [m/min] and polymer throughput per meter die [kg/h/m]/ conveying belt speed [m/min] play an important role for the final appearance of the produced web.

[0056] Thus the ratio of polymer throughput [kg/h]/ conveying belt speed [m/min] is in the range of 0.40 to 1.20, preferably in the range of 0.50 to 1.00 and more preferably in the range of 0.55 to 0.80.

[0057] The ratio of polymer throughput per meter die [kg/h/m]/ conveying belt speed [m/min] is in the range of 1.5 to 3.5, preferably in the range of 1.7 to 3.0 and more preferably in the range of 1.8 to 2.5.

[0058] If the produced web is a multilayer melt-blown web these ratios have to be adapted accordingly.

[0059] Thus the present invention is also related to the process for producing the above defined non-woven melt-blown web.

[0060] The process being characterized by the following steps:

(i) the metallocene catalyzed ethylene based plastomer is introduced into an extruder having at least two up to five temperature zones, with a metering pump,

(ii) from the extruder the molten plastomer is moved to a die with holes of 0.3 to 0.5 mm diameter and a hole density of 25 to 60 per inch,

(iii) the molten plastomer is pressed through the die holes, whereby fibers are formed with the aid of a high-velocity hot air stream

(iv) the formed fibers are solidified with ambient air drawn into the hot air stream and collected onto a conveying belt whereby

a) the ratio of polymer throughput [kg/h]/ conveying belt speed [m/min] is in the range of 0.40 to 1.20 and

b) the ratio of polymer throughput per meter die [kg/h/m]/ conveying belt speed [m/min] is in the range of 1.5 to 3.5.

EXPERIMENTAL PART

Definitions/Measuring Methods

[0061] The following definitions of terms and determination methods apply for the above general description of the invention as well as to the below examples unless otherwise defined.

[0062] MFR₂ (190°C) is measured according to ISO 1133 (190 °C, 2.16 kg load).

[0063] Density is measured according to ISO 1183.

Melting temperature T_m

[0064] The melting temperature T_m, was measured with a TA Instruments Q2000 differential scanning calorimetry device (DSC) according to ISO 11357/3 on 5 to 10 mg samples. Melting temperatures were obtained in a heat/cool/heat cycle with a scan rate of 10 °C/min between 30 °C and 180°C. Melting and crystallisation temperatures were taken as the peaks of the endotherms and exotherms in the cooling cycle and the second heating cycle respectively.

[0065] Number average molecular weight (M_n), weight average molecular weight (M_w) and polydispersity (M_w/M_n) are determined by Gel Permeation Chromatography (GPC) according to the following method:

The weight average molecular weight M_w and the polydispersity (M_w/M_n), wherein M_n is the number average molecular weight and M_w is the weight average molecular weight) is measured by a method based on ISO 16014-1:2003 and ISO 16014-4:2003. A Waters Alliance GPCV 2000 instrument, equipped with refractive index detector and online viscosimeter was used with 3 x TSK-gel columns (GMHXL-HT) from TosoHaas and 1,2,4-trichlorobenzene (TCB, stabilized with 200 mg/L 2,6-Di tert butyl-4-methyl-phenol) as solvent at 145 °C and at a constant flow rate of 1 mL/min. 216.5 µL of sample solution were injected per analysis. The column set was calibrated using relative calibration with 19 narrow MWD polystyrene (PS) standards in the range of 0.5 kg/mol to 11 500 kg/mol and a set of well characterized broad polypropylene standards. All samples were prepared by dissolving 5 - 10 mg of polymer in 10 mL (at 160 °C) of stabilized TCB (same as mobile phase) and keeping for 3 hours with continuous shaking prior sampling in into the GPC instrument.

[0066] Comonomer content in polyethylene was measured in a known manner based on Fourier transform infrared spectroscopy (FTIR) calibrated with ¹³C-NMR, using Nicolet Magna 550 IR spectrometer together with Nicolet Omnic FTIR software. Films having a thickness of about 250 µm were compression molded from the samples.

[0067] Similar films were made from calibration samples having a known content of the comonomer. The comonomer content was determined from the spectrum from the wave number range of from 1430 to 1100 cm⁻¹. The absorbance is measured as the height of the peak by selecting the so-called short or long base line or both. The short base line is drawn in about 1410 - 1320 cm⁻¹ through the minimum points and the long base line about between 1410 and 1220 cm⁻¹. Calibrations need to be done specifically for each base line type. Also, the comonomer content of the unknown sample needs to be within the range of the comonomer contents of the calibration samples.

Average fibre diameter in the web

[0068] The number average fibre diameter was determined using scanning electron microscopy (SEM). A representative part of the web was selected and an SEM micrograph of suitable magnification was recorded, then the diameter of 20 fibres was measured and the number average calculated.

Grammage of the web

[0069] The basis weight (grammage) of the webs in g/m² was determined in accordance with ISO 536:1995.

Softness/Elasticity

[0070] Evaluation of softness/elasticity was by black box panel.

An expert panel consisting of 14 (for softness) and 10 (for elasticity) persons compared the surface feel/elasticity feel of the webs according to the invention and the reference web with the surface feel/elasticity feel of a control web made of HL708FB (PP homopolymer; melt-blown grade, MFR₂ of 800 g/10 min; T_m (DSC) of 158°C, average fiber diameter of 2.3 μm ; commercially available from Borealis)

Results are reported as a softness/elasticity score with higher values denoting a more pleasing hand/higher elasticity "1" means that the web has about the same softness/elasticity as the reference web produced under the same conditions. "5" means that the web is very much softer/ very much more elastic than the reference web produced under the same conditions.

Examples

[0071] For Inventive Example IE1 an ethylene-octene plastomer (8285LA) from the Queo grade family provided by Borealis was used. The plastomer is produced in a solution polymerisation process (Compact) using a metallocene catalyst and has the following properties as shown in Table 1.

Table 1:

Property	unit	
Density	kg/m ³	882
MFR ₂	g/10 min	85
MFR ₁₀	g/10 min	1257
Melting point T _m	°C	76
C ₈ -content	wt%	26.8
C ₂ -content	wt%	73.2
MWD	-	2.7

[0072] For the Comparative Example 1 (CE1) Queo 8230, commercially available from Borealis, was used. Queo 8230 is an ethylene based octene plastomer, produced in a solution polymerisation process (Compact) using a metallocene catalyst and has a density of 882 kg/m³, a melt flow rate MFR₂ of 30 g/10 min and a melting point of 76°C.

[0073] Thus the difference between Queo 8230 and the plastomer used in the inventive Examples is the MFR.

Melt-blown webs and testing

[0074] The materials have been converted into melt-blown webs on a 350 mm wide Reicofil melt-blown pilot line using a Reifenhäuser Extruder (D = 35mm; L/D 30 mm) with 4 temperature zones and a die with holes of 0.4 mm diameter and 35 holes per inch.

The temperature profile in the extruder was 180°C/200°C/230°C/230°C.

The air temperature was 230°C. The distance from die to collector (DCD) was fixed at 500 mm. Other parameters have been varying in the different Examples as shown in Table 2.

Inventive Example 1 (IE1):

[0075] The plastomer as described above (MFR₂ of 85 g/10 min) was used.

Comparative Example 1 (CE1)

[0076] Queo 8230 (MFR₂ of 30 g/10 min) was used.

Comparative Example 2 (CE2)

[0077] Plastomer of IE1 was used but different process parameters

Comparative Example 3 (CE3)

[0078] Plastomer of IE1 was used but different process parameters

Table 2

parameter	unit	IE1	CE1	CE2	CE3
Polymer Throughput	kg/h	3	10	3	7
Throughput per meter die	kg/h/m	10	30	10	20
Conveyer belt speed	m/min	5.0	10	8.0	4.9
PT/CBS		0.6	1.0	0.375	1.42
TPMD/CBS		2.0	3	1.25	4.1
Basic weight	g/m ²	31	50	19	63.3
Average fiber diameter	μm	32	143	45	65

PT/CBS ratio Polymer Throughput/ Conveyer belt speed

TPMD/CBS ratio Throughput per meter die/ Conveyer belt speed

[0079] The webs of IE1 and CE1 were further tested by a panel test as described above in a panel test with 7 persons. The results are shown in Table 3 and 4. As reference (ref) web, a web made of HL708FB was taken (produced as web of IE1 with the exception of melt temperature being 280°C and air temperature being 280°C). The reference web has score "1"

Table 3: softness

	softness	
web	IE1	CE1
Tester 1	3	-1
Tester 2	3	-2
Tester 3	3	-2
Tester 4	3	-2
Tester 5	3	-1
Tester 6	3	-2
Tester 7	3	-1
Tester 8	3	-2
Tester 9	3	-1
Tester 10	1	-2
Tester 11	2	-1
Tester 12	3	-1
Tester 13	3	-2

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(continued)

	softness	
web	IE1	CE1
Tester 14	3	-1

[0080] People found that the web of CE1, prepared from Queo 8230, was more "rigid" than the reference web made of PP homopolymer. Therefore they noted this impression down with "minus" score.

Table 4: elasticity

	elasticity	
web	IE1	CE1
Tester 1	5	2
Tester 2	5	3
Tester 3	5	3
Tester 4	5	3
Tester 5	4	2
Tester 6	5	3
Tester 7	5	2
Tester 8	5	3
Tester 9	5	2
Tester 10	5	2

[0081] People found clearly that both webs made of plastomers have higher elasticity compared to the reference web made of PP homopolymer. The web according to IE1 had also higher elasticity than the comparative web of CE1.

[0082] The web of IE1 has a much better appearance than the webs of CE1 to CE3. This can be seen in the Figures 1 to 4 where pictures of the webs on black coloured background are shown.

Claims

- Soft non-woven melt-blown web comprising a metallocene catalyzed ethylene based plastomer being a copolymer of ethylene and a C₄ to C₁₀ alpha olefin with a density according to ISO 1183 in the range of 860 to 900 kg/m³ and an MFR₂ according to ISO 1133 (190°C, 2.16kg) in the range of 55 to 100 g/10 min as the sole polymer component.
- Soft non-woven melt-blown web according to claim 1, wherein the web comprises at least 90 wt% of the metallocene catalyzed ethylene based plastomer and up to 10 wt% of additives.
- Soft non-woven melt-blown web according to claim 1 or 2, wherein the metallocene catalyzed ethylene based plastomer is a copolymer of ethylene and octene.
- Soft non-woven melt-blown web according to anyone of the preceding claims, wherein the metallocene catalyzed ethylene based plastomer has a density in the range of 870 to 895 kg/m³ (ISO 1183) and an MFR₂ according to ISO 1133 (190°C, 2.16kg) in the range of 65 to 95 g/10 min.
- Soft non-woven melt-blown web according to anyone of the preceding claims, wherein the metallocene catalyzed ethylene based plastomer has a melting point (measured with DSC according to ISO 11357-1) of below 100°C.
- Soft non-woven melt-blown web according to anyone of the preceding claims, wherein the metallocene catalyzed ethylene based plastomer has been prepared by a one stage or two stage solution polymerization process, especially by high temperature solution polymerization process at temperatures higher than 100°C.

7. Soft non-woven melt-blown web according to anyone of the preceding claims, wherein the metallocene catalyzed ethylene based plastomer is in the form of melt-blown fibers having an average diameter of not more than 50 μm measured with scanning electron microscopy.

8. Soft non-woven melt-blown web according to anyone of the preceding claims, wherein the melt-blown web is a single layer having a basis weight of at least 15 g/m^2 .

9. Soft non-woven melt-blown web according to anyone of the preceding claims, wherein the melt-blown web is part of a SMS-web, whereby the melt-blown web has a basis weight of at least 1 g/m^2 .

10. Process for producing a soft non-woven melt-blown web according to anyone of the preceding claims, whereby

(i) the metallocene catalyzed ethylene based plastomer is introduced into an extruder having at least two up to five temperature zones, with a metering pump

(ii) from the extruder the molten plastomer is moved to a die with holes of 0.3 to 0.5 mm diameter and a hole density of 25 to 60 holes per inch,

(iii) the molten plastomer is pressed through the die holes, whereby fibers are formed with the aid of a high-velocity hot air stream,

(iv) the formed fibers are solidified with ambient air drawn into the hot air stream and collected onto a conveying belt

whereby

a) the ratio of polymer throughput $[\text{kg/h}]$ / conveying belt speed $[\text{m/min}]$ is in the range of 0.40 to 1.20 and

b) the ratio of polymer throughput per meter die $[\text{kg/h/m}]$ / conveying belt speed $[\text{m/min}]$ is in the range of 1.5 to 3.5.

11. Use of soft non-woven melt-blown web according to anyone of the preceding claims 1 to 9 for producing articles comprising the non-woven melt-blown web, wherein said article is selected from hygiene products, as well as protective films or articles for medical/surgical applications.

12. Articles comprising a soft non-woven melt-blown web according to anyone of the preceding claims 1 to 9, wherein said article is selected from hygiene products, as well as protective films or articles for medical/surgical applications.

Figure 1: Web of Inventive Example 1

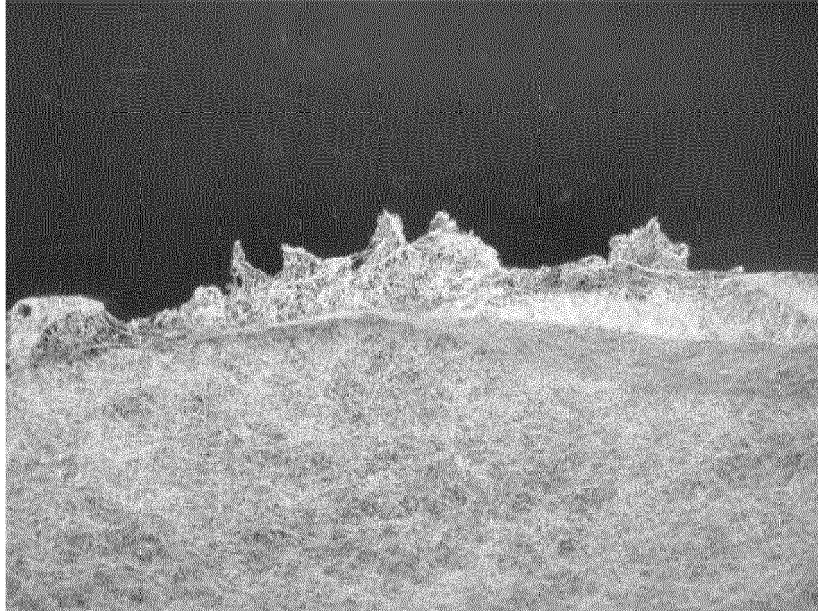


Figure 2: Web of Comparative Example 1

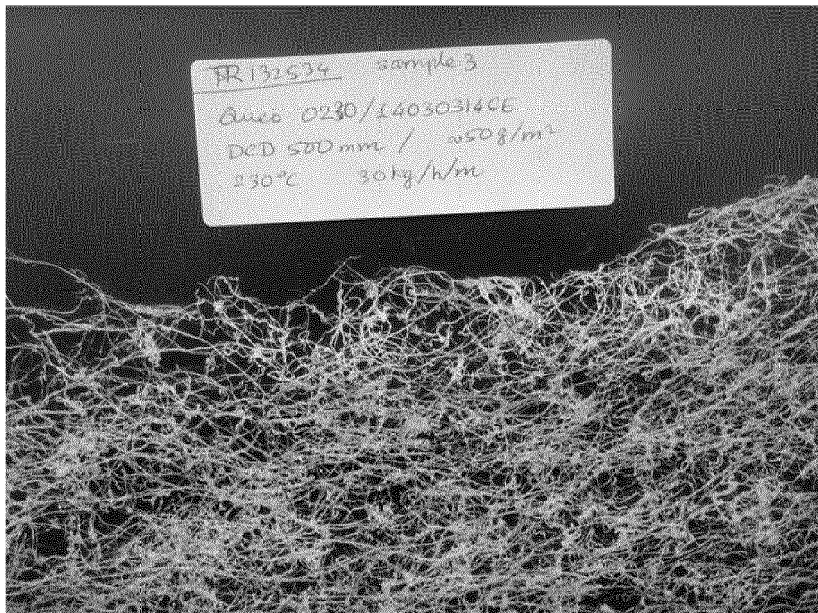


Figure 3: Web of Comparative Example 2

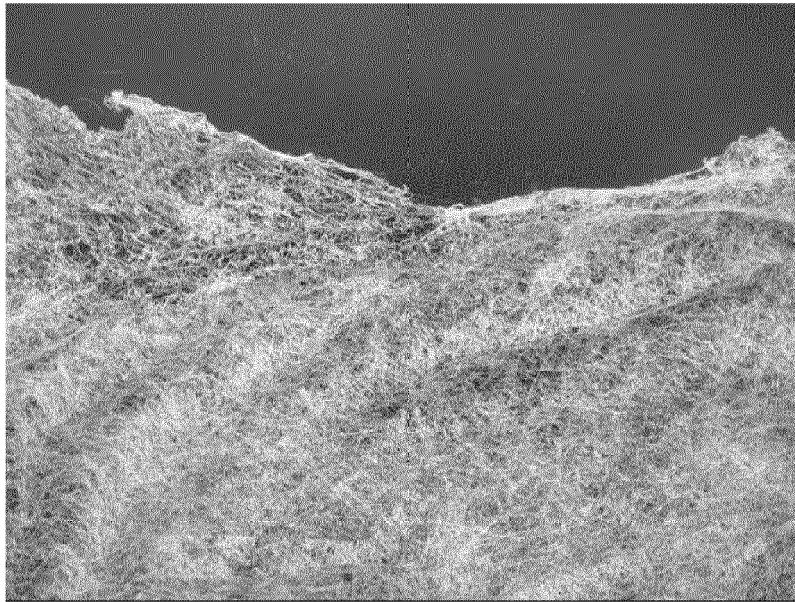
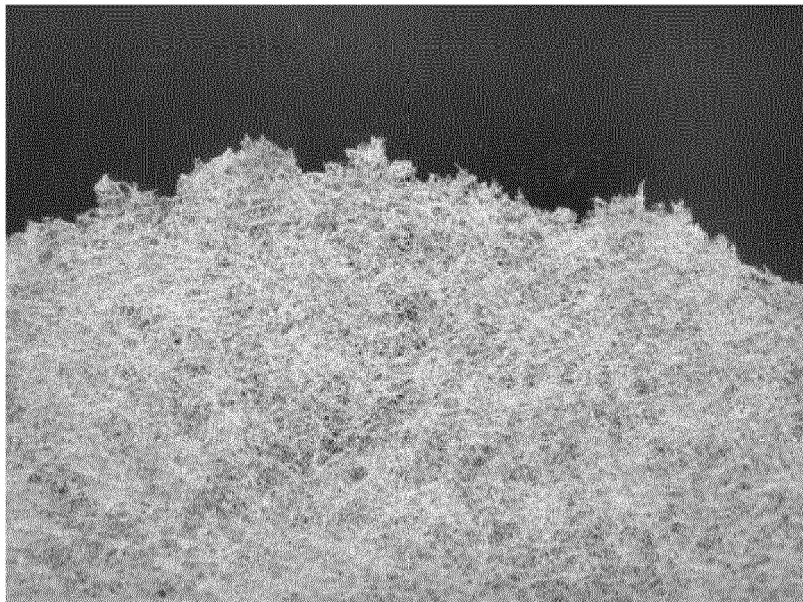


Figure 4: Web of Comparative Example 3





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