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**CONTINUOUS FILAMENT NONWOVEN FABRIC**Field of the Invention

This invention relates to continuous filament nonwoven fabrics and to a process for producing such fabrics. More particularly, the present invention  
5 produces continuous filament nonwoven fabrics formed of a polymer blend which exhibit desirable strength properties, and which can be manufactured by existing equipment.

Background of the Invention

10 Nonwoven fabrics of the type to which the present invention pertains comprise a plurality of continuous filaments formed from a blend of thermoplastic polyolefin polymers randomly disposed to form a web. The continuous filaments of the web are  
15 thermally bonded to one another to form a cohesive network of filaments which gives the fabric good strength and flexibility properties. Accordingly, the fabrics are suitable for use in hygiene applications, such as disposable diapers, or in medical applications,  
20 such as in disposable medical garments and the like.

Continuous filament nonwoven fabrics of this type may be produced by the well-known "spunbond" process in which molten thermoplastic polymer is extruded from a spinneret to form an array of  
25 continuous filaments, the filaments are attenuated and drawn pneumatically, they are deposited on a collection

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surface to form a web, and the filaments are thermally bonded to form a strong, coherent fabric.

In accordance with one well-known type of spunbonding process, known as the Lurgi process, the continuous filaments are attenuated and drawn by passing through venturi tubes. Pressurized air supplied to the venturi tubes accelerates the filaments to a linear velocity on the order of 3500 meters per minute, causing attenuation and drawing of the filamentary polymer extrudate. The rapidly moving filaments are discharged from the venturi tubes and deposited on a moving belt or wire to form a web. The filaments of the web are then bonded at filament intersections to render the web coherent and impart strength to the nonwoven fabric. The bonding may, for example, be carried out by passing the web of filaments through the nip of a pair of cooperating heated calender rolls. One of the calender rolls may be engraved with a pattern of raised areas or lands so that the bonding forms individual discrete bond areas throughout the fabric.

In another spunbond process, filaments are accelerated through a slot from an open-air quench chamber, by means of a vacuum from beneath the moving belt. The continuous filaments are attenuated and quenched primarily above the slot, but continue to be pulled to the wire by means of reduced pressure below the wire. Filaments velocities range from several hundred meters per minute to greater than 1000 meters per minute. The filaments of the web are then bonded at filament intersections similar to other spunbond processes.

In other known spunbond processes, the freshly extruded filaments of thermoplastic polymer are attenuated and drawn by an attenuator device in the form of an elongate slot rather than by individual venturi tube attenuators. The slot extends in the

cross-machine direction typically the full width of the nonwoven fabric. Air is caused to move downwardly through the elongate slot, entraining the filaments and causing them to be attenuated and drawn before being discharged from the slot and deposited on a moving belt or wire. This type of "slot-draw" system accelerates the filaments to speeds typically in excess of 1500 meters per minute, with higher filament velocities (e.g., greater than 10,000 meters per minute) being possible.

The above-noted spunbond process for producing continuous filament nonwoven fabrics (spunbonded fabrics) is distinctly different in a number of respects from other conventional manufacturing processes for producing nonwoven fabrics, such as staple fiber nonwovens for example. Very significant differences reside in the conditions under which the filaments are formed and deposited to form a nonwoven fabric. The linear filament velocity and filament melt draw conditions are much more severe in a spunbond process than, for example, in the manufacture of melt-spun filaments for staple fiber nonwoven webs. In those applications, the filaments are typically drawn mechanically, e.g. by rotating rolls, which handle the filaments more gently and more steadily and generally at lower linear velocities, e.g., from several hundred meters per minute up to about 1200 meters per minute, than the pneumatic attenuator devices used in most spunbond processes. Whereas spunbond processes generally spin at velocities to achieve the desired denier in the web, staple processes spin higher deniers which are then drawn in separate downstream processes to the final desired denier. Therefore even when filament velocities are roughly equivalent between spunbond and staple processes, spunbond processes are producing finer deniers with greater air turbulence and force variation than in

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staple processes. The melt-spun filaments for staple fiber nonwovens are typically "cold drawn" to the desired denier, chopped into staple fibers, and the staple fibers are formed into nonwoven webs in a separate subsequent operation, typically by carding or air laying. The webs can be bonded together either with chemical binders or by thermal bonding, e.g., calendering.

In general, the spunbond process is more complex than staple fiber nonwoven processes since the formation of the filaments, drawing of the filaments to fine deniers, quenching of the filaments, separation of the filaments, and formation of the filaments into a web occur in a continuous operation. Because of the integrated nature of the operation, the selection of the polymer is significant in achieving good processability. The selected polymer should have desirable processing attributes which may sometimes conflict. Because air is used to draw the filaments, a polymer with an optimal melt tension should be selected to enable drawing of the filaments to a desired fineness at reasonable air pressures and volumes. Excessive tension or elasticity will result in higher deniers and an increased number of filament breaks resulting in molten droplet contamination of the forming wire. Conversely, polymers with a lower than desirable melt tension can lead to filament collisions and ductile filament failure. Web formation can also be negatively impacted by low melt tension. Melt tension typically does not directly affect filament denier in staple fiber processes since the filaments are cold drawn utilizing mechanical godets and rolls. As such, filament denier is primarily determined by the capillary throughput relative to the take-up roll velocity. Regarding filament distribution and web formation in a spunbond process, a number of polymer, filament, and processing characteristics have been

found to impact these steps including capillary throughput, quench and smoke removal, flow of entrained air, melt tension, filament surface properties, filament flexibility, denier, air/filament velocity ratio, static charge, forming system air flow, and wire design. Many of these factors are interdependent.

In spite of its complexity, the spunbonding process offers advantages relative to staple fiber processes. For example, the integrated process of spinning, web formation, and bonding is less costly than a multiple step staple fiber operation. Additionally, the continuous filaments of the spunbond fabrics tend to produce stronger fabrics than staple fiber products made from comparable polymers.

An important factor in developing strength in a spunbonded or staple fabric is the bonding operation. This is especially true with respect to staple fabrics. For example, the discontinuous fiber of carded staple nonwovens, are more dependent upon bonding for the development of tensile strength properties. Bonding serves to join the filaments of the web into a cohesive network. The bonds assist in the transfer of a load or stress to a larger population of filaments. The greater number of filaments which contribute to load bearing, in combination with individual filament strength or toughness, the stronger the fabric.

Process conditions during filament spinning also greatly affect resulting nonwoven fabric strength properties. Especially significant are factors which impact polymer melt flow rate such as temperature. A particularly troubling technical problem relates to the careful control required to minimize polymer breakdown, especially in the processing of polyolefins at high commercial speeds. The rheology of such "minimally-process-altered" polymer is suitable for stable spinning usually over a limited range of melt temperatures. Employing high temperatures (i.e., over

260°C) can result in "over cracked" polymer, characterized by excessively reduced molecular weight and molecular weight distribution (MWD). The combination of "cracked" polymer with high temperature  
5 can adversely affect web formation. Moreover, poor spinning, characterized by limp spinline, filament collisions, and ductile failure is also experienced.

Recent efforts have focused on improving process control over polymer degradation so as to  
10 provide fabrics with improved strength and toughness. In particular, spinning conditions have been employed which facilitate the controlled oxidation of the fiber surface. One condition which is of particular importance involves maintaining a polymer of lower melt  
15 flow rate (MFR) in an extruder and at the spinneret at a higher temperature, preferably above 250°C, and most preferably above 280°C, depending upon time in the extrusion process, and the level of stabilization, than employed in traditional processes. As a result of the  
20 surface of the fibers being modified in such a "hot block" process, improved filament bonding is obtained and hence a stronger fabric. For example, U.S. Patent No. 5,281,378 and European Patent Application No. 391,438 have reported producing polypropylene fabrics  
25 with improved strength and heat-bonding properties by employing "hot spun" conditions. In particular, the references primarily focus on forming fabrics comprised of staple fibers formed from melt-spun filaments with an oxidatively degraded sheath or surface.

30 The production of fabrics comprising spunbonded continuous filaments under "hot block" conditions has yet to be fully addressed. From a processing standpoint, difficulties must be confronted which are not largely faced in producing staple fiber  
35 fabrics. For example, due to the higher velocities associated with the spunbonded process, polymers with lower melt flow rates and excessively broad molecular



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weight distributions often display a high resistance to draw, resulting in poor spinnability. This is especially troublesome in the production of fine denier continuous filaments which are very desirable in medical, hygiene, and barrier fabric applications. Furthermore, air turbulence and filament velocity fluctuations place another demand on the polymer system generally not encountered in mechanical take-up spinning in that the surface oxidized filaments tend to associate and bundle together during filament distribution, thus disrupting proper web formation. As a result, the resulting structure of bundled filaments is nonuniform, displaying poor aesthetics and strength properties.

15

#### Summary of the Invention

The present invention is directed to the production of continuous filament nonwoven fabrics spun at high velocities under high temperature conditions. The process of the invention provides filaments which exhibit high drawability and minimal association or bundling. Accordingly, good filament distribution is realized along with a uniform, coherent, strong fabric.

In accordance with the invention, it has been found that a blend of thermoplastic polymers can be melt spun under conditions which are responsible for controlled oxidation of the fiber outer surface so that the resulting fibers are capable of forming strong interfilamentary bonds. In particular, these conditions include selecting a polymer blend which is higher in molecular weight (MW) than is typically used for a low temperature process or given product, maintaining the polymer blend in the extruder and at the spinneret at a temperature higher than usually employed for a lower MW polymer or product, and controlling the extrusion conditions (e.g. spinneret capillary diameter, polymer blend throughput) and

quench conditions, depending upon polymer molecular and rheological characteristics, as well as the level of stabilizer in the polymer blend, in order to promote a controlled oxidative degradation, and consequent  
5 reduction in molecular weight, in a zone at the outer surface of the filaments.

In accordance with the invention, the blend comprises at least two thermoplastic polymers with one of the polymers being a polyolefin. In addition, it is  
10 preferred that one of the polymers comprise a majority of the blend by weight. A propylene polymer (i.e., a polymer composed of greater than 40% weight propylene moieties, such as a polypropylene homopolymer,  
copolymer, or terpolymer) having a melt flow rate of 35  
15 g/10 min. or lower is a preferable majority component. An ethylene-propylene copolymer having a melt flow rate of 15 g/10 min. or lower is another preferred majority component.

Various minority components can be utilized  
20 in the blends including, for example, polymers which are soft and elongatable, including an ethylene polymer. Numerous other components can be employed as well, such as polybutene and propylene copolymers. A preferred blend employing a soft, elongatable polymer  
25 comprises between about 1 to 50 percent by weight of ethylene polymer and about 99 to 50 percent by weight polypropylene, with high density polyethylene more preferably being utilized. Other preferred blends and compositions may be employed and are as follows: 1 to  
30 50 percent by weight polybutene and 99 to 50 percent by weight polypropylene; 1 to 50 percent by weight of ethylene polymer and 99 to 50 percent by weight of an ethylene-propylene copolymer having a melt flow rate of  
15 g/10 min. or less; and 1 to 50 percent by weight  
35 polybutene and 99 to 50 percent by weight of ethylene-propylene copolymer having a melt flow rate range as above.

The blends of the invention may also employ more than two polymers; for example, three and four polymer components may be added to a two component blend to modify blend compatibility, viscosity, or polymer crystallinity. A preferred three component blend comprises 1 to 50 percent by weight of polypropylene having a melt flow rate of 35 g/10 min. or less with the balance of the blend comprising a propylene copolymer and an ethylene polymer.

According to the present invention, a continuous filament nonwoven fabric is produced by forming a melt blend of at least two thermoplastic polymers wherein at least one is a polyolefin, and preferably containing a propylene polymer of melt flow rate of 35 or lower as the majority component, extruding the melt blend through a spinneret to form continuous filaments at a temperature and throughput such that oxidative degradation of at least one polymer component of the outer sheath portion of the filaments occurs, preferably at a temperature above 250°C, and most preferably between 270°C and 320°C and at a throughput preferably greater than about 0.1 gram per minute per hole, and most preferably between about 0.5 to 5.0 grams per minute per hole, pneumatically accelerating the filaments, preferably at speeds in excess of 100 meters per minute, and most preferably at speeds in excess of 1500 meters per minute to attenuate and draw the filaments to a preferred fineness of 5 denier or less, forming the drawn and attenuated filaments into a continuous filamentary web, wherein the dominant thermoplastic polymer in the blend which form the filaments preferably has an average molecular weight distribution of less than 5.5, and thermally bonding the filaments to form a coherent continuous filament nonwoven fabric.

The invention provides a nonwoven fabric comprising drawn continuous filaments of a

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thermoplastic polymer blend, the filaments being randomly arranged to form a web. A multiplicity of thermal bonds serve to bond the filaments together to form a coherent continuous filament nonwoven fabric.

5 Oxidative degradation of at least one polymer component in the outer sheath portion of the filaments is evidenced by a relative reduction in weight average molecular weight of the polymer component compared to the polymers present in the inner fiber portion. The  
10 MFR of the web is preferably between 5 and 100, and most preferably between 5 and 35 g/10 min.

In accordance with the invention, a uniform, coherent spunbonded fabric is obtained displaying excellent strength, toughness, elongation, and bonding  
15 properties. Accordingly, the nonwoven fabric is especially desirable in numerous applications including those involving medical, hygiene, and industrial.

#### Detailed Description

The present invention is directed to the  
20 production of continuous filament nonwoven fabrics from blends of thermoplastic polymers including at least one polyolefin polymer derived by polymerization from relatively simple olefins. More particularly, the invention is primarily directed to the formation of  
25 spunbonded nonwoven fabrics from blends comprised of a propylene polymer of low melt flow rate.

For the purposes of the invention, the term "polymer" is used in a general sense, and is intended to include homopolymers, copolymers, grafted  
30 copolymers, and terpolymers. In general, the invention can be effectively practiced with starting polymers of a wide variety of different distributions. The term "blend" is also used generally herein, and is intended to include immiscible and miscible polymer blends. For  
35 the purposes of the invention, the polymers are considered to be "immiscible" if they exist in

separate, distinct phases in the molten state; all other blends are considered to be "miscible". In accordance with the invention, the polymer blend which forms the fabric has sufficiently low melt flow rate (MFR) such that the resulting filament web has an MFR between 5 and 100 g/10 min., and more preferably between 5 and 35 g/10 min. The MFR is determined according to ASTM test procedure D-1238 and refers to the amount of polymer (in grams) which can be extruded through an orifice of a prescribed diameter under a mass of 2.16 kg at 230 °C in 10 minutes. The MFR values as used herein have units of g/10 min. or dg/min.

Moreover, the polymers can encompass a variety of molecular weight distributions. For the purposes of the invention, molecular weight distribution (MWD) is defined as the weight average molecular weight of the dominant polymer (i.e., the polymer which comprises the greatest percentage of the blend) divided by the number average molecular weight of the dominant polymer. Both molecular weight determinations used in calculating the MWD are made in accordance with standard procedures. Preferably, the MWD of the dominant thermoplastic polymer in the blend is less than 5.5. For the purposes of the invention, the preferred MWD range is applicable to the polymers just prior to being drawn into filaments and to the polymers present in the filaments of the formed web.

For purposes of the invention, the polymers which comprise a miscible or immiscible blend can be combined in manners utilized in conventional extrusion processes. For example, the polymers can be dry blended in any acceptable form and heated in the barrel of an extruder to form a melt blend. In particular, a suitable level of mixing is necessary such that the polymers which form an immiscible blend become adequately dispersed. In some cases, sufficient mixing

of the polymer components may be achieved in the extruder as the polymers are converted to the molten state, although it may be preferable to use an additional mixing zone or step.

5           At least two thermoplastic polymers will be present in the blend, in which at least one is a polyolefin polymer. A preferred blend comprises two polymers, with one being the majority component by weight and the other being the minority component.

10 Various polymers can be utilized as the majority component, including but not limited to, polyolefins such as a propylene polymer (e.g., homopolymer, copolymer, or terpolymer), a polymethyl pentene (TPX), a polymethyl pentene copolymer, and an ethylene-

15 propylene copolymer. Polycondensate polymers may also be used such as polyethylene terephthalate, polybutylene terephthalate, or a polyamide (e.g., nylon).

          Various polymers can be utilized as minority

20 components in the blend, and preferably, for example, those which are soft and elongatable. Examples of soft, elongatable polymers include metallocene polyolefin polymers, elastomers, and plastomers. Preferred soft, elongatable polymers include standard

25 ethylene polymers made by Ziegler-Natta or high pressure techniques as well as commercially suitable soft, elongatable polymers such as the Catalloy polyolefins available from Himont Incorporated, the Exact Series of polymers available from the Exxon

30 Chemical Company, and the Affinity polymers available from the Dow Chemical Company. The minority component can also include well known polymers which are miscible or soluble with the majority component including, for example, a polybutene or another propylene polymer,

35 copolymer, or terpolymer differing in either chemistry or molecular characteristics (e.g., molecular weight or molecular weight distribution) from the low MFR

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propylene polymer employed as the majority component. Ethylene-propylene copolymers may also be used.

In the case of either miscible or immiscible polyolefin blends, a propylene polymer (e.g.,  
5 polypropylene homopolymer, copolymer, or terpolymer) having a melt flow rate of less than 35 is a preferred majority component in the blend. More preferably, the propylene polymer has a melt flow rate of less than 15. A preferred immiscible blend comprises about 1 to 50  
10 percent by weight of an ethylene polymer and 99 to 50 percent by weight propylene polymer. More preferably, the blend comprises about 2 to 20 percent by weight of polyethylene and about 98 to 80 percent by weight polypropylene. High density polyethylene is preferably  
15 employed in the above compositions.

Several preferred miscible blends may also be employed. For example, one blend comprises polybutene from about 1 to 50 percent by weight and 99 to 50 percent by weight propylene polymer having the  
20 MFR values listed above, and, more preferably, between about 2 to 10 percent by weight polybutene and 98 to 90 percent by weight polypropylene. Other preferred blends comprise an ethylene-propylene copolymer as the majority component. For example, one blend comprises an  
25 ethylene polymer from about 1 to 50 percent by weight and an ethylene-propylene copolymer from about 99 to 50 percent by weight and having a melt flow rate of less than 15 g/10 min. More preferably, the blend comprises between 2 to 10 percent by weight of ethylene polymer  
30 and 98 to 90 percent by weight ethylene-propylene copolymer. Another preferred blend comprises polybutene from about 1 to 50 percent by weight and 99 to 50 percent by weight ethylene-propylene copolymer, and most preferably, between 2 and 10 percent by weight  
35 polybutene and 98 to 90 percent by weight ethylene-propylene copolymer.

Specific blend compositions utilizing polycondensate polymers may be also employed in accordance with the invention. For example, polyethylene terephthalate (PET) may be blended in any ratio with a polyolefin. In one preferred embodiment PET may comprise 50 to 99 percent by weight of the blend while the other polymer comprises the balance of the blend (1 to 50 percent by weight) and may be selected from any one of the following: an ethylene polymer, a propylene polymer, an ethylene-propylene copolymer, a methyl pentene polymer and polybutene. In another embodiment, polyamide (PA) may be blended in any ratio with a polyolefin. In one preferred embodiment PA may comprise between 50 and 99 percent by weight of the blend while the other polymer comprises the balance of the blend (1 to 50 percent by weight) and may be selected from those polymers listed above.

Blends with more than two polymers may also be utilized, including those with three and four polymer components. Both immiscible and miscible polymers may be added to a two component blend to impart additional properties or benefits with respect to blend compatibility, viscosity, polymer crystallinity or phase domain size. A preferred category of blends are those comprised of a dominant low MFR propylene polymer component, a separate ethylene component, and at least one additional polymer component selected from the following: polybutenes (e.g., Shell Duraflex polymers and copolymers), Catalloys (i.e., co- and ter- polymers of propylene), polyvinyl acetates, acrylates (e.g., polymethacrylate, polymethylmethacrylate), acrylic acid copolymers, grafted copolymers of ethylene or propylene (e.g., maleic anhydride grafted onto polyethylene), polylactic acids, and thermoplastic starch based polymers. A preferred blend includes 5 to 50 percent by weight of a propylene co- or ter- polymer with the balance



comprising polypropylene having a melt flow rate of less than 35 g/10 min. and polyethylene. Most preferably, the blend comprises between 2 and 20 percent by weight of propylene co- or ter- polymer with the balance comprising polypropylene and polyethylene.

Since the polymer blends employed in the invention will almost universally undergo some level of degradation in the extrusion process, stabilizers and antioxidants are conventionally added to the polymer blend. The level and kind of stabilizer/antioxidant can affect the degree to which the blend undergoes degradation. The stabilizer/ antioxidant concentrations in the polymer blend typically may range from 0-1% by weight. When present, the antioxidant/stabilizer is preferably within a range of about .005%-0.5%. Antioxidant/ stabilizer compositions which can be used include at least one composition selected from the group consisting of organic phosphites, organic phosphonites, hindered phenols, and hindered amines. Examples of such compositions include phenylphosphites such as Sandostab PEP-Q from Sandoz Chemical Co., distearyl pentaerythritol diphosphite (DSTDP); phenol substituted nitrogen heterocyclic compounds, e.g. Goodrite 3114; N,N'-bis-piperidinyl diamine-containing compositions; hindered amine stabilizers such as 1,2,2,6,6-pentamethyl piperidines. More specific examples of antioxidant/stabilizer compositions which may be used in the polymer blends for this invention are disclosed in published European Patent Application, EP 391,438, which is incorporated herein by reference. Other additives conventionally used in the production of continuous polymer filaments can also be incorporated in the polymer blend such as antiblocking agents, impact modifiers, plasticizers, UV stabilizers, pigments, delusterants, lubricants, wetting agents, antistatic agents, nucleating agents, water and alcohol repellents, etc, in the conventional amounts, which are

typically no more than about 10% by weight. Polymeric additives may also be used in conjunction with the blends which impart specific benefits to either processing and/or end use. For example, plastomers, 5 compatibilizers, viscosity modifiers or diluents which affect phase domain size or crystallinity may be included.

The polymer blend continues to undergo thermo-oxidative and/or photo-oxidative degradation 10 after exiting the extrusion die. At the elevated extrusion temperatures used in the present invention, it appears that an oxidation reaction occurs on the surface of the molten filaments, which forms an oxidized sheath on the cooled filaments. Oxidation of 15 the filament surface activates the surface so that it assists in bonding, lamination and retention of topical additives, such as surfactants, water or alcohol repellents, printing inks, and the like.

The process parameters which control the 20 polymer blend surface oxidation include the following:

1. Extrusion temperature;
2. Extrusion shear;
3. Extrusion residence time (time at temperature);
- 25 4. Presence of oxygen in the extrusion process;
5. Die temperature;
6. Extruded polymer blend temperature;
7. Spinneret capillary diameter (affects die swell, surface to volume ratio, and time at 30 elevated temperature);
8. Polymer blend capillary throughput (grams/minute/hole);
9. Oxidizer (oxygen) concentration beneath the die and in the draw zone;
- 35 10. Temperature of the draw zone area;
11. Draw rate.

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The oxidation reaction is complex, since the key process variables are constantly changing in any moderate to high speed spunbonding operation. For example, filament temperature (and therefore time at 5 temperature), density and diameter (and therefore surface to volume ratio) are changing constantly and non-linearly between the capillary exit and the freeze point of the spinline. The concentration of active stabilizer changes as it reacts with diffused oxidizer. 10 Also, the polymers in the blend are constantly changing as they react, are drawn, and cool. However, these process parameters can be manipulated in order to achieve a desired controlled degree of surface oxidation for various polymer blends with various 15 stabilizer levels. Thus, as described in Examples 1 and 2, highly stabilized, high molecular weight blends can be processed through manipulation of process parameters 1 to 11 above to produce spunbond nonwoven fabrics with excellent filament bonding.

20 Die temperature affects the temperature of the polymer blend just before it is exposed to the atmosphere below the die. The temperature of the blend as it exits the die capillary, and before it is significantly quenched, will affect the rate of 25 oxidation. The higher the temperature of the polymer blend melt, the more rapid the oxidization. For moderately stabilized blends, the die temperature is preferably above 250°C, and for highly stabilized thermoplastic polymer blends, the die temperature is 30 preferably above 270°C, and most desirably within the range of 285°C to 320°C.

At constant capillary throughput, larger capillary diameters, or capillary cross-sectional areas in the case of non-cylindrical capillaries, will 35 decrease the polymer blend linear velocity in and just beneath the die. This increase in polymer blend residence time in and near the die, where the polymer

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blend temperature is at its peak, has a significant affect on the extent of oxidation. While smaller diameter capillaries may create higher die swell, which in turn decreases the linear velocity, this effect tends to reduce the surface to volume ratio. Therefore capillary diameters must be balanced with other materials and process conditions. Larger diameters will, however, tend to increase the extent of oxidation. Preferably, to achieve optimum levels of oxidation, the spinneret capillaries are from 0.4 to 1.2 mm, and most preferably between about 0.6 to 1.0 mm, or have a cross-sectional area from about 0.2 to 1.2 mm<sup>2</sup>.

Capillary throughput affects the polymer blend linear velocity just beneath the die, and can therefore affect the extent of oxidation for reasons similar to those given above. Throughput also affects the extent of oxidation indirectly, by having an affect on the total mass of the material to be oxidized and the die swell. Higher polymer blend throughput, in general, will tend to reduce the extent of oxidation. Preferably, the polymer blend throughput is within the range of 0.1 to 5 grams/minute/hole for spinning speeds of about 100 to 10,000 meters/minute, and most preferably from 0.5 to 2.0 grams/minute/hole for spinning speeds of about 1500 to 5000 meters/minute.

The concentration of oxygen or other oxidizing gases just below the die and in the draw zone will affect the rate and extent of oxidation. If the cooling rate of the extruded molten filament is retarded, the time it spends at elevated temperature is increased, giving it more time to oxidize. Draw zone conditions (e.g. quench temperature, quench and smoke removal flow rate) should have an affect on the extent of oxidation. Generally, slower quenching will increase the extent of oxidation.

Draw rate can affect oxidation in several ways. Higher draw rates increase the surface to volume ratio of the molten polymer blend strand, by rapidly decreasing filament diameter. However, the increased surface to volume ratio also increases the rate at which the filament is quenched.

Generally, more highly stabilized polymer blends will require one or more of the following process adjustments: higher extrusion temperature; higher shear extrusion; longer extrusion resident time; higher melt temperature at the die; larger capillary diameter; delayed quenching. For polymer blends that contain less stabilizer, some or all of these condition may be reversed. For polymer blends whose stabilizers are inactivated in the extrusion process, die temperature and capillary diameters would be similar to those of less stabilized polymers.

The nonwoven fabrics described herein can be used in various applications where spunbonded nonwoven fabrics are found useful. Especially preferred are fabrics formed of fine denier continuous filaments (i.e., 5 or below), which are desirable in many areas including medical applications, hygiene, agricultural, industrial fabrics, and the like. As an example, such fabrics serve as an effective liner or top sheet component in disposable absorbent articles such as diapers, incontinence briefs, and feminine hygiene products. The fabrics may also be formed and/or laminated to at least one other component to form a composite nonwoven fabric which can be effectively employed in a disposable absorbent article. For example, the spunbond fabric may be formed and/or laminated to at least one other component selected from the group consisting of a carded nonwoven fabric, a spunbonded nonwoven fabric, a meltblown nonwoven fabric, a net, and a film.

The invention, and how to make and use the same, will be understood more completely from the examples which follow, which are intended to be illustrative of the invention, but not to limit the scope of the invention.

#### Comparative Examples 1-4

For the purposes of comparing Examples 5-16, Examples 1-4 were prepared as outlined below. Examples 1 and 2 represent standard hygiene fabrics prepared from traditional spunbond polymers. Examples 3 and 4 represent fabrics comprising a blend spun at conventional low temperatures. Spinning performance and fabric properties are reported in Table I.

#### Example 1

A 35 MFR (CR Grade) polypropylene (Exxon 3445) was melt spun into continuous filaments on a 60 mm diameter, 5 heating/cooling zone, 30:1 l/d extruder, equipped with a barrier flighted, high work screw designed for polypropylene extrusion, with a pin mixing head. The extruder zones were maintained at a temperature profile as follows: 265/265/250/250/250°C. The melt block, pump and die were maintained at a temperature of 255°C.

The spinneret employed had 1134 holes, each with a 0.4 mm capillary diameter. The melt temperature near the die was measured to be about 250°C. A 50 cc/revolution pump was used at a speed of 27 RPM, producing a throughput of about 0.9 grams per minute per hole.

The filaments were extruded into a 1 meter single quench zone equipped with temperature and flow control. The filaments were thereafter directed through Lurgi attenuators operating with compressed air at a pressure of 20 bar. The filaments were deposited onto a moving collection surface such that a fabric

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resulted using an oil heated calender system, equipped with parallel embossed and smooth rolls which formed a nip. The embossed roll surface temperature was 147°C and a smooth roll surface temperature of 146°C.

5

Example 2

A 35 MFR (CR) PP polypropylene (Aristech 380B) was melt spun into continuous filaments utilizing the system and under the conditions described in Example 1.

10

Example 3

A blend of 10% by weight 400 MFR polypropylene (PP, Himont HH 441) and 90% by weight polypropylene (Aristech 380B) was formed using a Conair hopper additive system. The blend was melt spun into continuous filaments utilizing the system and under the conditions described in Example 1.

20

Example 4

A blend of 5% by weight high density polyethylene (Dow HDPE 08065E, 8 MI, 0.965 g/cc, 130°C melt. temp.) and 95% by weight polypropylene (Exxon 3445, 35 MFR, 0.9 g/cc, 165°C melt. temp.) was formed using a Conair hopper system and spun into continuous filaments utilizing a similar system to Example 1 with the following exceptions: (1) the extruder zones were maintained at a temperature profile of 215/225/240/250/250°C and (2) the melt block, pump, and die were maintained at a temperature of 245°C.

25

Example 5

A blend of 10% by weight 400 MFR polypropylene (Himont HH 441) and 90% by weight polypropylene (Appryl 3130) was formed using a Conair hopper additive system. The blend was melt spun into fine denier filaments utilizing the system described in

30

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Example 1 with the following exceptions: (1) the extruder zones were maintained at a temperature profile of 270/270/280/290/285°C, (2) the spinneret used had 756 holes, each with a 0.9mm capillary diameter, (3) 5 the speed of the pump was 18 RPM, and (4) the compressed air utilized in the Lurgi attenuators was 15 bar.

Spinning performance and fabric properties are reported in Table I. In general, RMS grab tensile 10 and toughness values were superior to the comparison fabrics of Examples 1-4 and in particular Example 4. Moreover, MD and CD percent elongation compared favorably with the comparison fabrics. Good spinnability of the sample filaments was also observed.

15

Example 6

A blend of 5% by weight high density polyethylene (Dow HDPE 08065E) and 95% by weight polypropylene (Appryl 3130) was formed using a Conair hopper additive system and spun into continuous 20 filaments on a 60 mm diameter, 5 heating/cooling zone, 30:1 l/d extruder, equipped with a barrier flighted, high work screw designed for polypropylene extrusion, with a pin mixing head. The extruder zones were maintained at a temperature profile as follows: 25 275/265/290/295/290. The melt block, pump and die were maintained at a temperature of 290°C.

The spinneret employed had 756 holes, each with a 0.65mm capillary diameter. The melt temperature of the polymer near the die was measured to be about 30 275°C. A 50 cc/revolution pump was used at a speed of 18 RPM, producing a throughput of approximately 0.9 g/m/h.

The filaments were extruded into a 1 meter single quench zone equipped with temperature and flow 35 control. The filaments were thereafter directed through Lurgi attenuators operating with compressed air



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at a pressure of 13 bar. The filaments were deposited onto a moving collection surface to form a web. The web was bonded such that a fabric resulted using an oil heated calender system, equipped with parallel embossed and smooth rolls which formed a nip. The embossed roll surface temperature was 148°C and a smooth roll surface temperature of 147°C.

Spinning performance and fabric properties are reported in Table I. Similar to Example 5, RMS grab tensile and toughness values were superior to the comparison fabrics of Examples 1-4. Additionally, the MD and CD percent elongation values of the sample also compared favorably. Good spinnability of the sample filaments was also observed.

#### 15 Examples 7-8

Examples 7-8 represent fabrics formed of polyethylene and polypropylene. In Example 7, a blend of 4% by weight high density polyethylene (Dow HDPE 08065E, 8 MI, 0.965 g/cc, 130°C melt temp.) and 96% by weight polypropylene (Appryl 3130) was formed using a Conair hopper additive system and spun into continuous filaments on a 60 mm diameter, 5 heating/cooling zone, 30:1 l/d extruder, equipped with a low work, single flighted, 'Nylon' screw. The extruder zones were maintained at a temperature profile of 270/280/290/300/300°C. The melt block, pump, and die were maintained at a temperature profile of 300/300/300/295°C. The spinneret employed had 756 holes, each with a 0.65mm capillary diameter. A 70 cc/revolution pump was used at a speed of 11.4 RPM, producing a constant throughput of approximately 0.8 g/m/h. The filaments were extruded into a 1 meter single quench zone equipped with temperature and flow control. The filaments were thereafter directed through Lurgi attenuators operating with compressed air at a pressure of 20 bar. The filaments were deposited

onto a moving collection surface to form a web. The web was bonded such that a fabric resulted using an oil heated calender system.

In Example 8, 8% by weight high density  
5 polyethylene was blended with 92% by weight Appryl 3130 under conditions employed in Example 7.

Spinning performance and fabric properties are reported in Table II. As shown, the samples yielded superior grab tensile strength values relative  
10 to Examples 1-4, along with improved elongation. Good spinnability of the filaments in both examples was also observed along with good web formation.

#### Examples 9-11

Examples 9-11 represent fabrics comprising  
15 blends of polybutene and polypropylene. In Example 9, a blend of 10% by weight polybutene homopolymer (Shell Duraflex DP0300, 4 MI, 0.915 g/cc, 125°C melt temp.) and 90% by weight polypropylene (Appryl 3130) was formed and melt spun into filaments utilizing the  
20 system described in Example 7 with the following exceptions: (1) the extruder zones were maintained at a temperature profile of 250/270/290/290/290°C and (2) the melt block, pump, and die were maintained at a constant temperature of 290°C.

25 In Example 10, 10% by weight polybutene/ethylene copolymer (Shell Duraflex DP8340, 4.0 MI, 0.908 g/cc, 116°C melt temp.) was blended with 90% by weight Appryl 3130 under conditions similar to those in Example 9.

30 In Example 11, 10% by weight polybutene homopolymer (Shell Duraflex DP0800, 200MI, 0.915 g/cc, 125°C melt temp.) is blended with 90% by weight Appryl 3130 under conditions similar to Example 10 with the exception that the extruder zones were maintained at a  
35 temperature profile of 280/270/280/290/290°C.

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Spinning performance and fabric properties are reported in Table II. As shown, the samples yielded superior tensile strength values relative to Examples 1-4, along with favorable elongation values.

5 Good spinnability of the filaments in both examples was also observed along with good web formation.

#### Examples 12-16

Examples 12-16 represent fabrics comprising blends of heterophasic propylene copolymers (e.g.,

10 Catalloys produced by Himont) and polypropylene. In Example 12, a blend of 10% by weight of (i.e., Catalloy produced by Himont) Himont KS054P. (3.5 MI) and 90% by weight polypropylene (Appryl 3130) was formed and melt spun into filaments utilizing the system described in

15 Example 7 with the following exceptions: (1) the extruder zones were maintained at a temperature profile of 270/280/290/300/300°C and (2) the filter/piping/static mixer/pack zones were maintained at a temperature profile of 300/300/300/290°C.

20 In Example 13, 10% by weight of Himont KS059 (12 MI) was blended with 90% by weight Appryl 3130 under conditions similar to those in Example 12.

In Example 14, 15% by weight of Himont KS059 was blended with 85% Appryl 3130 under conditions

25 similar to Example 12 with the following exceptions: (1) the extruder zones were maintained at a temperature profile of 260/280/290/300/300°C and (2) the melt block, pump, and die were maintained at a temperature profile of 300/300/300/290°C.

30 In Example 15, 20% by weight of Himont KS059 was blended with 80% Appryl 3130 under conditions similar to Example 14.

In Example 16, 10% by weight of Himont KS057P was blended with 90% by weight of Appryl 3130 under

35 conditions similar to Example 12 with the following exceptions: (1) the extruder zones were maintained at

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a temperature profile 250/270/290/290/290°C and (2) the melt block, pump, and die was maintained at a temperature of 290°C.

Spinning performance and fabric properties are given in Table II. As shown, the examples yielded substantially higher strength values (up to 107% higher) relative to the comparison fabrics. Elongation and Toughness (TEA) values also yielded substantially higher results (up to 57% and 51% higher values, respectively). Good to excellent spinning results were also observed. Favorable web formation was observed with the possible exception of Examples 14, 15, and 16, although it is believed that this could be improved through the optimization of separation devices.

15

Example 17

A blend of 4% by weight of high density polyethylene (Dow HDPE 08065E) and 96% by weight polypropylene (Appryl 3130) was formed using a Conair hopper additive system and melt spun into continuous filaments on a 90 mm., 32:1 l/d extruder, equipped with a barrier flighted, low work screw with a pin mixing head. The extruder zones were maintained at a temperature profile as follows: 270/290/300/300/300°C. The melt block, pump, and die were maintained at a temperature of 290°C.

The spinneret employed has 1421 holes, each with a 0.65 mm. capillary diameter. A 46 cc/revolution pump was used producing an output of 0.8 grams/minute/hour.

The filaments were extruded into a 1 meter single quench zone equipped with temperature and flow control. The filaments were thereafter directed through a slot attenuator operating with compressed air. The filaments were deposited onto a moving collection surface such that a fabric resulted using an

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oil heated calender system, equipped with parallel embossed and smooth rolls which formed a nip.

Spinning performance and web formation is reported in Table III. As shown, the example displays  
5 favorable results.

#### Examples 18-20

Examples 18-20 represent fabrics comprising three component blends of a heterophasic propylene copolymer, high density polyethylene, and  
10 polypropylene. In Example 18, a blend of 10% by weight of Himont KSO59P, 4% by weight of HDPE (Dow 08065E), and 86% by weight of Appryl was formed and melt spun into filaments under conditions similar to Example 17.

In Example 19, the same percentage of Dow  
15 08065E HDPE and Himont KSO59P was blended with 86% by weight of polypropylene (Himont HOXP 621, 13 MFR) and melt spun into filaments under conditions similar to Example 19 with the following exceptions: (1) the extruder zones were maintained at a temperature profile  
20 of 270/280/290/290/290°C and (2) the melt block pump, and die were maintained at a temperature profile of 290/280°C.

In Example 20, 8% by weight of Dow 08065E HDPE, 10% by weight of Himont HOXP 621, and 82% by  
25 weight of Himont KSO59P were blended and melt spun into filaments under conditions similar to Example 19.

Spinning performance and web formation is reported in Table III. As shown, all of these examples show favorable results.

#### Examples 21-22

Examples 21 and 22 represent fabrics comprising blends of a heterophasic propylene copolymer (Himont KSO59P) and polypropylene (Appryl 3130). In  
30 Example 21, a blend of 10% by weight of Himont KSO59P was formed with 90% by weight of Appryl 3130 and melt  
35

spun into continuous filaments utilizing a system similar to Example 19.

In Example 22, a blend of 20% by weight of the Himont KSO59P was formed with 80% by weight of Appryl 3130 and melt spun into continuous filaments using a system similar to Example 21.

Spinning performance and web formation is reported in Table III. As shown, both of these examples show favorable results.

10

#### Examples 23-24

Examples 23 and 24 represent fabrics comprising blends of polybutenes (i.e., a homopolymer and a copolymer) and Himont HOXP 621 polypropylene. In Example 23, a blend of 10% by weight of polybutene copolymer with ethylene (Shell DP 8340, 4 MI) and 90% by weight of Himont HOXP 621 was formed and melt spun into continuous filaments utilizing a system similar to that used in Example 22.

In Example 24, a blend of 10% by weight of polybutene homopolymer (Shell DP 0400, 20 MI) and 90% by weight of Himont HOXP 621 was formed and melt spun into continuous filaments utilizing a system similar to that used in Example 20.

Spinning performance and web formation were reported in Table III. Example 23 displayed good results in both categories, while Example 24 showed excellent spinning, but only acceptable web formation.

#### Example 25

A four component blend was formed comprising: 4% by weight polyethylene, 10% by weight Himont KSO59P, 20% Appryl 3130, and 66% by weight of ethylene propylene copolymer (Exxon 18131-122-001, 10 MFR). The formed blend was melt spun into continuous filaments using similar conditions as employed in Example 24 with the following conditions: (1) the extruder block was

TABLE I:

GRAB TENSILE SUMMARY																	
COMPARISONS	EXAMPLE	BASE POLYMER (1)	ADD. (2)	SPNRT TYPE (3)	MELT TEMP (°C)	(6) SPIN RATING	DPF	WEB MFR	MD (lbs)	GRAB TENSILES (4)				RMS (5) TENS. (lbs)	RMS (5) TENS. % Increase (1,2)	RMS (5) TEA (lbs-in)	RMS (5) TEA % Increase (1,2)
										% E	TEA (lbs-in)	CD (lbs)	% E				
Std. Hygiene	1	A	--	x	250	4.3	2.2	53	6.7	45	5.0	8.6	49	6.6	7.7	5.9	--
Std. Hygiene	2	B	--	x	250	4.2	2.2	52	7.2	38	4	7.25	41	4.5	7.2	4.3	--
Low Temp. Blend	3	B	10% 441	x	250	4.5	2.2	60	7.1	35	4.3	10.4	40	6.8	8.9	5.7	--
Low Temp. Blend	4	A	5% HDPE	x	250	5.25	2.3	44	7.5	52	7.4	8.3	53	6.7	7.9	7.1	--
Invention	5	C	10% 441	y	274	3.5	2.7	30	8.6	46	7.0	9.5	42	5.7	9.1	6.4	25/12
Invention	6	C	5% HDPE	y	275	3.4	2.6	20	11.5	60	11.7	7.2	43	4.7	9.6	8.9	75/25
**All throughputs = 0.9 grams/minute/hole (g/m/h)													(3) SPINNERET TYPE: x: 1134 Capillaries, 0.4mm x 1.6mm y: 756 Capillaries, 0.65mm x 1.8mm				
(1) BASE POLYMER: A. Exxon 3445 (35 MFR CR PP) B. Arstetech 380B (35 MFR, CR PP) C. Appryl 3130 (13 MFR PP)													(4) Values corrected to 20 gsm. Values based on 8 replicates.				
(2) ADDITIVE TYPE: a. HIMONT 441 (400 MFR Polypropylene) b. DOW 08065E HDPE (8MI, 0.965G/CC, High Density Polyethylene)													(5) RMS: Root Mean Square of the MD & CD values. (1) % Increase relative to std. hygiene fabric average. (2) % Increase relative to corresponding low temp. blend fabric.				

The spinnability was assigned a rating according to the following spin rating system:

(6) SPIN RATING SYSTEM (1-8):

RATING

- 1 Unspinnable
- 2 Poor Spinning
- 3 Good Spinning
- 4 Perfect Spinning
- 5 Good Spinning
- 6 Marginal Spinning
- 7 Poor Spinning
- 8 Unspinnable

COMMENTS

- Severe elastic filament breaks, very low speed only.
- Frequent elastic filament breaks. Taut spinline, generally high stickpoint.
- Occasional filament breaks, taut spinline.
- No Breaks. Balanced spinline tension.
- Occasional ductile filament break. Spinline slightly limp, filaments tend to wander.
- Persistent ductile filament breaks, limp spinline.
- Excessive ductile filament breaks, very limp spinline.
- Spinline pulls apart, drips, cannot be maintained in either slot or guns.

TABLE I: GRAB TENSILE SUMMARY

COMPARISONS	EXAMPLE	BASE POLYMER (1)	ADD. (2)	SPNRT TYPE (3)	MELT TEMP (°C)	(6) SPIN RATING	DPF	WEB MFR	MD (lbs)	GRAB TENSILES (4)				RMS TENS. (5) Increase (1,2)	RMS (5) TEA (lbs-in)	RMS (5) TEA % Increase (1,2)
										% E	TEA (lbs-in)	CD (lbs)	% E			
Std. Hygiene	1	A	--	x	250	4.3	2.2	53	6.7	45	5.0	8.6	48	6.6	7.7	5.9
Std. Hygiene	2	B	--	x	250	4.2	2.2	52	7.2	38	4	7.25	41	4.5	7.2	4.3
Low Temp. Blend	3	B	10% 441	x	250	4.5	2.2	60	7.1	35	4.3	10.4	40	6.8	8.9	5.7
Low Temp. Blend	4	A	5% HDPE	x	250	5.25	2.3	44	7.5	52	7.4	8.3	53	6.7	7.9	7.1
Invention	5	C	10% 441	y	274	3.5	2.7	30	8.6	46	7.0	9.5	42	5.7	9.1	6.4
Invention	6	C	5% HDPE	y	275	3.4	2.6	20	11.5	60	11.7	7.2	43	4.7	9.6	8.9

\*\*All throughputs = 0.9 grams/minute/hole (g/mfh)

(1) BASE POLYMER: A. Exxon 3445 (35 MFR CR PP)  
B. Aristech 380E (35 MFR, CR PP)  
C. Appryl 3130 (13 MFR PP)

(2) ADDITIVE TYPE: a. HIMONT 441 (400 MFR Polypropylene)  
b. DOW 08065E HDPE (8MI, 0.565G/CC, High Density Polyethylene)

(3) SPINNERET TYPE: x: 1134 Capillaries, 0.4mm x 1.6mm  
y: 756 Capillaries, 0.65mm x 1.8mm

(4) Values corrected to 20 gm. Values based on 8 replicates.

(5) RMS: Root Mean Square of the MD & CD values.  
(1) % Increase relative to std. hygiene fabric average.  
(2) % Increase relative to corresponding low temp. blend fabric.

The spinnability was assigned a rating according to the following spin rating system:

(6) SPIN RATING SYSTEM (1-8):	COMMENTS
1 Unspinnable	Severe elastic filament breaks, very low speed only.
2 Poor Spinning	Frequent elastic filament breaks. Taut spinline, generally high stickpoint.
3 Good Spinning	Occasional filament breaks, taut spinline.
4 Perfect Spinning	No Breaks. Balanced spinline tension.
5 Good Spinning	Occasional ductile filament break. Spinline slightly limp, filaments tend to wander.
6 Marginal Spinning	Persistent ductile filament breaks, limp spinline.
7 Poor Spinning	Excessive ductile filament breaks, very limp spinline.
8 Unspinnable	Spinline pulls apart, drips, cannot be maintained in either slot or guns.



TABLE II: HOT BLOCK SPINNING/FABRIC ANALYSIS PE, PB, CATALLOY BLENDS IN POLYPROPYLENE (1)																
SAMPLE	(1) POLYMER	MELT (°C)	ST. PT. (cm)	(2) DTEX	WEB MFR	(3) SPIN RATE	FABRIC PROPERTIES									
							STRIP TENSILE(4)				GRAB TENSILE(4)				TEAR(4)	
							Pk Load (g)	Pk Elong. (%)	TEA @ Brk (lbs/in)	Pk Load (lbs)	Pk Elong. (%)	TEA @ Brk (lbs/in)	Pk Load (lbs)	TEA @ Yield (lbs/in)		
	POLYETHYLENE BLENDS															
7	4% HDPE	310	70	3.1	30+	4.4	1348	34	346	10.9	54	12.5	6.5	3.2		
8	8% HDPE	312	75	2.8	--	3.5	1352	33	348	12.6	52	12.3	6.1	2.4		
	POLYBUTENE BLENDS															
9	10% DP0300	310	70	2.9	22	4.3	1886	42	517	11.5	51	11.5	4.6	1.6		
10	10% DP8340	312	80	2.7	--	4.6	1813	40	449	12.4	55	12.5	5.6	2.6		
11	10% DP0800	306	85	3	--	4.3	1871	41	535	12.3	49	13.1	6.0	3.4		
	CATALLOY BLENDS															
12	10% KS054P	308	75	2.9	--	3.8	1975	43	571	14.9	59	16.5	6.4	4.0		
13	10% KS059P	307	80	2.7	26	4.2	1807	40	497	12.8	53	17.6	6.1	4.0		
14	15% KS059P	316	75	2.9	26	4.2	1823	38	479	11.8	52	14.6	5.5	3.6		
15	20% KS059P	317	90	2.8	27	4.6	1526	33	352	10.4	51	12.1	4.9	3.1		
16	10% KS057P	312	85	2.9	27	4.4	1746	35	430	10.5	52	12.6	5.0	3.1		

1) All Blends made with Appryl 3130. Output constant at 0.8 g/m/h.  
 2) DTEX values averaged from 15 different filament measurements using scanning electron microscopy (SEM).  
 3) Spin Rating System - See Table I.  
 4) Values are the root mean square of MD and CD values. 16 replicates per sample (8 MD + 8 CD).

TABLE III: HOT BLOCK SLOT SPINNING/FABRIC ANALYSIS PE, PB CATALLOY BLEND IN PP AND EPC (1)							
EXAMPLE	(1) POLYMER BLENDS	MELT (°C)	ST.PT. (cm)	(2) DTEX	WEB MFR	(3) SPIN RATE	COMMENTS
	HOT-BLOCK BLENDS						
17	4% HDPE/3130	293	110	3	30	4.5	EXCELLENT SPINNING, GOOD WEB FORMATION
18	4%HDPE/10% Catalloy/3130	293	110	2.95	27	4.3	EXCELLENT SPINNING, GOOD WEB FORMATION
19	4% HDPE/10% Catalloy/HOXP 621	285	45	3	25	3.8	EXCELLENT SPINNING, GOOD WEB FORMATION
20	8% HDPE/10% Catalloy/HOXP 621	285	45	3.1	24	3.8	EXCELLENT SPINNING, GOOD WEB FORMATION
21	10% Catalloy/3130	292	90	3.1	30	4.3	EXCELLENT SPINNING, GOOD WEB FORMATION
22	20% Catalloy/3130	292	110	2.9	28	4.3	EXCELLENT SPINNING, GOOD WEB FORMATION
23	10% DP8340/ HOXP 621	293	85	2.9	33	4.7	GOOD SPINNING, GOOD WEB FORMATION
24	10% DP0400/ HOXP 621	286	55	3.15	30	4.5	EXCELLENT SPINNING, ACCEPTABLE WEB FORMATION
25	4% PE/ 10% Catalloy/ 20% 3130/EPC	286	80	4.4	21	3.0	ACCEPTABLE SPINNING, GOOD WEB FORMATION
(*) Output constant at 0.8 g/m/h.							
1) LIST OF POLYMERS & ADDITIVES: HDPE DOW 08065E HDPE 8 MI, 0.965 G/CC High Density Polyethylene 3130 APPRYL 3130 13 MFR PP Catalloy Himont Catalloy KSO59P 12 MFR, Heterophasic Propylene Copolymer HOXP 621 HIMONT HOXP 621 13 MFR PP DP 8340 Shell DP 8340 4 MI, Polybutene Copolymer with Ethylene DP 0400 Shell DP 0400 20 MI, Polybutene Homopolymer EPC Exxon 18131-122-001 10 MFR Ethylene Propylene Copolymer (EPC)							
2) DTEX values averaged from 8 different filament measurements using light microscopy (SEM).							
3) Spin Rating - Refer to Table I.							

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## THAT WHICH IS CLAIMED IS:

1. A process for producing a continuous filament nonwoven fabric comprising:
  - a) forming a melt blend of at least two thermoplastic polymers, wherein at least one is a polyolefin polymer;
  - b) extruding the melt blend through a spinneret to form continuous filaments, said step of extruding being performed at a temperature and throughput such that oxidative degradation of at least one polymer component in the outer sheath portion of the filaments occurs;
  - c) pneumatically accelerating the filaments to attenuate and draw the filaments;
  - d) forming the drawn and attenuated filaments into a continuous filamentary web; and
  - e) thermally bonding the filaments of the web to form a coherent continuous filament nonwoven fabric.
2. A process according to Claim 1, wherein said step of forming a continuous filamentary web comprises forming a web having a melt flow rate of 5 to 100 g/10 min.
3. A process according to Claim 1, wherein said step of forming a continuous filamentary web comprises forming a web wherein one of the polymers is dominant and has a molecular weight distribution of less than 5.5.
4. A process according to Claim 1, wherein said step of forming a melt blend comprises forming a melt blend wherein a propylene polymer of melt flow rate of 35 g/10 min. or lower comprises a majority of the melt blend.

5. A process according to Claim 4, wherein said step of forming a melt blend comprises forming a blend of about 1 to 50 percent by weight an ethylene copolymer and 99 to 50 percent by weight polypropylene of melt flow rate of 35 g/10 min. or lower.

6. A process according to Claim 4, wherein said step of forming a melt blend comprises forming a blend of about 2 to 20 percent by weight high density polyethylene and 98 to 80 percent by weight polypropylene of melt flow rate of 35 g/10 min. or lower.

7. A process according to Claim 4, wherein said step of forming a melt blend comprises forming a blend of about 1 to 50 percent by weight polybutene and 99 to 50 percent by weight polypropylene of melt flow rate of 35 g/10 min. or lower.

8. A process according to Claim 1, wherein said step of forming a melt blend comprises forming a blend of about 1 to 50 percent by weight of an ethylene polymer and 99 to 50 percent by weight of an ethylene-propylene copolymer having a melt flow rate of less than 35 g/10 min.

9. A process according to Claim 8, wherein said ethylene-propylene copolymer has a melt flow rate of less than 20 g/10 min.

10. A process according to Claim 1, wherein said step of forming a melt blend comprises forming a blend of about 1 to 50 percent by weight of polybutene and 99 to 50 percent by weight of an ethylene-propylene copolymer having a melt flow rate of less than 35 g/10 min.

11. A process according to Claim 10, wherein said ethylene-propylene copolymer has a melt flow rate of less than 20 g/10 min.

12. A process according to Claim 4, wherein  
5 said step of forming a melt blend comprises forming a blend of about 5 to 50 percent by weight of propylene copolymer with a balance of the blend comprising polypropylene having a melt flow rate of less than 35 g/10 min. and polyethylene.

10 13. A process according to Claim 1, wherein said step of extruding the melt blend comprises maintaining the spinneret die at a temperature above 250°C.

14. A process according to Claim 13, wherein  
15 said spinneret die is maintained at a temperature above 270°C.

15. A process according to Claim 1, wherein  
said step of extruding the melt blend comprises  
extruding said blend at a throughput ranging from 0.1  
20 to 5.0 grams per minute per hole.

16. A process according to Claim 15, wherein  
said step of extruding the melt blend comprises  
extruding said blend at a throughput ranging from 0.5  
to 2.0 grams per minute per hole.

25 17. A process according to Claim 1, wherein said step of pneumatically accelerating the filaments comprises accelerating the filaments to a linear velocity of at least 100 meters per minute.

18. A process according to Claim 17, wherein said step of pneumatically accelerating the filaments comprises accelerating the filaments to a linear velocity of at least 1500 meters per minute.

5           19. A process according to Claim 1, wherein said step of pneumatically accelerating the filaments comprises attenuating and drawing the filaments to a fineness of 5 denier or less.

10           20. A process according to Claim 1, wherein said step of thermally bonding the filaments of the web comprises directing the web through a heated calender nip and forming thermal point bonds throughout the fabric.

15           21. A process according to Claim 1, wherein the melt blend contains at least one stabilizer or antioxidant composition selected from the group consisting of organic phosphites, organic phosphonites, hindered phenols, and hindered amines.

20           22. A process for producing a spunbonded nonwoven fabric comprising  
a) dry blending a propylene polymer of melt flow rate of 35 g/10 min. or less and at least one other polyolefin polymer such that the propylene polymer comprises a majority of the blend;  
25           b) heating the blend of polymers in the barrel of an extruder between to form a molten polymeric blend;  
c) extruding said molten blend at a temperature above 250°C through a spinneret at a  
30 throughput 0.1 to 5.0 g/minute/hole to form continuous filaments;

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- d) exposing the extruded filaments of said molten blend to an oxygen-containing atmosphere to allow oxidative degradation of the filament surface;
- e) directing the filaments into and through  
5 a pneumatic filament attenuator device and accelerating the filaments to a linear velocity in excess of 100 meters per minute to attenuate and draw the filaments to a fineness of 5 denier or less;
- f) collecting the drawn and attenuated  
10 filaments onto a surface such that the filaments distribute and form a continuous filamentary web of melt flow rate of 5 to 35 g/10 min.; and
- g) thermally bonding the filaments of the web to form a coherent nonwoven fabric.

15           23. A process according to Claim 22, wherein the step of blending comprises forming a blend of about 2 to 20 percent by weight high density polyethylene and 98 to 80 percent by weight polypropylene of melt flow rate of 35 g/10 min. or less.

20           24. A continuous filament nonwoven fabric comprising drawn continuous filaments of a blend of at least two thermoplastic polymers wherein at least one is a polyolefin polymer, said continuous filaments being randomly arranged to form a web and a  
25 multiplicity of thermal bonds bonding the filaments together to form a coherent continuous filament nonwoven fabric wherein at least one polymer component of the outer sheath portion of the filaments is oxidatively degraded.

30           25. A continuous filament fabric according to Claim 24, wherein one of said polymers is dominant and has a molecular weight distribution of less than 5.5.

26. A continuous filament nonwoven fabric according to Claim 24, wherein said web has a melt flow rate of 5 to 100 g/10 min.

27. A continuous filament nonwoven fabric  
5 according to Claim 24, wherein a propylene polymer of melt flow rate of 35 g/10 min. or lower comprises a majority of said blend of polymers.

28. A continuous filament nonwoven fabric according to Claim 27, wherein said blend of polymers  
10 comprises about 1 to 50 weight percent of an ethylene polymer and 99 to 50 weight percent polypropylene of melt flow rate of 35 g/10 min. or lower.

29. A continuous filament nonwoven fabric according to Claim 27, wherein said blend of polymers  
15 comprises about 2 to 20 weight percent high density polyethylene and 98 to 80 weight percent polypropylene of melt flow rate of 35 g/10 min. or lower.

30. A continuous filament nonwoven fabric according to Claim 27, wherein said blend of polymers  
20 comprises about 1 to 50 percent by weight polybutene and 99 to 50 percent by weight polypropylene having a melt flow rate of 35 g/10 min. or lower.

31. A continuous filament nonwoven fabric according to Claim 27, wherein said blend of polymers  
25 comprises about 1 to 50 percent by weight of an ethylene polymer and 99 to 50 percent by weight of an ethylene-propylene copolymer having a melt flow rate of less than 35 g/10 min.

32. A process according to Claim 31, wherein  
30 said ethylene-propylene copolymer has a melt flow rate of less than 20 g/10 min.



33. A continuous filament nonwoven fabric according to Claim 27, wherein said blend of polymers comprises about 1 to 50 percent by weight of polybutene and 99 to 50 percent by weight of an ethylene-propylene copolymer having a melt flow rate of less than 35 g/10 min.

34. A process according to Claim 33, wherein said ethylene-propylene copolymer has a melt flow rate of less than 20 g/10 min.

10 35. A continuous filament nonwoven fabric according to Claim 26, wherein said blend of polymers comprises 5 to 50 percent by weight of a propylene copolymer with the balance of the blend comprising polypropylene having a melt flow rate of less than 35  
15 g/10 min. and polyethylene.

36. A disposable absorbent article comprising a nonwoven spunbonded component and at least one other absorbent or nonabsorbent component, said nonwoven spunbonded component comprising a continuous  
20 filament nonwoven fabric according to Claim 24.

37. A composite nonwoven fabric comprising a nonwoven spunbonded component laminated to at least one other component selected from the group consisting of a carded nonwoven fabric, a spunbonded nonwoven  
25 fabric, a meltblown nonwoven fabric, a net, and a film, said nonwoven spunbonded component comprising a continuous filament nonwoven fabric according to Claim 24.

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/US 96/12732

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 D04H3/14 D01F6/46

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)  
IPC 6 D04H D01F

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 practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	EP,A,0 719 879 (HERCULES INC) 3 July 1996 see page 4, line 43 - page 6, column 35 ---	1,13,14, 21,24
P,X	EP,A,0 670 385 (HERCULES INC) 6 September 1995 see page 5, line 5 - page 6, line 50 ---	1,24
A	EP,A,0 630 996 (HERCULES INC) 28 December 1994 see page 5, line 4 - page 7, line 18 ---	1,24
A	EP,A,0 445 536 (HERCULES INC) 11 September 1991 see claim 1 --- -/--	1,21,22

Further documents are listed in the continuation of box C.       Patent family members are listed in annex.

\* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"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</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>
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Date of the actual completion of the international search  <b>12 December 1996</b>	Date of mailing of the international search report  <b>27. 01. 97</b>
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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, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	Authorized officer <i>V Beurden-Hopkins</i> <b>V Beurden-Hopkins, S</b>
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# INTERNATIONAL SEARCH REPORT

International Application No <b>PCT/US 96/12732</b>
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**C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT**

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A	US,A,5 281 378 (KOZULLA RANDALL E) 25 January 1994 cited in the application see claim 1; example 1 ---	1,21
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Information on patent family members

International Application No <b>PCT/US 96/12732</b>
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