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(54) BIO-DEGRADABLE COPOLYESTER NONWOVEN FABRIC

BIOLOGISCH ABBAUBARER FASERVLIESSTOFF AUS COPOLYESTER

NON-TISSE BIODEGRADABLE EN COPOLYESTER

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This invention relates to an improved fabric and nonwoven fabric web such as a spunbond web having a unique combination of properties heretofore unachievable with nonwoven fabrics made of nylon, polyester, and polypropylene polymers or other polymers. The invention includes fabrics produced from the method of extruding and drawing filaments in a spunbond process to produce nonwoven fabrics comprising an aliphatic-aromatic copolyester material. The fabrics produced have exceptional drapability, resist creasing, are elastic, can be gamma ray sterilized and are biodegradable under the right conditions.

2. Description of the Prior Art

[0002] U.S. Patent No. 5,545,371 issued to Fumin Lu, August 13, 1996 and U.S. Patent No. 6,183,684 issued to Fumin Lu, Feburary 6, 2001 describe a process and apparatus for producing nonwoven webs or fabric webs. The apparatus includes a polymer extruder and melt spinning device with a spinneret having multiple spaced apertures for providing a plurality of continuous filaments, a drawing unit that includes a longitudinal elongated slot strategically positioned at a predetermined distance below the spinneret, a nozzle for providing an air supply within the drawing unit for creating a drawing force on the filaments in the drawing unit and a filament collecting moving platform positioned below the drawing unit slot which collects the filaments forming them into a nonwoven fabric or web or sheet.

[0003] The most common synthetic textile fibers used in nonwoven fabric webs are made from nylon, polyester, or polypropylene polymer and their copolymers. These polymers are all melt-spinnable and may be fabricated into nonwoven fabrics using the apparatus described in U.S. Patent 5,545,371 above. The polymers can be spunbond, meltblown, air laid, needlepunched, hydroentangled or carded. While these processes each have certain advantages of producing fabrics with particular properties, often the fabrics share certain limitations which limit the fabric application.

BRIEF SUMMARY OF THE INVENTION

[0004] The purpose of the present invention is to provide a fabric that surpasses these prior art polymer fabric limitations. The applicants have determined that using, for example, the apparatus and method described in U.S. Patent 5,545,371 and a copolyester manufactured by Eastman Chemical Company of Kingsport, Tennessee described in U.S. Patent 5,599,858 (which is incorporated by reference into this application) for producing the filaments, applicants have achieved a fabric that is nonwoven, has exceptional drapeability, is elastic and may be stretched and relaxed over repeated cycles without failure or rupture. The new fabric may be bonded to various components including films, cellulosics such as cotton, lyocell, polylactide polymers, wood pulp, wood fiber and paper, and other natural fibers such as wool. The new fabric is fully biodegradable leaving only carbon dioxide and water when fully decomposed. The finished fabric can be gamma ray or E-beam sterilized. Various bonding technologies may beed in conjunction with the fabric including but not limited to point bonded thermobond, resin bonded, needle punched, hydroentangled, through air bonded or ultrasonically, radio frequency, microwave or dielectrically bonded.

[0005] The new fabric can also be formed by using the apparatus and method described in U.S. Patent No. 5,545,371 and an aliphatic-aromatic copolyester (hereinafter referred to as "AAEP") described in U.S. Patent Nos. 5,446,079, 5,599,858 and 6,020,393 (which are incorporated herein by reference and referred to herein as the AAPE patents) for producing the filaments.

[0006] The new fabric is typically biodegradable in warm shallow coastal saltwater environments over a 15-20 week timeframe. Similar results are also seen in fresh water. Seawater biodegradability is a highly desirable attribute for ecology reasons. Sea life such as sea turtles are widely known to ingest discarded plastic objects such as bags and packaging materials (mistaking them for jelly fish) often resulting in death.

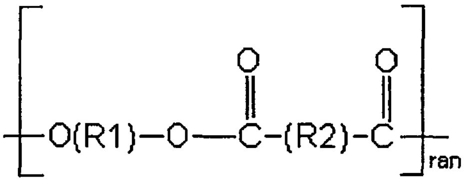
[0007] The uses made of the new fabric produced in the invention described herein includes surgical drapes and gowns, sterile wraps and surgical packs, disposeable hygiene components, durable products as a substitute for woven fabrics, synthetic leather, wiping products capable of stretching and elastic elements for products such as disposable diapers and incontinent products where good fit and shape are important.

DETAILED DESCRIPTION OF THE INVENTION

[0008] This invention relates to a product by process and specifically to nonwoven fabrics made from a specific copolyester produced by Eastman Chemical Company of Kingsport, Tennessee that includes an aliphatic-aromatic copolyester that is described in U.S. Patent 5,599,858 issued February 4, 1997 to Charles Buchanan et al. entitled "Aliphatic-Aromatic Copolyesters and Cellular Ester/polymer," and specifically for the use of the aliphatic copolyester as the polymer material that is employed in a process and apparatus such as that described in U.S. Patent 5,545,371 (which is incorporated herein by reference). In the production of the preferred embodiment, the spunbond process using the apparatus described in the '371 Patent above is run at a high filament velocity.

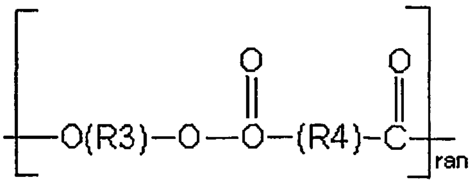
[0009] Additionally the nonwoven fabrics may be made from the aliphatic-aromatic copolyesters that are described in the AAPE Patents as the polymer that is employed in the process and apparatus described in the '371 Patent.

[0010] The invention employs a polyester described in the AAPE Patents. In one preferred embodiment the AAPE is manufactured and produced by Eastman Chemical Company of Kingsport, Tennessee and is sold under the Trademark EASTAR BIO™ GP CoPolyester family. More specifically, the AAPE's are essentially, linear, random copolyesters or branched and/or chain extended copolyesters thereof having repeating units of:



$$\left[-O(R1)-O-\overset{\overset{O}{\|}}{C}-(R2)-\overset{\overset{O}{\|}}{C}- \right]_{ran}$$

and



$$\left[-O(R3)-O-\overset{\overset{O}{\|}}{O}-(R4)-\overset{\overset{O}{\|}}{C}- \right]_{ran}$$

[0011] Wherein

R1 is selected from one or more of the groups consisting of C2-C8 alkylene or oxyalkylene and the mole percent of R1 is from about 80 to 100;

R3 is selected from one or more of the groups consisting of C2-C8 alkylene or oxyalkylene; C2-C8 alkylene or oxyalkylene substituted with one to four substituents independently selected from the group consisting of halo, C6-C10 aryl, and C1-C4 alkoxy; C5-C12 cycloalkylene (for example, 1,4-cyclohexanedimethanol); C5-C12 cycloalkylene substituted with one to four substituents independently selected from the group consisting of halo, C6-C10 aryl, and C1-C4 alkoxy; and the mole percent of R3 is from 0 to about 20;

R2 is selected from one or more of the groups consisting of C2-C12 alkylene or oxyalkylene; C2-C12 alkylene or oxylalkylene substituted with one to four substituents independently selected from the group consisting of halo, C6-C10 aryl, and C1-C4 alkoxy; C5-C10 cycloalkylene; C5-C10 cycloalkylene substituted with one to four substituents independently selected from the group consisting of halo, C6-C10 aryl, and C1-C4 alkoxy; and the mole percent of R2 is from about 35 to about 95;

R4 is selected from one or more of the groups consisting of C6-C10 aryl; C6-C10 aryl substituted with one to four substituents independently selected from the group consisting of halo, C6-C10 aryl, and C1-C4 alkoxy; C5-C10 cylcoalkylene; C5-C10 cycloalkylene substituted with one to four substituents independently selected from the group consisting of halo, C6-C10 aryl, and C1-C4 alkoxy; and the mole percent of R4 is from about 5 to about 65.

[0012] Preferred AAPEs are those wherein R1 is selected from C2-C8 alkylene and is present in an amount of from about 90 to 100 mole percent; R3 is present in an amount of from 0 to about 10 mole percent; R2 is selected from one or more of the groups consisting of C2-C8 alkylene or oxyalkylene and is present in an amount from about 35 to about 95 mole percent; and R4 is selected from one or more of the groups consisting of C6-C10 aryl and is present in an amount of from about 5 to about 65 mole percent. More preferred AAPEs are those wherein R1 is selected from C2-C4 alkylene and is present from about 95 to 100 mole percent; R3 is present from 0 to about 5 mole percent; R2 is selected from one or more of the groups consisting of C2-C6 alkylene and is present from about 35 to about 65 mole percent; R4 is 1,4-disubstituted-C6 aryl and is present from about 35 to about 65 mole percent.

[0013] As used herein the terms "alkyl" and "alkylene" refer to either straight or branched chain moieties such as - CH2 - CH2 - CH2 - CH2-and- CH2CH(x)- CH2 -. The term "oxyalkylene" refers to alkylene chains containing from 1 to 4 ether oxygen groups. The term "cycloalkylene" refers to any alkyl group that contains a cycloalkyl moiety.

[0014] Other preferred compositions for these AAPE are those prepared from the following diols and diacids (or polyester forming derivatives thereof) in the following mole percent, based on 100 mole percent of a diacid component and 100 mole percent of a diol component:

(1) glutaric acid (about 30 to about 75%); terephthalic acid (about 25 to about 70%); 1,4-butanediol (about 90 to 100%); and modifying diol (0 to about 10%).

(2) succinic acid (about 30 to about 95%); terephthalic acid (about 5 to about 70%); 1,4-butanediol (about 90 to 100%); and modifying diol (0 to about 10%).

(3) adipic acid (about 30 to about 75%); terephthalic acid (about 25 to about 70%); 1,4-butanediol (about 90 to 100%); and modifying diol (0 to about 10%).

[0015] The modifying diol is preferably selected from 1,4-cyclohexanedimethanol, triethylene glycol, polyethlene glycol and neopentyl glycol. The most preferred AAPEs are linear, branched or chain extended copolyesters comprising about 50 to about 60 mole percent adipic acid, about 40 to about 50 mole percent terephthalic acid, and at least 95 mole percent 1,4-butanediol. Even more preferably, the adipic acid is present from about 55 to about 60 mole percent, the terephthalic acid is present from about 40 to about 45 mole percent and at least 95 mole percent 1,4-butanediol. Such compositions are commercially available from Eastman Chemical Company, Kingsport, TN.

[0016] Specific examples of preferred AAPE include a poly(tetramethylene glutarate-co-terephthalate) containing (a) 50% glutaric acid/50% terephthalic acid/100% 1,4-butanediol, (b) 60% glutaric acid/40% terephthalic acid/ 100% 1,4-butanediol or (c) 40% glutaric acid/60% terephthalic acid/100% 1,4-butanediol; a poly (tetramethylene succinate-co-terephthalate) containing (a) 85% succinic acid/15% terephthalic acid/100% 1,4-butanediol or (b) 70% succinic acid/30% terephthalic acid/100% 1,4-butanediol; a poly(ethylene succinate-co-terephthalate) containing 70% succinic acid/30% terephthalic acid/ 100% ethylene glycol; and a poly(tetramethylene adipate-co-terephthalate) containing 85% adipic acid/15% terephthalic acid/100% 1,4-butanediol.

[0017] Desirably, the AAPE has from about 10 to 1,000 repeating units and preferably, from about 15 to about 600 repeating units. Preferably, the AAPE has an inherent viscosity of about 0.4 to about 2.0 dL/g, more preferably about 0.7 to about 1.4, as measured at a temperature of 25°C. for a 0.5 gram sample in 100ml of a 60/40 by weight solution of phenol/tetrachloroethane.

[0018] The AAPE of the present invention may also contain a branching agent. The weight percent ranges for the branching agent are from about 0.01 to about 10 percent, preferably 0.1 to 1.0 weight percent, based on the total weight percent of the AAPE.

[0019] The branching agent preferably has a weight average molecular weight of about 50 to about 5000, more specifically about 92 to about 3000, and a functionality of about 3 to about 6. The branching agent may be a polyol having 3 to 6 hydroxyl groups, a polycarboxylic acid having 3 or 4 carboxyl groups or a hydroxy acid having a total of 3 to 6 hydroxyl and carboxyl groups.

[0020] Representative low molecular weight polyols that function as branching agents include glycerol, trimethylolpropane, 1,2,4-butanetriol, pentaerythritol, 1,2,6-hexanetriol, sorbitol, 1,1,4,4,-tetrakis (hydroxymethyl) cyclohexane, tris(2-hydroxyethyl) isocyanurate, and dipentaerythritol. Particular branching agent examples of higher molecular weight polyols (MW 400-3000) are triols derived by condensing alkylene oxides having 2 to 3 carbons, such as ethylene oxide and porpylene oxide with polyol initiators.

[0021] Representative polycarboxylic acids that may be used as branching agents include glycerol, trimethylolpropane, 1,2,4-butanetriol, pentaerythritol, 1,2,6-hexanetriol, sorbitol, 1,1,4,4-tetrakis (hydroxymethyl) cyclohexane, tris(2-hydroxyethyl) isocyanurate, and dipentaerythritol. Particular branching agent examples of higher molecular weight polyols (MW 400-3000) are triols derived by condensing alkylene oxides having 2 to 3 carbons, such as ethylene oxide and porpylene oxide with polyol initiators.

[0022] Representative hydroxy acids as branching agents include malic acid, citric acid, tartaric acid, 3-hydroxyglutaric acid, mucic acid, trihydroxyglutaric acid, and 4-(beta-hydroxyethy)phthalic acid. Such hydroxy acids contain a combination of 3 or more hydroxyl and carboxyl groups.

[0023] Especially preferred branching agents include trimellitic acid, trimesic acid, pentaerythritol, trimethylol propane and 1,2,4-butanetriol.

[0024] One example of the branched AAPE of the present invention is poly(tetramethylene adipate-co-terephthalate) containing 100 mole percent 1,4-butanediol, 43 mole percent terephthalic acid and 57 mole percent adipic acid and being branched with 0.5 weight percent pentaerythritol. This copolyester is produced when dimethyladipate, dimethyl terephthalate, pentaerythritol and 1,4-butanediol are heated at 190°C. for 1 hour, 200°C. for 2 hours, 210°C. for 1 hour, then at 250°C. for 1.5 hours under vacuum in the presence of 100 ppm of Ti present initially as Ti(OiPr)4. The copolyester is typically pelletized after formation for use in extrusion foaming.

[0025] Another branched AAPE of the present invention is poly(tetramethylene adipate-co-terephthalate) containing 100 mole percent 1,4-butanediol, 43 mole percent terephthalic acid and 57 mole percent adipic acid and being branched with 0.3 weight percent pyromellitic dianhydride. This copolyester is produced via reactive extrusion of linear poly (tetramethylene adipate-co-terephthalate) with pyromellitic dianhydride using an extruder.

[0026] The AAPE of the present invention may also contain a chain extender. Exemplary chain extenders are divinyl ethers as disclosed in U.S. Patent no. 5,817,721 and herein incorporated by reference. Preferred divinyl ethers are 1,4-butanediol divinyl ether, 1,5-hexanediol divinyl ether and 1,4-cyclohexandimethanol divinyl ether. The weight percent ranges for the chain extender are from 0.01 to 5 percent, preferably 0.3 to 2.5 weight percent, based on the total weight percent of the AAPE.

[0027] The preparation of the polyesters and copolyesters is well known in the art (U.S. Patent No. 2,012,267). Such reactions are usually carried out at room temperature from 150°C to 300°C. in the presence of polycondensation catalysts such as titanium tetrachloride, manganese diacetate, antimony oxide, dibutyl tin diacetate, zinc chloride, or combinations thereof. The catalysts are typically employed in amounts between 10 to 1000 ppm, based on total weight of the reactants. For the purpose of the present invention, a representative aliphatic polyester is the polycondensation product of dimethylglutarate and 1,6-hexanediol. This polyester, poly(hexamethylene glutarate), is produced when dimethylglutarate and 1,6-hexanediol are heated at approximately 210°C. for 4 hours and then at 260°C. for 1.5 hours under vacuum in the presence of 100ppm of Ti. A representative aliphatic-aromatic copolyester is poly(tetramethylene glutarate-coterephthalate) containing 30 mole percent terephthalate. This polyester is produced when dimethylglutarate, dimethyl terephthalate, and 1,4-

butanediol are heated at 200°C. for 1 hour then at 245°C. for 0.9 hour under vacuum in the presence of 100ppm of Ti present initially as Ti(OiPr)4.

[0028] The spunbond fabric produced with the Eastman EASTAR BIO GP CoPolyester material for the filaments produces a fabric that has exceptional drapeability combined with an inherent resistance to creasing at room temperature. The fabric achieves softness without slickness or shininess and is quiet in use. Additives and pigments can be incorporated in the fabrics thus produced. Finishing treatments can also modify hand aestatpicts.

[0029] The fabric produced provides for a sheet that is elastic in that it may be stretched and then relaxed and stretched again over repeated cycles without failing. Fleeces produced from this material exhibit high elasticity without rupture. Upon modification of the spinning process conditions, the degree of elasticity may be tailored to specific fabric applications. Likewise appropriate selection of the process conditions may vary the surface frictional characteristic from a rubbery feel to a soft cottony texture. Furthermore, the selection of process conditions can also vary the surface characteristics from ropy filament bundle appearance to ropy filament bundle free.

[0030] The fabric produced by this invention may be bonded to many components and substrates including but not limited to films, fabrics, nonwovens, metalic sheets or layers and papers. The fabric can be extrusion coated with various polymers and formulations, including itself. The fabric is suitable for bonding to cellulosics and other natural fibers and biodegradable polymers such as polylactides. Other fibrous spunbond structures can also be made by pellet or melt blending the copolyester of this invention with other polymers, including other biodegradable or compostable polymers.

[0031] Very importantly the fabric produced by the invention in the spunbond process will degrade in a composting environment leaving only carbon dioxide and water when fully decomposed. When kept from decomposting environments, durable nonwovens are possible.

[0032] The copolymester described herein can be spunbonded onto other fibrous materials on-line, to make multilayer products.

[0033] Fabrics and composites produced with this family of materials can be gamma ray sterilized.

[0034] Various bonding techniques may be used in conjunction with this fabric. The fabric bonding may, for example, be point bond calendering, resin bonded, needle punched, through air bonded or ultrasonically, radio frequency, microwave or dielectrically bonded. Bonding of the finished fabric to other materials may include hot melt adhesive, ultrasonic, radio frequency, microwave, and dielectrical bonding, hot air or radiant bonding and other laminating techniques. The low crystalline melting point of this polymer (approximately 108 degrees) improves high speed bonding in fabrication processes.

[0035] The fabric may be heat shrunk around an object or form to produce an elastic, form-fitting fabric retaining elastic properties, strength and toughness.

[0036] The fabric produced under this invention may come from multi-component filament forms including but not limited to one or more of components comprised of the Eastman biodegradeable copolyester. Multi-component filament styles can be used such as side-by-side, sheath/core, island-in-the-sea, regardless of filament cross-sectional shape (for example round, ribbon, hollow, trilobal and other high surface geometries).

[0037] This invention can be further illustrated by the following examples of preferred embodiments thereof, although it will be understood that these examples are included merely for purposes of illustration and are not intended to limit the scope of the invention unless otherwise specifically indicated.

[0038] In accordance with these and other objects which will become apparent hereinafter, the instant invention will now be described with particular reference to the accompanying drawings.

PREFERRED EMBODIMENT OF THE INVENTION

[0039] Fabrics were produced with the process and a spunbond machine described in U.S. Patent No. 5,545,371 and U.S. Patent No. 6,183,684 in the following examples:

EXAMPLE ONE

[0040] The Eastar BIO™ GP copolyester pellets were dried at 45° C for 6 hours to achieve the moisture content of the resin about 300 ppm before feeding into the extruder. The temperature of the extruder and spin beam was set at 195° C. The width of the spinneret wetted area was 500 mm with orifices of 0.35 mm in diameter. The total number of orifices was 2016. The extruded filaments were drawn downwardly by a drawing device having a longitudinal slot 100 mm longer than the wetted area of the spinneret. Compressed air of 35 psi was supplied to the slot and the drawn filaments exiting the slot were laid down on a moving belt with suction box underneath the wire. The melt throughput was metered by a pair of metering pumps at a rate of 0.5 gram per hole per minute (ghm). The web formed on the belt was moving at 15 meters per minute and thermally bonded at temperature of 85° C by a calender. The fabric thus produced was wound up on a roll. The filament before calendering had a denier of 1.3 and the fabric had a basis weight of 130 grams per square meter. The spunbond fabric exhibited a good appearance, elastic properties, and good handleability without scroop or noise with handling.

[0041] Qualities of the fabric can be observed from DSC test results. The first DSC curve (which reflects the fabric properties) showed a bi-modal characteristic with the major endotherm melting point at 120°C. The second scan (which erases fabric characteristics and reflects polymer properties) showed a relatively broad but single mode endotherm melting point at 108°C. First scan DSC estimated crystallinity was 29%.Spunbond fabrics with higher throughput and with both higher and lower spinning speeds were also successfully produced.

EXAMPLE TWO

[0042] The same machine was set up and the process and procedure was used as in Example one for Eastar BIO™ GP resin except that the melt temperature used was 205° C and the pressure of the compressed air increased to 45 psig. The filaments produced at 0.5 ghm had a denier of 1.0 and the fabrics were obtained at 30 m/min with basis weight of 70 gsm. Fabrics with basis weight of 40 gsm were also produced at line speed of 40 m/min.

[0043] By changing conditions, spunbond fabrics having 10-17gsm basis weight were produced. significantly higher throughputs were also achieved. All these webs exhibited good structural integrity.

[0044] Some of the benefits of this fabric composition include:

a) fabrics produced have an exceptional drapeability combined with an inherent resistance to creasing at room temperatures. The fabric achieves softness without slickness or shininess and is quiet in use.

b) the sheet is elastic in that it may be stretched then relaxed and stretched again over repeated cycles without failing. Fleeces produced from this material exhibit high elasticity without rupture. By modification of the spinning process conditions, the degree of elasticity may be tailored to specific fabric applications. Likewise, appropriate selection of the process conditions may vary the surface frictional characteristics from a rubbery feel to a soft cottony texture and from ropy appearance to ropy free.

c) the fabric may be bonded to many component substrates made from, including but not limited to, wool, cotton, lyocell, wood pulp, polylactide polymers, polycaprolactone, paper, and other compostable/biodegradable polymers. The fabric can also be laminated to films and other polyesters.

d) the material will degrade in a composting environment leaving only carbon dioxide, water and trace minerals when fully decomposed but durable or long-life outside such environments.

e) fabrics and composites produced with this family of materials may be e-beam or gamma ray sterilized.

f) bondable by most available technologies to itself or to other materials in single or multi-plies. Various bonding technologies may be used in conjunction with this fabric. The fabric bonding may, for example, be thermally bonded by point-bond calendering, resin bonded, through air bonded, hot melt adhesive, hydroentangling, needling, ultrasonic, radio frequency, microwave, and dialectrical bonding, binder fiber bonding and molding. The low crystalline melting point of this polymer improves high speed bonding in fabrication processes. Products are typically quiet when handled or in use.

g) the fabric may be heat shrunk around an object or form to produce anelastic, form fitting fabric retaining elastic properties, strength and toughness.

[0045] The use of the fabric can include but are not limited to the following:

a) surgical drapes and gowns, plus other barrier fabrics such as for protection from pesticides, etc.

b) sterile wraps and surgical pack components;

c) disposable hygiene components including but not limited to diapers, incontinence pads and garments, tampons, feminine hygiene pads, disposable underwear and bed pads, and other bodily fluid containment vehicles, disposable washcloth or other limited life products, etc.;

d) nonwoven substitutes for woven and knitted fabrics without compromising its biodegradability in use, such as pillow liners and cases, upholstery, insulation, drapery, clothing, gloves, and some industrial articles;

e) agricultural, horticultural, and geotextile fabrics and nettings for a number of applications, including weed and erosion control, seedling mats and containers, thermoformed flower pots, tree and shrub ball coverings, delivery systems for plant treatments, etc.

f) compliant and extensible substrate for synthetic leathers, vinyls, suedes and other high-value luxurious fabrics;

g) wiping products requiring a durable, tear resistant fabric which is capable of stretching substantially before tearing yet picks up and retains dust or other particulate matter; in other embodiments spunbonded fabrics may be used to deliver cleansing and disinfectant chemicals, medical/cosmetic skin treatments, furniture waxes and the like;

h) any of the above combined with film backing or liner or other layers to form unique structure;

i) combinations of the above products with a film of the same family of resins, formed or laminated to a nonwoven fabric;

j) combinations of the above products with a film formed or laminated to a nonwoven fabric;

k) fabrics produced from multi-component filament forms including one or more of the components comprised of this biodegradable CoPET. Such multi-component filament styles may include, but not limited to, side-by-side, sheath/core, islands-in-the sea regardless of filament cross-sectional shape (for example, round, ribbon, trilobal, hollow);

l) fabrics produced from multi-filament forms. This fabric construction is a mixture of two or more different types of filaments and where at least a portion of one of these filamentary constituents is comprised of this biodegradable coPET. Such multi-filament styles may be combined with the multi-component forms of item k above; and

m) elastic elements for products such as disposable diapers, adult incontinence products, as well as durable articles where elastic properties are needed.

[0046] The fabric produced exhibits a shrinkable property upon exposure to heat. The resulting shrunk fabric retains the elastic characteristics of the preshrunk fabric without becoming brittle. The material shrinks to form fit the surface of the object around which it is wrapped. The shrinkage can be as high as 90% of the original sheet dimensions while total available shrinkage may be predetermined through selection of processing conditions under which the base sheet is produced. The primary determinates of shrinkage in the spunbonded process are filament speed and thermobonding conditions. Effective quenching and threadline temperature control are also important.

[0047] As the fabric sheet shrinks, the fibrous structure features of the sheet shrink with the dimensions such that the porosity of the sheet decreases, the barrier properties of the sheet increase along with the basis weight however the elastic nature remains. Conventional polyester fabrics that shrink under the influence of heat typically become brittle and stiff - the novelty of this invention is retention of flexibility and elasticity. Additionally, constraining the shrinkage allows production of elastic articles to predetermined dimensions and extension/recovery characteristics. With a controllable heat shrinking, the pore-size can be controlled and a disposable filter can be produced.

[0048] Such properties are of particular applicability in the fabrication of articles which are initially fabricated at one dimension then dimensionally altered through the use of heat to a final product form. Such application is not only useful in the production of disposable diapers and training pants, adult incontinence products, garments, shaped feminine hygiene pads, but also is applicable to packaging materials requiring insulation, barrier protection with breathability or form fitting such as, but not limited to, gamma ray or E-beam sterilizable surgical wraps and garments, bandages, backing fabrics, gloves, car covers, mattress covers and pads, food contact material, shrink fit wine bottle packaging and container labels.

[0049] Typically, the fabric of the present invention is biodegradable in warm shallow coastal saltwater environments over a 15-20 week timeframe. Testing consisting of suspending a sample of the fabric from a weighted rope tied to a dock in Lighthouse Point, Florida, such that the sample was maintained below mean low tide level showed that after fifteen weeks the sample had degraded to a very weak, thin veil which broke up upon retrieval from the water.

[0050] It is an object of this invention to provide an improved fabric that is nonwoven and that has a unique combination of properties unachievable in other nonwoven fabrics using a special copolyester produced by and currently available from Eastman Chemical Company under the trademark EASTAR BIO GP CoPOLYESTER in a spunbond, nonwoven fabric process and apparatus.

[0051] And it is another object of this invention to provide a nonwoven fabric that may be spunbond that provides elastic qualities, thermobonding qualities, that is biodegradable and that can be gamma ray sterilized.

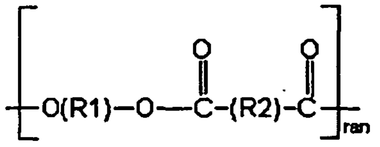
[0052] The instant invention has been shown and described herein in what is considered to be the most practical and preferred embodiment. It is recognized, however, that departures may be made therefrom within the scope of the invention and that obvious modifications will occur to a person skilled in the art.

Claims

1. A method for producing a biodegradable nonwoven fabric comprising the steps of:

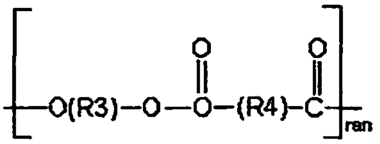
   Extruding a plurality of continuous filaments from a spinneret;
   drawing said filaments by a drawing unit positioned at a predetermined distance below the spinneret for providing a force on said filaments by applying air to the drawing unit;
   depositing said filaments on a collecting surface to form a nonwoven fabric;
   using an aliphatic-aromatic copolyester in said extruder as the material for the filaments.

2. The method according to claim 1, wherein the aliphatic-aromatic copolyester having repeating units of:



$$\left[-O(R1)-O-\overset{\overset{O}{\|}}{C}-(R2)-\overset{\overset{O}{\|}}{C}- \right]_{ran}$$

and



$$\left[-O(R3)-O-\overset{\overset{O}{\|}}{O}-(R4)-\overset{\overset{O}{\|}}{C}- \right]_{ran}$$

wherein
R1 is selected from one or more of the groups consisting of C2-C8 alkylene or oxyalkylene and the mole percent of R1 is from about 80 to 100;
R3 is selected from one or more of the groups consisting of C2-C8 alkylene or oxyalkylene; C2-C8 alkylene or oxyalkylene substituted with one to four substituents independently selected from the group

consisting of halo, C6-C10 aryl, and C1-C4 alkoxy; C5-C12 cycloalkylene (for example, 1,4cyclohexanedimethanol); C5-C12 cycloalkylene substituted with one to four substituents independently selected from the group consisting of halo, C6-C10 aryl, and C1-C4 alkoxy; and the mole percent of R3 is from 0 to about 20;
R2 is selected from one or more of the groups consisting of C2-C12 alkylene or
oxyalkylene; C2-C12 alkylene or oxylalkylene substituted with one to four substituents independently selected from the group consisting of halo, C6-C 10 aryl, andC1-C4 alkoxy; C5-C10 cycloalkylene; C5-C10 cycloalkylene substituted with one to four substituents independently selected from the group consisting of halo, C6-C10 aryl, andC1-C4 alkoxy; and the mole percent of R2 is from about 35 to about95 ;
R4 is selected from one or more of the groups consisting of C6-C 10 aryl;C6-C 10 aryl substituted with one to four substituents independently selected from the group consisting of halo, C6-C 10 aryl, andC1-C4 alkoxy; C5-C10 cylcoalkylene; C5-C10 cycloalkylene substituted with one to four substituents independently selected from the group consisting of halo, C6-C10 aryl, and C1-C4 alkoxy; and the mole percent of R4 is from about 5 to about 65..

3. Method according to claim 1 or 2 comprising the steps of:

using two or more melt spinning spinnerets or dies;
introducing layer (s) of other fibrous materials on the surface;
depositing said filaments from one or more spinneret (s), layered on the surface to create a nonwoven fabric; and
employing the aliphatic copolyester as at least one of the material that is extruded for the filament.

4. Method according to claim 1, 2 or 3, wherein a high velocity speed of said filaments is established.

5. Method according to claim 1, 2 or 3, wherein additives or pigments are added to the extruder.

6. Method according to claim 1, 2 or 3, wherein heat shrinkage is controlled.

7. A nonwoven fibre produced by a method according to one of the claims 1 to 6.

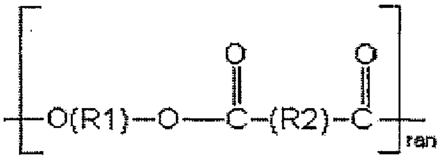
8. Use of a nonwoven fibre according to claim 7 for producing garments, diapers, training pants, adult incontinence products, feminine hygiene pads, surgical wraps, bandages packaging materials, food contact products, backing fabrics, mattress covers, pads.

Patentansprüche

1. Verfahren zur Herstellung eines biologisch abbaubaren Vliesstoffes, umfassend die Schritte:

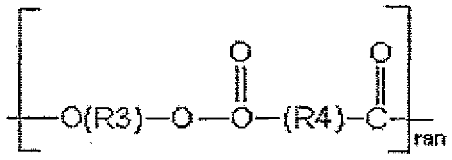
Extrudieren einer Mehrzahl Endlosfilamente aus einer Spinndüse;
Verstrecken der Filamente mit einer Verstrekkungseinheit, die in einem vorbestimmten Abstand unter der Spinndüse angebracht ist,
um durch Luftzufuhr zur Verstreckungseinheit eine Kraft auf die Filamente auszuüben;
Ablegen der Filamente auf einer Sammeloberfläche, um einen Vliesstoffs zu bilden;
Benutzen eines aliphatisch-aromatischen Copolyesters in dem Extruder als Material für die Filamente.

2. Verfahren nach Anspruch 1, bei dem der aliphatisch-aromatische Copolyester über wiederkehrende Einheiten gemäß



$$\left[-O(R1)-O-\overset{\overset{O}{\|}}{C}-(R2)-\overset{\overset{O}{\|}}{C}-\right]_{ran}$$

und



$$\left[-O(R3)-O-\overset{\overset{O}{\|}}{O}-(R4)-\overset{\overset{O}{\|}}{C}-\right]_{ran}$$

verfügt, wobei gilt:

R1 ist ausgewählt aus einer oder mehreren der Gruppen bestehend aus C2-C8-Alkylen oder Oxyalkylen; und verfügt über einen Molprozentanteil von etwa 80 bis 100;
R3 ist ausgewählt aus einer oder mehreren der Gruppen bestehend aus C2-C8-Alkylen oder Oxyalkylen; C2-C8-Alkylen oder Oxyalkylen, substituiert mit einem bis vier Substituenten, unabhängig voneinander ausgewählt aus der Gruppe bestehend aus Halogen, C6-C10-Aryl und C1-C4-Alkoxy; C5-C12-Cycloalkylen (zum Beispiel 1,4-Cyclohexandimethanol); C5-C12-Cycloalkylen, substituiert mit einem bis vier Substituenten, unabhängig voneinander ausge-

wählt aus der Gruppe bestehend aus Halogen, C6-C10-Aryl und Cl-C4-Alkoxy; und verfügt über einen Molprozentanteil von 0 bis etwa 20;
R2 ist ausgewählt aus einer oder mehreren der Gruppen bestehend aus C2-C12-Alkylen oder Oxyalkylen; C2-C12-Alkylen oder Oxyalkylen, substituiert mit einem bis vier Substituenten, unabhängig voneinander ausgewählt aus der Gruppe bestehend aus Halogen, C6-C10-Aryl und C1-C4-Alkoxy; C5-C10-Cycloalkyl; C5-C10-Cycloalkylen, substituiert mit einem bis vier Substituenten, unabhängig voneinander ausgewählt aus der Gruppe bestehend aus Halogen, C6-C10-Aryl und C1-C4-Alkoxy; und verfügt über einen Molprozentanteil von etwa 35 bis etwa 95;
R4 ist ausgewählt aus einer oder mehreren der Gruppen bestehend aus C6-C10-Aryl; C6-C10-Aryl, substituiert mit einem bis vier Substituenten, unabhängig voneinander ausgewählt aus der Gruppe bestehend aus Halogen, C6-C10-Aryl und C1-C4-Alkoxy; C5-C10-Cycloalkylen; C5-C10-Cycloalkylen, substituiert mit einem bis vier Substituenten, unabhängig voneinander ausgewählt aus der Gruppe bestehend aus Halogen, C6-C10-Aryl und C1-C4-Alkoxy; und verfügt über einen Molprozentanteil von etwa 5 bis etwa 65.

3. Verfahren nach Anspruch 1 oder 2, umfassend die Schritte:

Benutzen von zwei oder mehr Schmelzspinndüsen oder -Formen;
Aufbringen einer oder mehrerer Lage(n) anderer faserhaltiger Materialien auf die Oberfläche;
Ablegen der Filamente aus einer oder mehreren Spinndüse(n) geschichtet auf der Oberfläche zur Erzeugung eines Vliesstoffes; und
Einsetzen des aliphatischen Copolyesters als mindestens eines der zum Filament extrudierten Materialien.

4. Verfahren nach Anspruch 1, 2 oder 3, bei dem eine hohe Geschwindigkeit der Filamente eingestellt wird.

5. Verfahren nach Anspruch 1, 2 oder 3, bei dem man dem Extruder auch Additive oder Pigmente zuführt.

6. Verfahren nach Anspruch 1, 2 oder 3, bei dem der Hitzeschrumpf eingestellt wird.

7. Vliesstofffaser, hergestellt nach einem Verfahren gemäß einem der Ansprüche 1 bis 6.

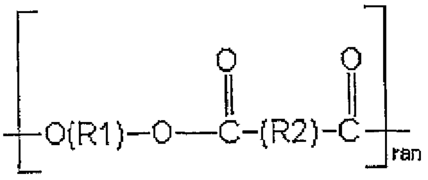
8. Verwendung einer Vliesstofffaser gemäß Anspruch 7 zur Herstellung von Kleidungsstücken, Windeln, Höschenwindeln, Inkontinenzprodukten für Erwachsene, Damenhygieneartikeln, Wundverbänden, Bandagen, Verpackungsmitteln, Produkten für den Lebensmittelkontakt, textilen Trägern, Matratzenüberzügen, Einlagen.

Revendications

1. Procédé pour produire un textile non-tissé biodégradable comprenant les étapes consistant à :

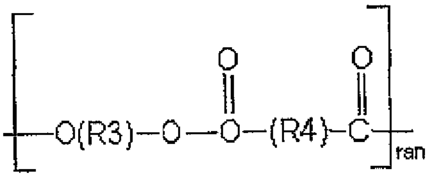
extruder une pluralité de filaments continus depuis une filière ;
étirer lesdits filaments par une unité d'étirage positionnée à une distance prédéterminée audessous de la filière pour appliquer une force auxdits filaments en appliquant de l'air à l'unité d'étirage ;
déposer lesdits filaments sur une surface de collecte pour former un textile non-tissé ;
utiliser un copolyester aliphatique-aromatique dans ladite extrudeuse en tant que matériau pour les filaments.

2. Procédé selon la revendication 1, dans lequel le copolyester aliphatique-aromatique ayant des motifs de répétition de :



$$\left[-O(R1)-O-\overset{\overset{O}{\|}}{C}-(R2)-\overset{\overset{O}{\|}}{C}- \right]_{ran}$$

et



$$\left[-O(R3)-O-\overset{\overset{O}{\|}}{O}-(R4)-\overset{\overset{O}{\|}}{C}- \right]_{ran}$$

dans lesquels
R1 est choisi parmi un ou plusieurs des groupes constitués d'un alkylène ou oxyalkylène en C2-C8 et le pourcentage en moles de R1 est d'environ 80 à 100 ;
R3 est choisi parmi un ou plusieurs des groupes constitués d'un alkylène ou oxyalkylène en C2-C8 ; un alkylène ou oxyalkylène en C2-C8 substitué par un à quatre substituants indépendamment choisis dans le groupe constitué d'un halogéno, un aryle en C6-C10, et un alcoxy en C1-C4 ; un cycloalkylène

en C5-C12 (par exemple, le 1,4-cyclahexanediméthanol) ; un cycloalkylène en C5-C12 substitué par un à quatre substituants indépendamment choisis dans le groupe constitué d'un halogéno, un aryle en C6-C10, et un alcoxy en C1-C4 ; et le pourcentage en moles de R3 est de 0 à environ 20 ;
R2 est choisi parmi un ou plusieurs des groupes constitués d'un alkylène ou oxyalkylène en C2-C12 ; un alkylène ou oxylalkylène en C2-C12 substit ué par un à quatre substituants indépendamment choisis dans le groupe constitué d'un halogéno, un aryle en C6-C10, et un alcoxy en C1-C4 ; un cycloalkylène en C5-C10 ; un cycloalkylène en C5-C10 substitué par un à quatre substituants indépendamment choisis dans le groupe constitué d'un halogéno, un aryle en C6-C10, et un alcoxy en C1-C4 ; et le pourcentage en moles de R2 est d'environ 35 à environ 95 ;
R4 est choisi parmi un ou plusieurs des groupes constitués d'un aryle en C6-C10 ; un aryle en C6-C10 substitué par un à quatre substituants indépendamment choisis dans le groupe constitué d'un halogéno, un aryle en C6-C10, et un alcoxy en C1-C4 ; un cylcoalkylène en C5-C10 ; un cycloalkylène en C5-C10 substitué par un à quatre substituants indépendamment choisis dans le groupe constitué d'un halogéno, un aryle en C6-C10, et un alcoxy en C1-C4 ; et le pourcentage en moles de R4 est d'environ 5 à environ 65.

3. Procédé selon la revendication 1 ou 2 comprenant les étapes consistant à :

utiliser deux matrices ou filières de filage ou plus ;
introduire une/des couche(s) d'autres matériaux fibreux sur la surface ;
déposer lesdits filaments provenant d'une ou plusieurs filière(s), stratifiés sur la surface pour former un textile non-tissé ; et
utiliser le copolyester aliphatique en tant qu'au moins un des matériaux qui sont extrudés pour le filament.

4. Procédé selon la revendication 1, 2 ou 3, dans lequel une vitesse élevée desdits filaments est établie.

5. Procédé selon la revendication 1, 2 ou 3, dans lequel des additifs ou des pigments sont ajoutés à l'extrudeuse.

6. Procédé selon la revendication 1, 2 ou 3, dans lequel le retrait thermique est contrôlé.

7. Fibre non-tissée produite par un procédé selon une des revendications 1 à 6.

8. Utilisation d'une fibre non-tissée selon la revendication 7 pour produire des vêtements, des couches, des survêtements, des produits d'incontinence pour adultes, des tampons hygiéniques féminins, des bandages chirurgicaux, des matériaux de conditionnement de pansements, des produits pour contact alimentaire, des textiles de support, des couvertures de matelas, des serviettes hygiéniques.

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