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DESCRIPTION

[0001] The present invention relates to wound dressings. In particular, the invention relates to antimicrobial wound dressings, methods of making the same and uses of the same.

[0002] Topical wound dressings for use in the treatment of wounds or other openings at a physiological target site on a human or animal body which are exuding blood and/or other bodily fluids have been known for some time. The materials used to make the wound dressings act to absorb the blood and/or other bodily fluids, and also stem the flow of such fluids from the body. Materials for wound dressings are described in, for example, WO2010031995 to MedTrade Products Limited, and are commercially available.

[0003] The management of exudate is of course essential and critical during wound care and surgical procedures. The aim of managing the exudate is essentially to provide a moist wound environment at the wound bed to minimise the risk of maceration, which in turn may reduce the negative impact upon the human or animal body and also shorten the length of time the patient will take to recover.

[0004] Another important consideration, and a focus of the present invention, is the management of microorganisms such as bacteria at the wound site to reduce and prevent the risk of infection. Without suitable treatment or preventative measures, bacteria on the skin and at the wound site can repopulate and migrate into the bloodstream, placing a patient at risk of infection.

[0005] Wound dressings containing antimicrobial agents are known. Such wound dressings can comprise fibres and polymers and be in the form of textiles, gels, etc. The dressings can contain an antimicrobial agent within a layer of absorbent material, whilst some have been known to include an antimicrobial agent in an outermost layer.

[0006] A problem arises in incorporating an antimicrobial agent into a wound dressing in a sufficiently high concentration for it to be effective.

[0007] Biopatch[®] is a wound dressing, generally used for securing catheters, for delivering an antimicrobial agent at the site of insertion of the catheter into the body. The dressing contains chlorhexidine gluconate (CHG) bonded to collagen within the dressing. However, such a wound dressing requires the presence of a collagen cross-linked biopolymer which has an affinity to the antimicrobial agent enabling the antimicrobial agent to reversibly bind thereto. A collagen cross-linked biopolymer delivers a controlled release of antimicrobial agent over time. However, this is not desirable in cases when it is necessary to deliver a large quantity of antimicrobial agent faster with the aim of killing microorganism quicker.

[0008] It is a problem with existing wound dressings that wound contact layers are prone to distort when wet with wound exudate. The distortion of the wound dressing typically occurs

when the wound contact layer swells and expands outwardly. The effect is a curling of the wound contact layer away from the skin. This is undesirable as sections of the wound dressing lift off the skin, thereby reducing the strength of the contact between the skin and the wound dressing. Such a curling of the wound dressing can also leave it vulnerable to being caught and tearing off during routine activity, such as patient movement or treatment. This can lead to discomfort and, in some instances, the need to replace the dressing. It is therefore highly desirable to provide a wound dressing that avoids and alleviates this problem.

[0009] There is therefore a need to develop improved methods of incorporating antimicrobial agents into wound dressings to prevent the repopulation and migration of microorganisms such as bacteria at the wound site and into the bloodstream.

[0010] The present invention has been made from a consideration of the aforementioned limitations and problems.

[0011] According to the preferred embodiment there is provided a wound dressing comprising a wound contact layer in the form of a textile, a film or a foam and an absorption layer, the absorption layer being attached to the wound contact layer by an adhesive, wherein the wound contact layer comprises at least one antimicrobial agent dispersed across the wound contact layer and wherein the wound contact layer is compressed.

[0012] It has been discovered that compressing the wound contact layer to a width less than its original width and/or having a wound contact layer with a density of greater than 0.06 g/cm^3 provides a wound contact layer that reduces or avoids distortion when wet with wound exudate. The wound contact layer does not curl and lift off the skin nor lose its shape when swelled and wet. The wound contact layer does not tend to expand outwardly but can still expand vertically.

[0013] It has also been discovered that existing foams that do not have a compressed wound contact layer and/or a wound contact layer having a density of greater than 0.06 g/cm^3 can have disadvantages such as healthy wound tissue migrating into the foam. This can lead to trauma and discomfort on removal of the dressing.

[0014] The wound dressing of the present invention provides an absorbent, conformable and anti-microbial medical device that may be used in a variety of medical situations, including post and/or pre-operative.

[0015] The wound dressing is absorbent and can be used to absorb exudate and minimise wound site infection by covering the peri-wound area of a wound caused by vascular and non-vascular percutaneous medical devices such as IV catheters, central venous lines, arterial catheters, dialysis catheters, mid-line catheters, drains, chest tubes, externally placed orthopaedic pins and epidural catheters.

[0016] The wound dressing may also be used for the management of infected chronic wounds

and those wounds at risk of infection.

[0017] The terms 'proximal' and 'distal' are used relative to a wound site. For example, the term 'proximal' is used herein to refer to a surface of a layer that faces toward the wound site and the term 'distal' is used herein to refer to a surface of a layer that faces away from the wound site.

[0018] The wound contact layer is intended for direct contact with the wound. The wound contact layer may have a surface proximal to the wound site that contacts the wound and a surface distal to the wound site that is attached to the absorption layer. In use, the face of the proximal surface will be applied directly to the wound site and surrounding tissue.

[0019] The wound contact layer is operable to transmit wound exudate from the wound site to the absorption layer.

[0020] The wound contact layer may have a density of greater than 0.06 g/cm³.

[0021] The wound contact layer may be compressed to the desired density or alternatively the wound contact layer may be manufactured to the desired density using standard manufacturing techniques for the materials forming such a layer.

[0022] In some embodiments, the wound contact layer may have a density of greater than 0.10 g/cm³, preferably greater than 0.15 g/cm³ and more preferably greater than 0.2 g/cm³. In some embodiments, the wound contact layer may have a density of greater than 0.3 g/cm³. Thus, densities of greater than 0.07, 0.08, 0.09, 0.10, 0.11, 0.12, 0.13, 0.14, 0.15, 0.16, 0.17, 0.18, 0.19, 0.20, 0.21, 0.22, 0.23, 0.24, 0.25, 0.26, 0.27, 0.28, 0.29, 0.30, 0.31, 0.32, 0.33, 0.34, 0.35, 0.36, 0.37, 0.38, 0.39, 0.40 are envisaged.

[0023] The wound contact layer in the wound dressing may be compressed to a width less than that of its original width.

[0024] Compressing the wound contact layer increases its density whilst still allowing for the flow of wound exudate therethrough. However, if the wound contact layer is compressed too much, it will be too dense for wound exudate to flow therethrough.

[0025] The wound contact layer may be compressed to a width of from 20-90% of its original width, more preferably from 30-60% of its original width and most preferably from 40-55% of its original width. Good results have been observed where the wound contact layer has been compressed to a width of around 50% of its original width. For example, the wound contact layer may comprise an open celled polyurethane foam having an original width of 3mm, compressed to a thickness of 1.5mm.

[0026] A further consideration when treating wounds, it that it is desirable for a wound dressing

to absorb wound exudate and transfer it away from the wound site whilst also maintaining a moist environment to promote healing of the wound. When managing microorganisms, it is important that as much of the wound exudate as possible is exposed to the antimicrobial agent and at as early a stage as possible.

[0027] It is desirable that the wound contact layer has a high lateral wicking rate to enable the wound exudate to absorb and rapidly disperse laterally through the layer and then rapidly pass into the absorption layer. It is also desirable for the wound contact layer to have a lower absorbency than the absorption layer to facilitate the passage of the wound exudate through to the absorption layer.

[0028] Thus, the lateral wicking rate of the wound contact layer may be the same or higher than the lateral wicking rate of the absorption layer.

[0029] Such wound dressings are capable of absorbing and rapidly spreading wound exudate from the wound site in the wound contact layer. The wound contact layer comprises an antimicrobial agent. The wound exudate that is rapidly spread in the wound contact layer is exposed to a greater amount of the antimicrobial agent before it passes through to the absorption layer. Beneficially, this reduces the level of microorganisms in the wound exudate. It also means that the antimicrobial agent is exposed to both the wound site and the surrounding healthy tissue, which significantly reduces the risk of infection.

[0030] Moreover, the absorption layer enables the transmission of wound exudate away from the wound site, which allows the wound site to remain moist whilst not being too wet. Beneficially, this promotes healing and minimises the risk of maceration.

[0031] A high lateral wicking rate refers to the rapid speed at which the wound contact layer will absorb wound exudate and allow it to disperse throughout the layer. Typically, the lateral wicking rate of the wound contact layer will be from 0.1-20 seconds, preferably from 0.5-10 seconds and more preferably from 1-5 seconds as measured by the test method described herein. Rapidly dispersing the wound exudate in the wound contact layer activates more of the antimicrobial agent in that layer. This has the beneficial effect of improving antimicrobial activity at the wound interface and throughout the dressing.

[0032] The lateral wicking rate is preferably uniform across the wound contact layer. A uniform lateral wicking rate provides a more even distribution of wound exudate throughout the wound contact layer.

[0033] The wound contact layer may have an absorbency of less than the absorbency of the absorption layer. Absorbency is typically measured as grams of fluid that can be absorbed per gram of absorbent. The absorbency of the wound contact layer may be less than 20g/g, preferably less than 15g/g and most preferably less than 10g/g. The absorbency is based on the test methods described herein.

[0034] The wound contact layer may comprise a biologically acceptable polymer material that has a wicking rate the same or equal to that of the absorption layer. Suitable biologically acceptable polymer materials may be selected from the group consisting of polyurethane, polyvinyl chloride, Styrofoam, polyimide and silicone.

[0035] Preferably, the biologically acceptable polymer is polyurethane.

[0036] The wound contact layer may be in the form of a textile, a film or a foam. Preferably, the wound contact layer is in the form of a foam, preferably still an open-celled foam. Thus, the biologically acceptable polymer materials may be selected from the group consisting of polyurethane foam, polyvinyl chloride foam, Styrofoam, polyimide foam and silicone foam.

[0037] Good results have been observed wherein the wound contact layer comprises polyurethane foam. The polyurethane foam is open-celled so as to allow for the passage of wound exudate through the foam and into the absorption layer. Closed-celled foams are not appropriate for the wound contact layer as they do not allow the passage of fluid through the foam.

[0038] The wound contact layer may have a thickness of from 0.5-4mm, preferably 1-3mm and more preferably 1.5-2mm. Good results have been observed with a wound contact layer having a thickness of around 3mm.

[0039] The wound contact layer may have any suitable shape common in the field of wound dressings. Typically, the wound contact layer will have a rectangular, elliptical or circular shape.

[0040] The wound contact layer may have a surface area the same as or less than that of the absorption layer.

[0041] The wound contact layer may be dimensionally stable. The term dimensionally stable is used herein to refer to a material that does not expand beyond 10% of its original dimension when wet.

[0042] The wound contact layer comprises at least one antimicrobial agent.

[0043] Antimicrobial agents are used primarily to kill microorganisms or inhibit their growth. It is important in wound management to remove or reduce the risk of infection at the wound site or in the bloodstream. In the wound dressings of the present invention, the antimicrobial agent is operable to kill or inhibit the growth of microorganisms at and around the wound site and in the wound exudate.

[0044] The antimicrobial agent may act as an antibacterial, an antifungal, or both. Preferably, the antimicrobial agent is antibacterial.

[0045] The wound contact layer may comprise one or more antimicrobial agents. For example,

the wound contact layer may comprise two, three, four or five different antimicrobial agents.

[0046] Antimicrobial agents for use in wound dressings will be familiar to a person skilled in the art. Suitable antimicrobial agents for use in the wound dressings of the present invention may be selected from the group consisting of silver, polyhexamethylene biguanide (PHMB), chlorhexidine gluconate (CHG), chitosan, chitosan derivatives, octenidine, iodine and combinations of any two or more thereof. Preferably, the antimicrobial agent is selected from CHG, silver or a combination thereof. More preferably, the antimicrobial agent is CHG, since CHG has a broader activity range than other antimicrobials.

[0047] The CHG is preferably applied in the form of a solution. The solution comprises CHG in water. The solution is preferably British Pharmacopoeia (BP) grade. Preferably, the CHG solution is a 20% CHG solution. Other concentrations are suitable for use in the present invention. However, the more concentrated the solution, the thicker it is. This affects the absorption of the solution. Also, the more dilute the concentration is, the more liquid has to be applied. As such, increased drying is required.

[0048] The antimicrobial agent is typically applied to the wound contact layer in the form of a solution. If the antimicrobial agent is in solid form, such as a powder or particulate form, it may be mixed with a solution prior to application to the wound contact layer. Preferably, the antimicrobial agent dissolves in the fluid.

[0049] The antimicrobial agent in solution may be applied to the wound contact layer by any liquid application process known in the art. Such methods may include spraying the solution onto a surface of the wound contact layer, pipetting the solution onto a surface of wound contact layer, dip coating the wound contact layer in the solution, and the like.

[0050] Prior to application, the wound dressing is preferably dry. It is therefore desirable to dry the wound contact layer following application of the antimicrobial agent. The drying process can comprise driving off any excess fluid from the wound contact layer after the solution containing the antimicrobial agent has been applied. This is typically performed by heat treating the wound contact layer. Suitable heat treatment techniques will be familiar to a person skilled in the art. They may include treatment in an oven or infrared treatment.

[0051] In some embodiments, the wound contact layer and the absorbent layer are formed into the wound dressing prior to application of the antimicrobial agent. In such embodiments, the techniques for applying the antimicrobial agent are the same as described herein.

[0052] In some embodiments, the antimicrobial agent is introduced as an additive in the process for preparing the biologically acceptable polymer.

[0053] The amount of antimicrobial agent required in the wound contact layer may vary depending on the specific antimicrobial agent, or combination of agents, applied. For example, certain antimicrobial agents, such as octenidine, may be required in a lesser amount than

CHG.

[0054] The wound contact layer may comprise around 0.1-2wt% of the antimicrobial agent. Where the antimicrobial agent is CHG, the wound contact layer may comprise from around 25-150mg of CHG, preferably around 50-100mg. Good results have been observed where the wound contact layer comprises around 85-95mg CHG.

[0055] Typically, the antimicrobial agent bonds to the surface of the wound contact layer.

[0056] The antimicrobial agent may be dispersed across and/or throughout the wound contact layer. Preferably, the antimicrobial agent is dispersed uniformly across and/or throughout the wound contact layer. This improves the efficacy of the antimicrobial action as a greater proportion of the wound exudate is exposed to the antimicrobial agent. Also, more of the antimicrobial agent is released at the wound interface. It is beneficial to also deliver the antimicrobial agent to the tissue surrounding the wound to prevent bacteria or microbes entering the wound through the channel between the dressing and the skin.

[0057] As least a portion of the antimicrobial agent may migrate into the absorption layer. This can occur during application of the antimicrobial agent to the wound contact layer and/or in use when the wound exudate passes through the wound contact layer into the absorption layer. It is beneficial to have antimicrobial agent in the absorption layer, as this enables the antimicrobial agent to act on the wound exudate in a greater proportion of the dressing as well as at the wound interface. The antimicrobial agent in the wound contact layer can act on microbes, such as bacteria, at the wound interface whilst the antimicrobial agent in the absorption layer can act on microbes that have entered the wound dressing so as to kill or inhibit bacterial growth within the dressing.

[0058] Thus, the wound dressing of the present invention may comprise a wound contact layer and an absorption layer, wherein the wound contact layer and the absorption layer comprise at least one antimicrobial agent and wherein the lateral wicking rate of the wound contact layer is the same or higher than the lateral wicking rate of the absorption layer.

[0059] The concentration of antimicrobial agent is typically higher in the wound contact layer than the absorption layer.

[0060] The absorption layer is operable to absorb wound exudate that passes through the wound contact layer. The absorption layer swells as it absorbs wound exudate. Typically, the absorption layer may swell by greater than 5%, preferably greater than 10% and more preferably greater than 15% when fully saturated.

[0061] The absorption layer may have a surface proximal to the wound site that contacts the wound contact layer and a surface distal to the wound site that faces away from the wound.

[0062] The absorption layer has an equal or lower lateral wicking rate than the wound contact

layer. Typically, the lateral wicking rate of the absorption layer will be from around 15-60 seconds or more as measured by the test method described herein.

[0063] It is desirable for the absorption layer to have a higher absorbency than the wound contact layer to facilitate the passage of the wound exudate through the wound dressing. The absorbency of the absorption layer may be greater than 5g/g, preferably greater than 8g/g and more preferably greater than 12g/g. In some instances, the absorbency of the absorption layer may be greater than 20g/g.

[0064] The absorption layer may comprise a biologically acceptable polymer material that has a wicking rate the same or lower than the wound contact layer. Preferably the biologically acceptable polymer material will also have an absorbency greater than that of the wound contact layer. Suitable biologically acceptable polymer materials may be selected from the group consisting of polyurethane and a superabsorbent material selected from polymeric materials such as poly(vinyl) alcohol (PVA), poly(ethylene oxide) (PEO) and poly(acrylic acid).

[0065] Preferably, the biologically acceptable polymer is polyurethane. The polyurethane of the absorption layer may have a pore size that is larger than that in the wound contact layer.

[0066] The absorption layer may be in the form of a foam.

[0067] Good results have been observed wherein the absorption layer comprises polyurethane foam. The polyurethane foam is typically open-celled.

[0068] The absorption layer typically has a greater thickness than that of the wound contact layer. The absorption layer may have a thickness of from 1-6mm, preferably 2-5mm and more preferably 3-4mm. Good results have been observed with an absorption layer having a thickness of around 4mm.

[0069] The absorption layer may have any suitable shape common in the field of wound dressings. The absorption layer may have the same shape as the wound contact layer. Preferably, the absorption layer will follow the same shape and contour as the wound contact layer.

[0070] The absorption layer may comprise a further antimicrobial agent. The further antimicrobial agent may be the same or different to the antimicrobial agent in the wound contact layer.

[0071] The further antimicrobial agent may be selected from the group consisting of silver, polyhexamethylene biguanide (PHMB), chlorhexidine gluconate (CHG), chitosan, chitosan derivatives, octenidine, iodine and combinations of any two or more thereof. Preferably, the further antimicrobial agent in the absorption layer is silver.

[0072] It is beneficial to have a further antimicrobial agent in the absorption layer as this will act

on microbes that have entered the dressing and/or have passed through from the wound contact layer. Such action will inhibit the growth of microorganisms, such as bacteria, within the dressing.

[0073] The absorption and/or wound contact layers may comprise one or more additional antimicrobial agents.

[0074] A proximal surface of the absorption layer may be attached to a distal surface of the wound contact layer. The respective layers may be attached using heat bonding or at least one adhesive. Where the absorption layer and the wound contact layer are both polyurethane based, they may be physically bonded to each other by bringing the two layers together under heat and pressure.

[0075] Preferably, the absorption layer is attached to the wound contact layer using an adhesive.

[0076] The adhesive may be applied to either or both of the surfaces that will be contacted with each other. The adhesive may be applied across substantially all of either or both surfaces or, alternatively, across a portion or portions thereof.

[0077] The adhesive may be in the form of a powder, a liquid, a web or a net. The web may be an acrylic web.

[0078] The adhesive may comprise a meltable adhesive and/or a pressure sensitive adhesive, or the like. The meltable adhesive may be a heat-bonding adhesive. The pressure sensitive adhesive may be acrylic based.

[0079] The adhesive may be in the form of a layer between the absorption layer and the wound contact layer. Preferably, the layer is porous so as to allow transmission of the wound exudate from the wound contact layer into the absorbent layer. If the adhesive covers the entire surface of either the absorption layer or the wound contact layer, it will not be feasible for wound exudate to pass from the wound contact layer into the absorption layer.

[0080] Preferably, the adhesive is a powder adhesive. The dry powder may be scattered onto a surface to be attached and then passed through a heat tunnel to laminate the absorption layer and wound contact layer.

[0081] The wound dressing of the present invention may further comprise a backing layer.

[0082] A proximal surface of the backing layer is typically attached to the distal surface of the absorption layer. The layers can be attached by any of the means referred to herein. Preferably, the backing layer is attached to the absorption layer using an adhesive. The adhesive is preferably an acrylic based pressure sensitive adhesive but may comprise any of the adhesives and be applied by any of the methods referred to herein.

[0083] The backing layer serves as a barrier and is operable to prevent microorganisms, such as bacteria, from entering the wound dressing from an external source, such as clothing, etc. The backing layer may also be waterproof. Further, the backing layer also serves to retain the wound exudate within the wound dressing and prevent it leaching out of the wound dressing.

[0084] The backing layer may have a surface area greater than that of the absorption layer and/or the wound contact layer. In such instances, there may be an overlap section whereby the backing layer extends beyond the edge of the absorption and wound contact layers.

[0085] The backing layer may be permeable to air and moisture but impermeable to water droplets and bacteria. In this regard, no water droplets or bacteria can penetrate the backing layer and enter the wound dressing.

[0086] The backing layer may be permeable to moisture. The backing layer may be occlusive. The permeability of the backing layer may be measured using established industry practices, such as the Paddington cup method (BS:EN 13726).

[0087] The backing layer may therefore comprise a material that is porous to air and moisture vapour but non-porous to water, such as water droplets, and microorganisms, such as bacteria.

[0088] The backing layer may be in the form of a film, a foam, or a combination thereof. Preferably, the backing layer is in the form of a film.

[0089] The backing layer may comprise any biologically acceptable polymer material that is impermeable to water droplets and microorganisms but permeable to air and moisture. Suitable biologically acceptable polymer materials for the backing layer may be selected from the group consisting of polyurethane and polyethylene.

[0090] The backing layer may comprise a polyurethane film, a polyurethane foam, a combination of the two, or a polyethylene film. The backing materials are preferably closed-celled.

[0091] Preferably, the backing layer comprises a polyurethane film.

[0092] The thickness of the film varies depending on the material of the backing layer.

[0093] For example, polyurethane and polyethylene films may have a thickness of from 10-100microns; polyurethane foam/film combinations typically have a thickness in the range 200-600microns. A particularly preferred example of a suitable polyurethane film envisaged by the present invention is polyurethane wherein the thickness of the film is 30microns. Other options include, for example, polyurethane having a film thickness of 15microns.

[0094] Thus, the wound dressing of the present invention may comprise a wound contact layer, an absorption layer, and a backing layer, wherein the wound contact layer comprises at least one antimicrobial agent and wherein the lateral wicking rate of the wound contact layer is the same or higher than the lateral wicking rate of the absorption layer.

[0095] The wound dressing of the present invention may comprise additional layers as desirable and as appropriate. For example, the wound dressing may comprise a second or more absorption layers. The second absorption layer may be located adjacent the first absorption layer. The second absorption layer may be operable to absorb wound exudate passing through the first absorption layer. This may be beneficial when treating wounds exuding a high amount of fluid, such as severe bleeding. The second and subsequent absorption layers may comprise any of the features described herein in relation to the absorption layer.

[0096] The second or subsequent absorption layer may comprise or consist of a superabsorbent material.

[0097] The term 'superabsorbent material' is used herein to refer to a hydrophilic material that is water-swellable, but not water soluble, and which is capable of absorbing fluid to greater than 2000% with a fluid retention of greater than 85%. Preferably, the superabsorbent material is capable of absorbing fluid to greater than 2500% with a fluid retention of greater than 90%.

[0098] The term 'water-swellable' is used herein to refer to a material that, when contacted with water or water-containing fluid, will absorb the fluid and swell, but will not substantially dissolve in that fluid.

[0099] The term 'water soluble' is used herein to refer to a material that, when contacted with water or a water-containing fluid, will dissolve in that fluid.

[0100] The superabsorbent material may be selected from polymeric materials such as poly(vinyl) alcohol (PVA), poly(ethylene oxide) (PEO) and poly(acrylic acid).

[0101] The superabsorbent material may be chemically modified. For example, the superabsorbent material may be a polymeric material obtained by graft polymerisation of acrylic acid onto a chain of carboxymethyl cellulose.

[0102] The superabsorbent material may comprise a chemically modified material selected from starch, cellulose and polymeric materials such as poly(vinyl alcohol) (PVA), poly(ethylene oxide) (PEO), and poly(acrylic acid). The poly(acrylic acid) may be a partially neutralised, lightly cross-linked poly(acrylic acid).

[0103] The terms "cross-linking" and "cross-linked" are used herein to refer to two or more polymer chains being linked by a primary bond, such as a covalent bond.

[0104] The term "lightly cross-linked" is used herein to refer to embodiments wherein the number of cross-linking primary bonds in the superabsorbent material is less than the total number of possible cross-linking bonds.

[0105] In some embodiments, the superabsorbent material is selected from polymeric materials such as PVA, PEO, and poly(acrylic acid), preferably a partially neutralised, lightly cross-linked poly(acrylic acid).

[0106] Typically, the superabsorbent material is a partially neutralised, lightly crosslinked poly(acrylic acid).

[0107] The superabsorbent material may be in the form of fibres. Typically, the superabsorbent material is in the form of non-woven fibres. The length of the fibres can be up to 100mm, and is typically from 20-75mm, more typically from 32 to 51mm.

[0108] The wound dressing of the present invention may further comprise adhesion means for adhering the wound dressing to the body of a user. The adhesion means may comprise a skin contact adhesive material.

[0109] For example, the adhesion means may comprise a skin contact adhesive material that can be applied over a portion of the outermost layer of the wound dressing and a portion of the patient's skin. The adhesive material, such as a medical grade tape, may be applied after the wound dressing is in place. Alternatively, the adhesive material may be attached to the wound dressing prior to the wound dressing being applied to the patient.

[0110] Additionally or alternatively, the adhesion means may comprise a skin contact adhesive material on the proximal surface of the wound contact layer. Preferably, such adhesive material may be fashioned to extend around some or all of a peripheral portion of the wound contact layer. Such an arrangement ensures that the skin contact adhesive material does not directly contact the wound and prevent wicking of the wound exudate through the wound dressing, i.e. it will leave a central portion of the wound contact layer exposed to the wound site. Alternatively, a perforated skin contact adhesive material may extend across the surface of the wound contact layer. The perforations are suitable to allow the passage of wound exudate through the adhesive material and into the wound contact layer.

[0111] Suitable skin contact adhesives may include, but are not limited to, acrylate, silicone, polyester or polyurethane based adhesives. They can be based on hydrogels and can be porous to moisture with a high moisture vapour transmission rate. They can be applied from water emulsions, solvents or using hot melt systems. The adhesives should have a good skin tack but give minimal skin trauma on removal. They can constitute 100% coverage of the wound contact layer, or a partial coverage thereof in the form of a pattern or mesh.

[0112] Preferably, the skin contact adhesive material is selected from the group consisting of pressure sensitive adhesives, polyurethane adhesives, silicone adhesives. Preferably, the

pressure sensitive adhesive is acrylic based. The silicone adhesives may be selected from common adhesives known in the art, such as Dow Corning, Bluestar, Wacker and Nusil.

[0113] The skin contact adhesive material may comprise an adhesive, such as those referred to herein, bonded to a carrier layer. The carrier layer may be coated with the skin contact adhesive. The carrier layer may have any of the features of the backing layer described herein.

[0114] The carrier layer may constitute 100% coverage of the wound contact layer, or a partial coverage thereof in the form of a pattern or mesh. For suitable operation, the carrier layer should be perforated in order to allow the passage of wound exudate through the carrier layer and into the wound contact layer.

[0115] Good results have been observed using a perforated silicone coated polyurethane film. In such embodiments, a polyurethane film, acting as a carrier layer, may be coated with an adhesive, such as silicone adhesive, and perforated. The perforated film is then bonded to the proximal surface of the wound contact layer. The silicone coated layer may bond to the wound and surrounding healthy tissue. Preferably, the silicone adhesive has a good skin tack and gives minimal skin trauma on removal.

[0116] The wound dressing of the present invention may also comprise additional components in the wound contact layer, absorption layer(s) and backing layer. Such additional components include, but are not limited to, pharmaceutical agents; wetting agents such as surfactants; growth factors; cytokines; agents which absorb agents which delay healing such as MMP's (matrix metalloproteinases) and elastase; and/or another wound dressing component, such as calcium, vitamin K, fibrinogen, thrombin, factor VII, factor VIII, clays such as kaolin, oxidised regenerated cellulose, gelatin, or collagen, etc.

[0117] Typical levels of any of these additional components could be from about 50 ppm up to about 50% by weight of the wound dressing. More typical levels would be less than 10%, still more typically less than about 5% by weight of the wound dressing. Additional components comprising less than about 1% by weight of the wound dressing are also envisaged by the present invention.

[0118] The wound dressing of the present invention is typically sterilised prior to packaging. This enables the physician or emergency responder to use the wound dressing directly from the packaging, thus saving further time.

[0119] The sterilisation may be carried out using any of the methods conventionally known in the art, such as gamma irradiation, electron beam treatment, heat treatment, x-ray, etc., or it may alternatively be carried out by treatment using ethylene oxide.

[0120] One such use for the wound dressing of the present invention is as a wound dressing for application at the site of a catheter.

[0121] In such embodiments, the wound dressing may comprise a radial slit extending from an edge of the wound dressing to a central point thereof. The central point need not necessarily be the exact centre of the wound dressing but should preferably be near or at the centre. The slit allows the wound dressing to be applied around the catheter.

[0122] The wound dressing may further comprises a central aperture suitable for receiving a catheter therethrough.

[0123] The wound dressing may be in the shape of rectangular, elliptical or circular disc.

[0124] The wound dressing of the present invention typically does not comprise collagen and/or a cross-linked biopolymer. Further, the wound dressing of the present invention typically has the antimicrobial agent applied directly to the wound contact layer and then dried to remove excess water.

[0125] According to a further aspect of the present invention, there is provided a method of manufacturing a wound dressing, the method comprising the steps according to claim 12.

[0126] The adhesive may be applied to a surface of the wound contact layer and/or the absorption layer. The adhesive may comprise a powder that is scattered onto a surface of the wound contact layer and/or absorption layer. It is important to ensure that the adhesive does not result in a continuous film providing 100% coverage of the wound contact layer and/or adhesive layer, as this will prevent passage of wound exudate through the dressing. In such instances, the adhesive may be perforated to ensure that wound exudate can pass through the dressing.

[0127] The wound contact layer and absorption layer may be laminated. The lamination may be conducted by means known in the art, such as a dry-heat lamination process using a heat tunnel.

[0128] The antimicrobial agent is preferably applied to the wound contact layer after step (a). However, in some instances the antimicrobial agent may be applied to the wound contact layer as a first step and the wound contact layer is then attached to the absorption layer using an adhesive.

[0129] The antimicrobial agent may be applied by spray coating or pipetting a solution containing antimicrobial agent onto the proximal surface of the wound contact layer. Alternatively, the wound contact layer may be dipped into a solution containing the antimicrobial agent.

[0130] The method may comprise the further step of drying the wound dressing. Such a step drives off any moisture resulting from the application of the antimicrobial agent.

[0131] The drying step may be conducted by any suitable drying means for wound dressings,

such as an oven.

[0132] The method may further comprise the step of attaching a backing layer to the distal surface of the absorption layer. Preferably, the backing layer is attached to the wound contact layer using an adhesive as described herein.

[0133] The method may further comprise the step of attaching an adhesion means to the wound dressing. The adhesion means may comprise any of the features described herein. The adhesion means may be attached to a distal surface of the absorption layer or, if present, the backing layer. Additionally or alternatively, the adhesion means may be attached to the proximal surface of the wound contact layer.

[0134] The method of attaching the adhesion means may first comprise the step of applying an adhesive to a carrier material. The adhesive may be applied to the carrier material by any suitable means known in the art, such as for example, spray coating, pipetting, dip-coating and the like.

[0135] The method may comprise a further step of sterilising the wound dressing. The sterilisation may comprise sterilising the individual components of the wound dressing prior to formation of the wound dressing or, additionally or alternatively, sterilisation of the prepared wound dressing.

[0136] According to a further aspect of the present invention, there is provided a wound dressing as described herein for use as a medicament.

[0137] According to a further aspect of the present invention, there is provided a wound dressing as described herein for use in killing or inhibiting the growth of microorganisms.

[0138] According to a further aspect of the present invention, there is provided a wound dressing as described herein for use in absorbing fluid discharged from a physiological target, or for use in stemming a flow of a fluid discharged from a physiological target site.

[0139] The further aspects of the present invention may incorporate any of the features described in respect of the first aspect of the present invention as desired or as appropriate.

[0140] Embodiments of the present invention will now be further described with reference to the following non-limiting examples and accompanying figures in which:

Figure 1:

is a representation of a wound dressing of the present invention;

Figure 2:

is a representation of an embodiment of a wound dressing of the present invention;

Figure 3:

is a representation of an embodiment of a wound dressing of the present invention;

Figure 4:

is a representation of an embodiment of a wound dressing of the present invention;

Figure 5:

is a graph showing the results of an elution test.

[0141] Referring to Figure 1, there is shown a wound dressing (1) comprising a wound contact layer (2) and an absorption layer (3). The wound contact layer comprises an antimicrobial agent (not shown).

[0142] Typically, the wound contact layer (2) is a polyurethane open celled foam having a thickness of around 3mm. The polyurethane foam can be compressed down to a thickness of 1.5mm and/or can have a density of greater than 0.06 g/cm³. The absorption layer (3) is typically a polyurethane foam having a thickness of around 4mm.

[0143] A distal surface of the wound contact layer (2) and a proximal surface of the absorption layer (3) are bonded to each other using an adhesive (not shown).

[0144] Referring to Figure 2, there is shown a wound dressing (11) comprising a wound contact layer (12), an absorption layer (13) and a backing layer (14). The wound contact layer (12) and absorption layer (13) may be the same as those shown to in Figure 1.

[0145] The backing layer (14) typically comprises a polyurethane film. The polyurethane film typically has a thickness of around 30microns. The backing layer (14) is permeable to air and moisture vapour but is impermeable to microorganisms, such as bacteria, and liquid droplets, such as water. A distal surface of the absorption layer (13) and a proximal surface of the backing layer (14) are bonded to each other using an adhesive (not shown).

[0146] Referring to Figure 3, there is shown a wound dressing (21) comprising a wound contact layer (22), an absorption layer (23), a backing layer (24) and a superabsorbent layer (25). The wound contact layer (22), absorption layer (23) and backing layer (24) may be the same as those described in Figure 2.

[0147] The superabsorbent layer (25) typically comprises nonwoven fibrous material. The superabsorbent layer (25) is bonded to the absorption layer (23) and the backing layer (24) using an adhesive (not shown). The adhesive may be a heat bonded net.

[0148] Referring to Figure 4, there is shown a wound dressing (31) comprising a wound contact layer (32), an absorption layer (33), a backing layer (34) and a skin contact adhesive layer (35). The wound contact layer (32), absorption layer (33) and backing layer (34) may be the same as those described in Figure 2.

[0149] The skin contact adhesive layer (35) comprises a polyurethane film coated with a

silicone adhesive. The film is perforated to as to allow for the passage of wound exudate into the wound contact layer (32).

[0150] The skin contact adhesive layer (35) is bonded to a proximal surface of the wound contact layer (32).

[0151] Table 1 shows changing density values for a 5mm thick polyethylene foam compressed to three different thicknesses.

Table 1

Density (g/cm ³)		Thickness (mm)
Min	Max	
0.07	0.09	4.5
0.22	0.28	1.5
<u>0.33</u>	0.43	1.0

Examples

Example 1:

[0152] 3mm thick open celled polyurethane foam wound contact layer was compressed to 1.5mm and adhesive bonded to 4mm thick polyurethane foam absorbent layer using an acrylic pressure sensitive adhesive. The polyurethane foam absorbent layer was then adhesive bonded to a polyurethane 30micron film. A 20% BP CHG solution was dosed onto the wound contact layer and the dressing was heat treated to leave approximately 92mg of CHG within the wound contact layer.

Example 2:

[0153] 3mm thick open celled polyurethane foam wound contact layer was compressed to 1.5mm and adhesive bonded to 3.25mm thick polyurethane foam absorbent layer using an acrylic pressure sensitive adhesive. The polyurethane foam absorbent layer was then adhesive bonded to a polyurethane 30micron film. A 20% BP CHG solution was dosed onto the wound contact layer and the dressing was heat treated to leave approximately 92mg of CHG within the wound contact layer.

Example 3:

[0154] 3mm thick open celled polyurethane foam wound contact layer was compressed to 1.5mm and adhesive bonded to 4mm thick polyurethane foam containing approximately 0.13% Ag using an acrylic pressure sensitive adhesive. The polyurethane foam absorbent layer was then adhesive bonded to a polyurethane 30micron film. A 20% BP CHG solution was dosed onto the wound contact layer and the dressing was heat treated to leave approximately 92mg of CHG within the wound contact layer.

Example 4:

[0155] 3mm thick open celled polyurethane foam wound contact layer was compressed to 1.5mm and adhesive bonded to 4mm thick polyurethane foam containing approximately 0.13% Ag using an acrylic pressure sensitive adhesive. The polyurethane foam absorbent layer was then adhesive bonded to a polyurethane 30micron film. A 20% BP CHG solution was dosed onto the wound contact layer and the dressing was heat treated to leave approximately 50mg of CHG within the wound contact layer.

Example 5:

[0156] 3mm thick open celled polyurethane foam wound contact layer was compressed to 1.5mm and adhesive bonded to 4mm thick polyurethane foam absorbent layer using an acrylic pressure sensitive adhesive. The polyurethane foam absorbent layer was then adhesive bonded to a polyurethane 30micron film. A chitosan lactate solution was dosed onto the wound contact layer and the dressing was heat treated to leave approximately 50mg of chitosan derivative within the wound contact layer.

Example 6:

[0157] 3mm thick open celled polyurethane foam wound contact layer was compressed to 1.5mm and adhesive bonded to 2.5mm thick polyurethane foam absorbent layer using an acrylic pressure sensitive adhesive. The polyurethane foam absorbent layer was then adhesive bonded to a polyacrylate superabsorbent nonwoven material with a net heat bonded on the side distal to the wound surface. The superabsorbent material was then adhesive bonded to a polyurethane 30micron film. A chitosan lactate solution was dosed onto the wound contact layer and the dressing was heat treated to leave approximately 92mg of chitosan lactate within the wound contact layer.

Example 7:

[0158] 3mm thick open celled polyurethane foam wound contact layer was compressed to 1.5mm and adhesive bonded to 3.25mm thick polyurethane foam absorbent layer using an acrylic pressure sensitive adhesive. On a proximal side of the polyurethane foam wound contact layer was bonded a perforated silicone coated polyurethane film. The polyurethane foam absorbent layer was adhesive bonded to polyurethane 30micron film. A 20% BP CHG solution was dosed onto the wound contact layer and the dressing was heat treated to leave approximately 92mg of CHG within the wound contact layer.

Test methods

[0159] Absorbency:

An area of a test wound dressing is cut to 50x50mm size and weighed. The test wound dressing is then fully immersed in saline solution for 30 minutes. After 30 minutes, the test wound dressing is removed by a corner of the dressing and allowed to drain for 15 seconds. The test wound dressing is then re-weighed and the fluid increase based on g/g calculated.

[0160] Wicking rate:

An area of a test wound dressing is cut to 50x50mm size. 2g of saline solution is measured and pipetted onto the surface of the test article. The time taken for the 2g of saline solution to be absorbed into the test article is recorded.

Comparative testing

[0161] The wound dressing of the present invention was tested in comparison to Biopatch[®], an antimicrobial dressing currently available on the market. The results are explained below.

[0162] A wound dressing of the present invention was prepared according to Example 2.

[0163] The wound dressing of the present invention comprised a 25mm diameter disc comprising a central 4mm hole and radial slit extending from the central hole to the edge of the disc.

[0164] For comparison purposes, a Biopatch[®] disc was obtained having a diameter of 25mm comprising a central 4mm hole and radial slit extending from the central hole to the edge of the disc.

Table 2 - Absorbency:

Example 2 test dressing	>10.0g/g
Biopatch [®]	>8.0g/g

Table 3 - Antimicrobial content:

Example 2 test dressing	87 +/- 2mg
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Biopatch®

89 +/- 2mg

Elution test:

[0165] An elution test was method devised to assess the level of CHG eluted from the each test dressing. The higher the elution value, the more CHG is being delivered to the microorganisms at the wound interface and within the wound dressing, the theory being that the more antimicrobial agent that can be exposed to the microorganisms, the greater the kill rate.

[0166] The aim of the test method is to determine the elution profile from the CHG impregnated test materials.

[0167] The following test method was followed:

1. (1) bond test wound dressing to a 30mm diameter disc of Corex, backing membrane side down, to prevent the test wound dressing from curling throughout testing;
2. (2) wet a filter paper disc with 0.4ml of deionised water;
3. (3) place the test wound dressing onto the filter paper;
4. (4) place the test wound dressing/filter paper inside a foil pouch, ensuring that the filter paper remains in contact with the entire surface of the wound contact layer side of the wound dressing;
5. (5) seal the pouch using a vacuum, to maintain contact between the filter paper and surface of the wound dressing;
6. (6) store the wound dressings at ambient conditions;
7. (7) at the required time interval carefully open the pouch & remove the test wound dressing / filter paper;
8. (8) remove the filter paper from beneath the test wound dressing;
9. (9) submerge the filter paper in a set amount of deionised water;
10. (10) leave the filter paper submerged for 60 minutes;
11. (11) measure the conductivity reading of the solution;
12. (12) record the result;
13. (13) repeat steps 3 -12, using the same test article, at further time intervals;
14. (14) calculate the amount of CHG (mg) from Conductivity ($\mu\text{S}/\text{cm}$) at the different time points.

[0168] The results of the testing are shown in Figure 5 and Table 4 below.

Table 4 - Cumulative elution CHG (mg) over time

Sample Type	Time Point (hrs)							
	2	24	48	72	96	120	144	168
Example 2 test dressing	29.82	45.05	55.16	61.58	66.13	69.94	72.72	74.67
Example 2 test dressing with 7mm centre hole	28.20	42.60	52.16	58.23	62.54	66.14	68.77	70.61
Composition as in Example 2 but as a 19mm disc with 1.5mm centre hole and radial slit	17.57	26.54	32.49	36.27	38.95	41.20	42.84	43.98
Biopatch®	2.55	5.67	13.31	20.15	24.63	28.33	31.19	33.44

[0169] It is clear from the Table 4 and from Figure 5 that the Biopatch® dressing releases CHG at a far slower rate, around 10x slower, than the dressing of the present invention. As such, the dressing of the present invention is beneficial for application to wounds where a large quantity of antimicrobial agent needs to be delivered quickly.

[0170] It is of course to be understood that the present invention is not intended to be restricted to the foregoing examples which are described by way of example only.

REFERENCES CITED IN THE DESCRIPTION

Cited references

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- [WO2010031995A \[0002\]](#)

Patentkrav

1. Sårforbinding, der omfatter et sårkontaktlag i form af et tekstil, en film eller et skum, og et absorptionslag, hvilket absorptionslag er fastgjort til sårkontaktlaget ved hjælp af et klæbemiddel, hvor sårkontaktlaget omfatter mindst ét antimikrobielt middel, der
5 er dispergeret ud over sårkontaktlaget, og hvor sårkontaktlaget er komprimeret.

2. Sårforbinding ifølge krav 1, hvor sårkontaktlagets laterale opsugningsrate er den samme som eller højere end absorptionslagets laterale opsugningsrate, hvor den laterale opsugningsrate måles ved hjælp af en test, der omfatter pipettering af 2 g
10 saltopløsning på en overflade af en 50x50 mm testsårforbinding og registrering af den tid, det tager for saltopløsningen at blive absorberet deri.

3. Sårforbinding ifølge et hvilket som helst af de foregående krav, hvor sårkontaktlagets laterale opsugningsrate er på fra 0,1 til 20 sekunder.
15

4. Sårforbinding ifølge et hvilket som helst af de foregående krav, hvor sårkontaktlagets absorptionsevne er mindre end absorptionslagets absorptionsevne, og eventuelt hvor sårkontaktlagets absorptionsevne er mindre end 20 g/g.

- 20 5. Sårforbinding ifølge et hvilket som helst af de foregående krav, hvor sårkontaktlaget omfatter polyurethanskum, og/eller hvor sårkontaktlagets tykkelse er på fra omkring 0,5 til 4 mm.

6. Sårforbinding ifølge et hvilket som helst af de foregående krav, hvor det
25 antimikrobielle middel er valgt fra gruppen bestående af sølv, polyhexamethylenbiguanid, chlorhexidingluconat, chitosan, chitosanderivater, octenidin, iod og kombinationer af hvilke som helst to eller flere deraf.

7. Sårforbinding ifølge et hvilket som helst af de foregående krav, hvor
30 absorptionslaget omfatter et antimikrobielt middel, der er det samme eller forskelligt

fra det antimikrobielle middel i sårkontaktlaget, og eventuelt hvor koncentrationen af antimikrobielt middel er højere i sårkontaktlaget end i absorptionslaget.

5 **8.** Sårforbinding ifølge et hvilket som helst af de foregående krav, hvor absorptionslaget har en tykkelse på fra 1 til 6 mm.

9. Sårforbinding ifølge et hvilket som helst af de foregående krav, hvor sårkontaktlagets absorptionsevne er større end 20 g/g, og/eller hvor absorptionslaget omfatter et polyurethanskum, og/eller hvor klæbemidlet er akrylbaseret.

10

10. Sårforbinding ifølge et hvilket som helst af de foregående krav, der endvidere omfatter et bagsidelag, hvor bagsidelaget eventuelt er gennemtrængeligt for luft og fugt, men uigennemtrængeligt for vanddråber og bakterier, og/eller hvor beklædningslaget omfatter en polyurethanfilm, der eventuelt har en tykkelse på fra 10
15 til 100 mikrometer.

11. Sårforbinding ifølge et hvilket som helst af de foregående krav, der endvidere omfatter et andet absorptionslag, hvilket andet absorptionslag eventuelt omfatter et
20 superabsorberende materiale og/eller endvidere omfatter et hudkontaktklæbemateriale, der er fastgjort til i det mindste en del af sårkontaktlaget, hvilket hudkontaktklæbemateriale eventuelt omfatter et klæbemiddel, der er bundet til bærelaget, hvor hudkontaktklæbematerialet eventuelt omfatter et
silikoneklæbemiddel, der er bundet til en polyurethanfilm.

25 **12.** Fremgangsmåde til fremstilling af en sårforbinding, hvilken fremgangsmåde omfatter følgende trin:

a. komprimering af et sårkontaktlag, hvilket sårkontaktlag er i form af et tekstil, en film eller et skum,

b. fastgørelse af sårkontaktlaget til et absorptionslag under anvendelse af et
30 klæbemiddel, og

c. påføring af mindst ét antimikrobielt middel på sårkontaktlaget, hvilket antimikrobielt middel dispergeres ud over sårkontaktlaget.

- 5 **13.** Fremgangsmåde ifølge krav 12, hvor klæbemidlet omfatter et akrylpulver, hvilket pulver spredes på en overflade af sårkontaktlaget og/eller absorptionslaget, hvorefter sårkontaktlaget og absorptionslaget lamineres, og/eller hvor det antimikrobielle middel påføres sårkontaktlaget som en opløsning.
- 10 **14.** Fremgangsmåde ifølge krav 12 eller krav 13, der endvidere omfatter et trin til tørring af sårforbindingen og/eller fastgørelse af et bagsidelag til absorptionslaget under anvendelse af et klæbemiddel og/eller fastgørelse af et adhæsionsmiddel til sårkontaktlaget, hvilket adhæsionsmiddel omfatter et klæbemiddel, der er bundet til et bærelag.
- 15 **15.** Sårforbinding ifølge et hvilket som helst af kravene 1 til 11 til anvendelse som et medikament og/eller til anvendelse til absorbering af fluid, der udledes fra et fysiologisk mål, eller til anvendelse til opdæmning af en strøm af et fluid, der udledes fra et fysiologisk målsted.

DRAWINGS

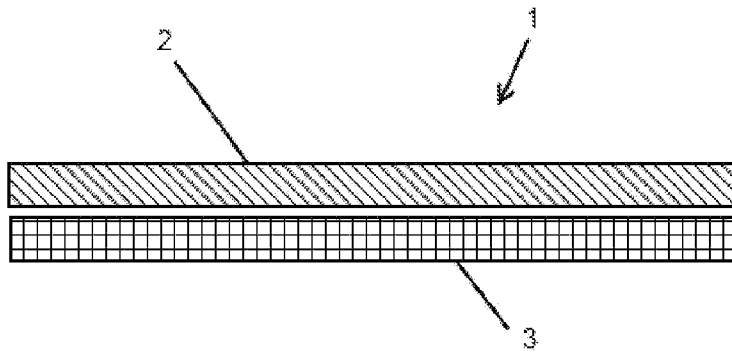


FIGURE 1

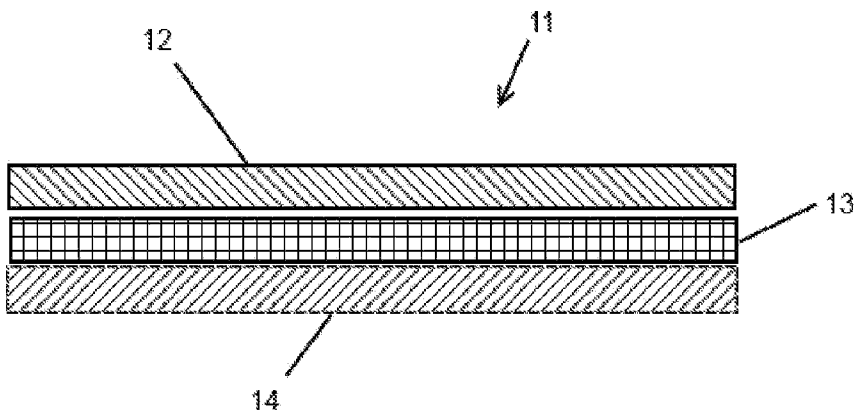


FIGURE 2

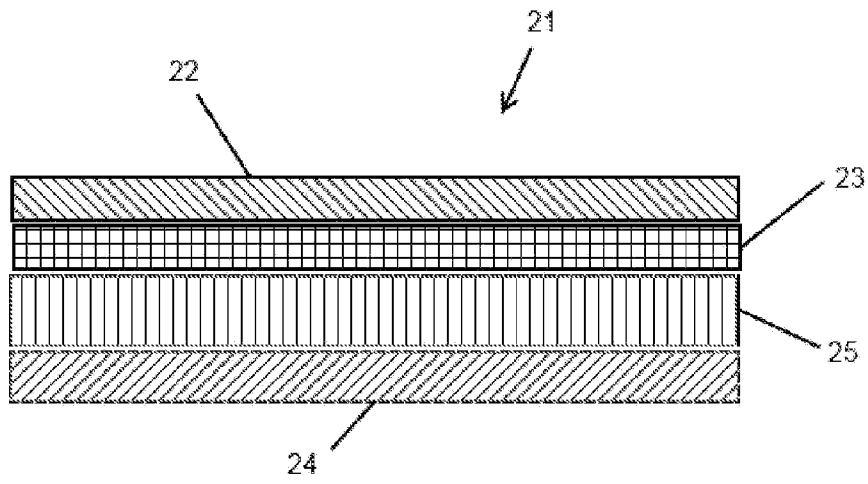


FIGURE 3

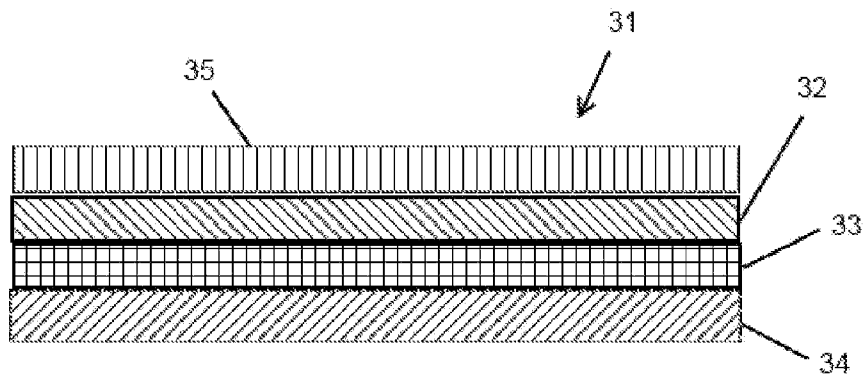


FIGURE 4

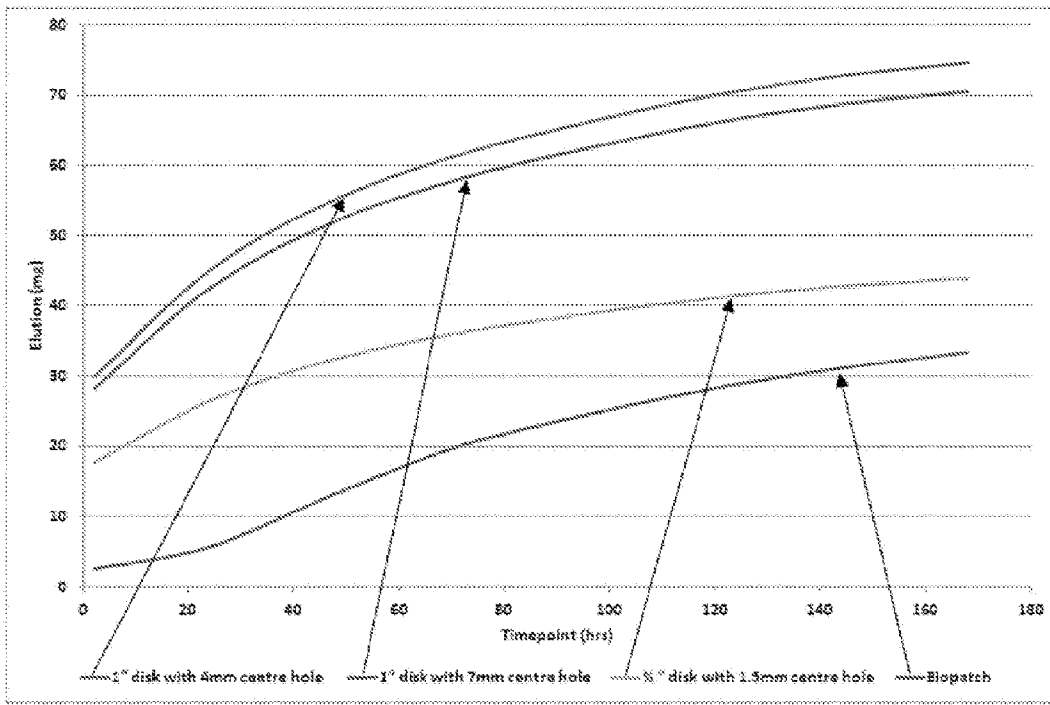


FIGURE 5