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TEXTILE

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Description

[0001] The present invention relates to a textile with increased water transport ability.

[0002] It is well known that standard waterproof textiles typically transport only 0.1 to 0.5 liters of water per square meter and hour, while human perspiration rates are often 1-2 liters per hours during vigorous activity. This creates challenges especially in foul weather clothing and in protective clothing such as fire-fighter or military uniforms, and can lead to reduced concentration and performance of wearers, in extreme cases hypo- or hyperthermia.

[0003] One solution is described in publications EP 0993328 and WO 2009/024779, where the liquid transport is aided by an electric field. By placing two porous conductive layers on each side of a textile or porous membrane and applying a voltage difference between said layers, a water transport up to 100 liters per square meter and hour has been shown. The mechanism for this transport is electroosmosis, which involves a small electric current through the porous structure.

[0004] However, there are some important drawbacks with this solution. In order to run a current between the electrodes, some electrochemical charge-transfer reaction must take place at the electrodes. For pure water this would involve the generation of hydrogen and oxygen, which is not dangerous in small amounts, but could pose the danger of explosions if in a non-ventilated system or if running high currents. With low water contents significant pH changes could appear near each electrode, potentially causing irritation to the skin. More serious challenges arise when contaminants are present, for example human sweat containing sodium chloride which could form dangerous chlorinated compounds upon electrolysis at about 1.3 V. Due to kinetics, chlorine reacts at lower voltages than oxygen in water. The creation of small gas bubbles could also dry out the pores and provide insulation at the electrodes, resulting in loss of performance.

[0005] Keeping the voltage below the reaction potentials of water and sodium chloride (and other compounds present) could solve the problem. However, with standard electrodes no other reaction would be available to support the charge transfer, hence the water transport would stop and the electrodes become polarized after a very short period.

[0006] The present invention addresses this, according to one aspect, by introducing electrodes with an inherent charge transfer mechanism which does not depend on the reaction potentials of the liquid to be transported, and for which the liquid is not taking part in electrochemical reactions.

[0007] According to another aspect, the invention provides a textile comprising first and second conductive layers, at least one porous layer positioned between the first and second conductive layers, the first and second conductive layers being arranged to generate an electric field whereby a current passes between the conductive

layers so as to induce liquid transport and so as to cause ions to be received at the second conductive layer, measurement means arranged to measure the amount of charge transferred between the first and second conductive layers during a liquid transport operation, the measurement means being able to take account of any variation in current or voltage during the liquid transport operation, and control means arranged to control a regenerating operation to regenerate the second conductive layer by transferring via it an amount of charge substantially equal to the measured amount so as to cause ions to be removed from the second conductive layer and thereby regenerate the conductive layer.

[0008] According to another aspect the invention provides a textile comprising first and second conductive layers, at least one porous layer positioned between the first and second conductive layers, the first and second conductive layers being arranged to generate an electric field, and means for reversing the electric field.

[0009] According to another aspect, the invention provides a textile pump with improved electrodes to avoid un-desired electrochemistry.

[0010] In one embodiment, the electrode material is made from a hydrogen storing material such as palladium or nanocrystalline nickel. For palladium, the oxidation and reduction of hydrogen occurs at only 0.3 V, hence an electric current causing electroosmotic liquid transport would happen at only 0.3 V, far below the reaction potential for water or sodium chloride solutions. Such electrodes could thus safely transport even salt containing water.

[0011] The following reactions take place at hydrogen storing conductive layers (electrodes):

1. Anode: $\text{H} \rightarrow \text{H}^+ + \text{e}^-$
2. Cathode: $\text{H}^+ + \text{e}^- \rightarrow \text{H}$

[0012] Thus, the hydrogen is stored in the electrodes as neutral atoms or molecules, and moved through the porous liquid filled structure as ions.

[0013] An important aspect disclosed herein is the incorporation of a device which counts the number of ions (charge) passing from one electrode to the other. As these ions are the current carriers, this can be done by an automatic measuring of the current (i.e. the current is proportional to the number of hydrogen ions transported). After applying the current for a certain period in one direction, the cathode would become saturated with hydrogen and the process would stop. Therefore, in a preferred embodiment of the present invention, an electronic control system connected to the charge counting system would reverse the voltage (regeneration step) from time to time in order to avoid the saturation of one electrode or the emptying of the other.

[0014] It is known that membranes and textiles can have asymmetric water transport properties, e.g. due to asymmetric pore structure along its cross section. The water transport could also be asymmetric e.g. due to liq-

liquid run-off at the outside of a jacket. Therefore, less water could be transported during the regeneration step, resulting in a net liquid transport in the desired direction. Especially, in a jacket the forward pumping could be applied during hard activity with high perspiration rates, and the regeneration could be carried out under dryer conditions or when the jacket is not in use.

[0015] The pores of the porous layer may extend in a direction substantially perpendicular to the conductive layer.

[0016] Steps in operation of certain preferred embodiments of the present invention:

1. In a new system electrodes (conductive layers) are partially pre-filled with hydrogen, to a known degree.
2. A number of forward cycles (causing liquid transport in the desired direction) and reverse cycles (causing electrode re-generation) are carried out, while the total charge (equalling the product of time and current) is counted and kept track of electronically. This way, the degree of hydrogen filling in each electrode is always kept track of. The length of the cycles can be adjusted depending on the need for water transport.
3. The system would automatically limit itself so as no electrode is saturated or totally emptied of hydrogen (in which case the hydrogen cycling would no longer work). The maximum time of operating the system in one direction would depend on the current, which again depends on voltage and liquid conductivity. For a given cycle it would also depend on the degree of hydrogen saturation in the electrodes from previous cycles.
4. There could also be any number of periods with no voltage applied, during which the hydrogen contents of each electrode would remain constant.

[0017] In other embodiments, ions different from hydrogen would be the charge carriers, e.g. silver-silver chloride electrodes. The charge counting and controlling system would be the same, however.

[0018] A preferred embodiment is shown by way of example in the attached drawing, labelled as Figure 1.

[0019] In the drawing:

1 is a porous textile or membrane where the liquid transport is to be induced by an electric field and current, 2 is a conductive layer (first electrode), 3 is a conductive layer (second electrode), A is a point where current is measured, and V is a voltage source. 4 is an electronic control system connected to the current measurer A to reverse the voltage (regeneration step) from time to time in order to avoid the saturation of one electrode or the emptying of the other

[0020] Nanocrystalline nickel or other hydrogen storing

metals could be used for the electrodes. Thin porous metal foils could be prepared by laser cutting a non porous foil, or by electroplating.

Claims

1. A textile comprising first and second conductive layers, at least one porous layer (1) positioned between the first and second conductive layers (2, 3), the first and second conductive layers (2, 3) being arranged to generate an electric field whereby a current passes between the conductive layers (2, 3) so as to induce liquid transport and so as to cause ions to be received at the second conductive layer (3), **characterised by** measurement means (A) arranged to measure the amount of charge transferred between the first and second conductive layers (2, 3) during a liquid transport operation, the measurement means (A) being able to take account of any variation in current or voltage during the liquid transport operation, and control means (4) arranged to control a regenerating operation to regenerate the second conductive layer (3) by transferring via it an amount of charge substantially equal to the measured amount so as to cause ions to be removed from the second conductive layer (3) and thereby regenerate the conductive layer (3).
2. Textile as claimed in claim 1, wherein the textile is arranged to be adjustable during the induced liquid transport operation by varying the voltage applied to the first and second conductive layers (2, 3).
3. Textile as claimed in claim 1 or 2, wherein the control means (4) is arranged to control the regenerating operation by effecting a current reversal between the first and second conductive layers (2, 3).
4. Textile as claimed in claim 1, 2 or 3, wherein the ions transported between the conductive layers (2, 3) are hydrogen ions, and the conductive layers (2, 3) contains a hydrogen storage material such as palladium or nanocrystalline nickel.
5. Textile as claimed in any of claims 1 to 4, wherein the porous layer (1) has asymmetrical geometry so as to cause more liquid transport when the electric field is applied in the one direction than when it is applied in the opposite direction.
6. Textile as claimed in any of claims 1 to 5, used for water removal in clothing, in automotive, train or plane seats, or in mattresses.

Patentansprüche

1. Gewebe, das erste und zweite leitfähige Schichten, mindestens eine poröse Schicht (1), die zwischen den ersten und zweiten leitfähigen Schichten (2, 3) positioniert ist, umfasst, wobei die ersten und zweiten leitfähigen Schichten (2, 3) angeordnet sind, um ein elektrisches Feld zu erzeugen, wobei ein Strom zwischen den leitfähigen Schichten (2, 3) fließt, um einen Flüssigkeitstransport hervorzurufen und um zu bewirken, dass Ionen an der zweiten leitfähigen Schicht (3) empfangen werden, **gekennzeichnet durch** Messmittel (A), das zum Messen der Ladungsmenge, die zwischen den ersten und zweiten leitfähigen Schichten (2, 3) während eines Flüssigkeitstransportvorgangs übertragen wird, angeordnet ist, wobei das Messmittel (A) instande ist, jegliche Veränderung von Stromstärke oder Spannung während des Flüssigkeitstransportvorgangs zu berücksichtigen, und **gekennzeichnet durch** Steuervorrichtung (4), die zum Steuern eines Regenerationsbetriebs zum Regenerieren der zweiten leitfähigen Schicht (3) angeordnet ist, indem **durch** sie eine Ladungsmenge, die im Wesentlichen gleich der gemessenen Menge ist, übertragen wird, um zu bewirken, dass Ionen von der zweiten leitfähigen Schicht (3) entfernt werden und dabei die leitfähige Schicht (3) regeneriert wird.
2. Gewebe nach Anspruch 1, wobei das Gewebe angeordnet ist, um während des herbeigeführten Flüssigkeitstransportvorgangs durch Variieren der Spannung, die an die ersten und zweiten leitfähigen Schichten (2, 3) angelegt wird, anpassungsfähig zu sein.
3. Gewebe nach Anspruch 1 oder 2, wobei die Steuervorrichtung (4) angeordnet ist, um den Regenerationsbetrieb durch Bewirken einer Stromrichtungsumkehr zwischen den ersten und zweiten leitfähigen Schichten (2, 3) zu steuern.
4. Gewebe nach Anspruch 1, 2 oder 3, wobei die Ionen, die zwischen den leitfähigen Schichten (2, 3) transportiert werden, Wasserstoffionen sind, und die leitfähigen Schichten (2, 3) ein Wasserstoffspeichermaterial wie Palladium oder nanokristallines Nickel enthalten.
5. Gewebe nach einem der Ansprüche 1 bis 4, wobei die poröse Schicht (1) eine asymmetrische Geometrie aufweist, um mehr Flüssigkeitstransport zu bewirken, wenn das elektrische Feld in die eine Richtung angelegt wird, als wenn es in die entgegengesetzte Richtung angelegt wird.
6. Gewebe nach einem der Ansprüche 1 bis 5, das für den Wasserentzug aus Kleidung, aus Kraftfahr-

zeugs-, Zug- oder Flugzeugsitzen oder aus Matratzen genutzt wird.

Revendications

1. Textile comprenant des première et seconde couches conductrices, au moins une couche poreuse (1) positionnée entre les première et seconde couches conductrices (2, 3), les première et seconde couches conductrices (2, 3) étant agencées pour produire un champ électrique de sorte qu'un courant passe entre les couches conductrices (2, 3) de façon à induire un transport de liquide et de façon à provoquer la réception d'ions au niveau de la seconde couche conductrice (3), **caractérisé par** un moyen de mesure (A) agencé pour mesurer la quantité de charge transférée entre les première et seconde couches conductrices (2, 3) pendant une opération de transport de liquide, le moyen de mesure (A) étant capable de prendre en compte n'importe quelle variation de courant ou de tension pendant l'opération de transport de liquide, et un moyen de commande (4) agencé pour commander une opération de régénération pour régénérer la seconde couche conductrice (3) en transférant via celle-ci une quantité de charge sensiblement égale à la quantité mesurée de façon à provoquer l'enlèvement d'ions depuis la seconde couche conductrice (3) et régénérer de ce fait la couche conductrice (3).
2. Textile selon la revendication 1, dans lequel le textile est agencé pour être réglable pendant l'opération de transport de liquide induite en faisant varier la tension appliquée aux première et seconde couches conductrices (2, 3).
3. Textile selon la revendication 1 ou 2, dans lequel le moyen de commande (4) est agencé pour commander l'opération de régénération en effectuant un renversement de courant entre les première et seconde couches conductrices (2, 3).
4. Textile selon la revendication 1, 2 ou 3, dans lequel les ions transportés entre les couches conductrices (2, 3) sont des ions d'hydrogène, et les couches conductrices (2, 3) contiennent une matière de stockage d'hydrogène comme du palladium ou du nickel nanocristallin.
5. Textile selon l'une quelconque des revendications 1 à 4, dans lequel la couche poreuse (1) a une géométrie asymétrique de façon à provoquer plus de transport de liquide quand le champ électrique est appliqué dans un sens particulier que lorsqu'il est appliqué dans le sens opposé.
6. Textile selon l'une quelconque des revendications 1

à 5, utilisé pour l'enlèvement d'eau sur des vêtements, sur des sièges d'automobile, de train ou d'avion, ou sur des matelas.

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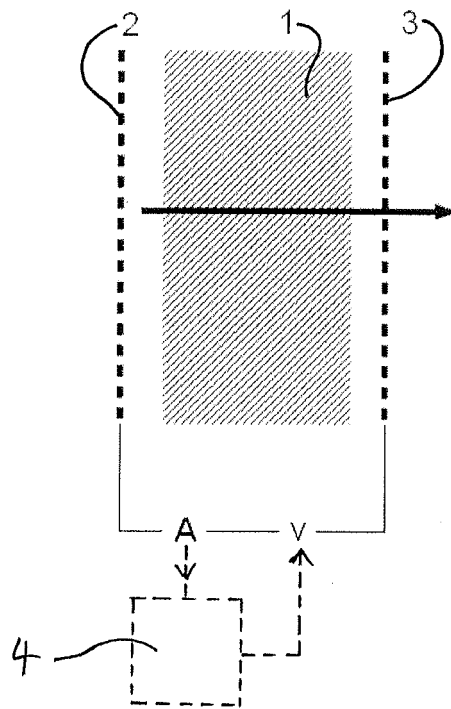


Figure 1

REFERENCES CITED IN THE DESCRIPTION

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