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(54) **A GARMENT FOR DIVING**

(57) A diver who will typically wear a garment (100) for diving can be readily detected in the Infra-Red. This goes even more if the garment (100) comprises a heating element against the cold. To reduce the risk of a diver,

such as a military diver, to be detected, the garment (100) for diving comprises a layer (210) of silica material. The silica material may be in the form of a pad (220) comprising a heating element, or a coating.

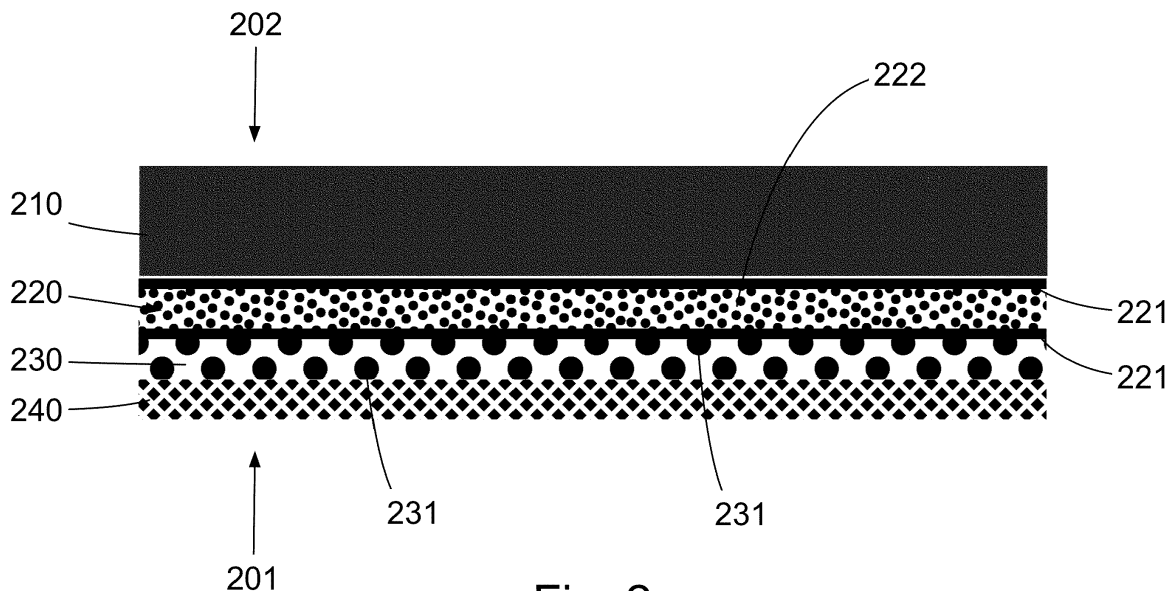


Fig. 2

Description

[0001] The present invention relates to a garment for diving.

[0002] A garment for diving is known in the art. For operations where the diver has to remain hidden, such as military operations, it is a problem that the diver can be detected using heat-sensing equipment such as an Infra-Red camera.

[0003] The object of the present invention is to reduce this problem.

[0004] To this end, a garment for diving according to the preamble is characterized in that the piece of garment comprises a layer of silica material chosen from aerogel and pyrogenic silica.

[0005] It has been found that this helps to render the diver harder to detect in the Infra-Red.

[0006] Within the scope of the present invention, the term "garment for diving" may constitute

- a piece of garment worn beneath a diving suit, i.e. a vest, or a piece of garment that will be in contact with the water while diving. The piece of garment may be a piece of garment to cover the feet (e.g. diving shoes), the legs, the torso, the hands (e.g. hand shoes) and/or the head.

[0007] Advantageously, the piece of garment is a diving suit. Within the scope of the present invention, the term "diving suit" comprises a diving jacket (which has an opening at the front connecting the collar with the bottom side and typically provided with a means for closing the jacket, e.g. a zipper), a diving jumper without an opening at the front (as such or as part of a two-piece garment called a Long-John), and a diving overall (a full body suit, i.e. a one-piece comprising pant legs). A diving suit may be a wet suit or a dry suit.

[0008] The silica material is typically in the form of a powder, helping the garment to be flexible so as to conform to the body of the diver and accommodate for the diver's movements. The silica material is preferably aerogel.

[0009] According to a favourable embodiment, the garment is a heating garment for diving, said heating garment comprising a heating element between the inside of the garment and the layer of silica material.

[0010] Thus the diver can remain warm without the heat giving away the diver.

[0011] According to a favourable embodiment, the garment is a heating garment for diving, said heating garment being a piece of garment comprising a front section for the front of a chest of a diver and a back section for the back of the chest of the diver, the piece of garment comprising an electrical heating element; wherein the piece of garment has a inner first side for facing the body of the diver and an outer second side facing away from the body, wherein the piece of garment is provided with a pad comprising the layer of silica ma-

terial provided in an enclosure made of plastic, with the heating element provided between the pad and the inner first side.

[0012] A heating garment for diving is known in the art. This may constitute a piece of garment worn below a diving suit or the diving suit itself. The heating element is typically an electric heating element. In contact with water, the human body cools down more rapidly than in air of the same temperature. Typically, a diving suit is made of thermally insulating material such as neoprene to counter this. However, in case of prolonged dives or relatively cold water, this is not enough. Thus it is known to provide a heating element, which is for example battery-powered heating element.

[0013] For operations where the diver has to remain hidden, such as military operations, in state of the art diving suits the heating element would exacerbates the problem that the diver can be detected using heat-sensing equipment such as an Infra-Red camera, which problem is reduced with the present invention.

[0014] The plastic will be typically flexible plastic. It will be water impermeable. The silica material will be sealed within the plastic, preventing contact with water.

[0015] According to a favourable embodiment, the heating element is provided between a 3D-textured fabric and the pad.

[0016] Thus direct contact between the body of the diver and the heating element can be avoided. Typically the 3D-textured fabric will provide the inner face of the garment.

[0017] A 3D-textured fabric is a fabric with an open structure of interconnected spaces allowing air to pass through the fabric both in a direction transverse to the surface of the fabric as well as through the fabric in a direction parallel to the surface. Obviously, in a wetsuit these spaces will be at least partially filled with water instead of air.

[0018] According to a favourable embodiment, the 3D-textured fabric provides a pouch for retaining the pad and the heating element.

[0019] This is a very simple and efficient construction. The pouch will typically be made by stitching, such as stitching the 3D-textured fabric to a convention piece of diving garment, mor specifically at the inside thereof. The pouch may be fully closed (stitched around) or partially open, e.g. with a slot, allowing easy replacement of any of the pad and the heating element, should this be desired. It is for example possible to exchange pads of different thickness (and hence insulation) depending on the circumstances.

[0020] According to a favourable embodiment, the piece of garment comprises an elastomeric layer with the pad between the elastomeric layer and the first side and the piece of garment is a diving suit.

[0021] Thus the pad and the heating element are integrally part of the diving suit, saving time to get ready diving.

[0022] According to a favourable embodiment, the

back section of the piece of garment comprises the electrical heating element and the pad.

[0023] This allows the piece of garment to be worn more comfortably with the heating silica material pad and the heating element at the diver's back while supplying heat efficiently. The present invention allows the back-side to be heated while reducing the detectability in the Infra-Red compared to a conventional heated garment.

[0024] According to a favourable embodiment, the garment is a coated garment, the coating comprising the silica material.

[0025] The coating will preferably have a thickness of at least 0.5 μm . It goes without saying that for a garment comprising an insulating pad, it is preferred that at least those areas of the garment that do not comprise the pad are coated, but typically the whole of the garment will be coated. Coating can be done using any suitable glue, such as WB acrylic, which is commercially available.

[0026] The coating may be applied on the outside of the garment, on the inside of the garment and both. For a diving garment composed of a multitude of layers, the coating may be applied on a side of one of the layers allowing the coating to be sandwiched between other layers. The layers may for example be two layers, such as a Neoprene outside layer and a fabric inside layer. At least the inward facing side of the Neoprene layer will be provided with glue and subsequently coated with the silica material.

[0027] It is also possible to coat a pad with silica material, and use that pad in a pouch as discussed above. If desired a multitude of relatively thin pads can be stacked to form the pad as a stack, the thin pads coated at one or both sides to provide a multitude of layers of silica material.

[0028] According to a favourable embodiment, the silica material is a hydrophobic silica material.

[0029] This helps to retain the desirable properties in moist environment better. The hydrophobic silica material is for example an alkylated silica material. By way of example, the alkyl group R will be methyl, ethyl, propyl, isopropyl, butyl, isobutyl or tert. butyl or a mixture thereof.

[0030] The present invention will now be illustrated with reference to the drawing where

Fig. 1 shows a diving suit according to the invention;
Fig. 2 shows a cross-sectional view through a part of the diving suit of Fig. 1; and
Fig. 3A to Fig. 3C show the characteristics at various wavelengths of a coated piece of dry suit cloth.

[0031] Fig. 1 shows a diving suit 100 according to the invention connected to a system comprising

- an electric power supply unit comprising two batteries 170,
- an optional connection box 175 for the batteries, and
- a control unit 180 for controlling heating of the diving suit 100.

[0032] In the embodiment discussed here, these components are connected via connectors 190 for the sake of convenience, allowing one component to be replaced by another similar component (e.g. in case of an empty battery).

[0033] Fig. 2 shows a cross-sectional view through a part of the diving suit of Fig. 1. The diving suit 100 comprises

- an inner face 201 facing a diver wearing the diving suit 100 when in use, and an outer face 202 facing away from the diver;
- an outer elastomeric layer 210, typically of a rubber material such as neoprene.
- a pad 220 (thickness 0.5 mm) comprising an enclosure of watertight flexible plastic 221 filled with silica aerogel 222. A suitable pad 220 can be obtained from Aerogel Technologies Corporation (Gyeonggi-do, KR).
- a flexible heating fabric 230 (thickness 0.3 mm) comprising heating elements 231, here heating wires 231. A suitable heating fabric is available from Sefar AG (Ruschlikon, CH).
- an 3D-textured fabric 240 (thickness 0.5 mm) made of polyester preventing direct contact of the heating fabric 230 with the skin of a diver wearing the diving suit 100. A suitable fabric is Spacetec® which is available from Heathcoat Fabrics (Tiverton, UK). The fabric's structure allows for built-in airflow, compression, moisture wicking and breathability, and holds advantages over foam.

[0034] The 3D-fabric is stitched at its outer circumference to the outer elastomeric layer 210, more specifically at the inside of the diving suit, forming a pouch retaining the pad 220 and the flexible heating fabric 230. A single 3D-fabric may retain more than one pad 220, in which case there will be stitching between the pads 220 so as to retain each one in place.

[0035] Fig. 3A to Fig. 3C show the characteristics at various wavelengths of a coated piece of dry suit cloth. More in particular Fig. 3A shows the reflective properties (as a percentage), Fig. 3B the absorption properties and Fig. 3C the transmission properties of a coating comprising silica aerogel. Coating was performed by applying WB acrylic, an adhesive, by spraying to a piece of Cordura Delinova, a material used for preparing diving dry suits. The thickness of the aerogel coating was 10 μm . From Fig. 3C it can be seen that the transmission is very low in the Infra-Red, as a result of which the body heat and heat from a heating pad is relatively hard to detect. The results of two coatings are shown (Fig. 3A and Fig. 3C), coating 2 containing twice as much aerogel compared to the coating 1. As the results are quite similar, this demonstrates the effectiveness of the aerogel.

[0036] An alternative method of manufacturing a garment according to the present invention comprises spraying a first layer chosen from an inner layer and an outer

layer (e.g. of Cordura or Neoprene) with a solution of adhesive and silica material. Then a second layer chosen from an outer layer and an inner layer (e.g. of Neoprene and Cordura) is contacted with the adhesive layer comprising silica material of the first layer, resulting in the IR-blocking garment.

Claims

1. A garment (100) for diving;
characterized in that the piece of garment (100) comprises a layer of silica material chosen from aerogel and pyrogenic silica. 10
2. The garment (100) for diving according to claim 1, wherein the garment (100) is a heating garment (100) for diving, said heating garment (100) comprising a heating element between the inside of the garment and the layer of silica material. 15
3. The garment (100) for diving according to claim 1 or 2, wherein the garment (100) is a heating garment (100) for diving, said heating garment (100) being a piece of garment comprising a front section for the front of a chest of a diver and a back section for the back of the chest of the diver, the piece of garment comprising an electrical heating element; wherein the piece of garment (100) has a inner first side (201) for facing the body of the diver and an outer second side (202) facing away from the body, wherein the piece of garment (100) is provided with a pad (220) comprising the layer of silica material (222) provided in an enclosure made of plastic (221), with the heating element (230) provided between the pad (220) and the inner first side (201) . 20
4. The garment (100) for diving according to claim 3, wherein the heating element (230) is provided between a 3D-textured fabric (240) and the pad (220). 25
5. The garment (100) for diving according to claim 4, wherein the 3D-textured fabric (240) provides a pouch for retaining the pad (220) and the heating element (230). 30
6. The garment (100) for diving according to any of the claims 3 to 5, wherein the piece of garment (100) comprises an elastomeric layer (210) with the pad (220) between the elastomeric layer (210) and the first side (201) and the piece of garment (100) is a diving suit (100). 35
7. The garment (100) for diving according to any of the claims 3 to 6, wherein the back section of the piece of garment (100) comprises the electrical heating element (230) and the pad (220). 40
8. The garment (100) for diving according to any of the preceding claims, wherein the garment (100) is a coated garment (100), the coating comprising the silica material. 45
9. The garment (100) for diving according to any of the preceding claims, wherein the silica material is a hydrophobic silica material. 50

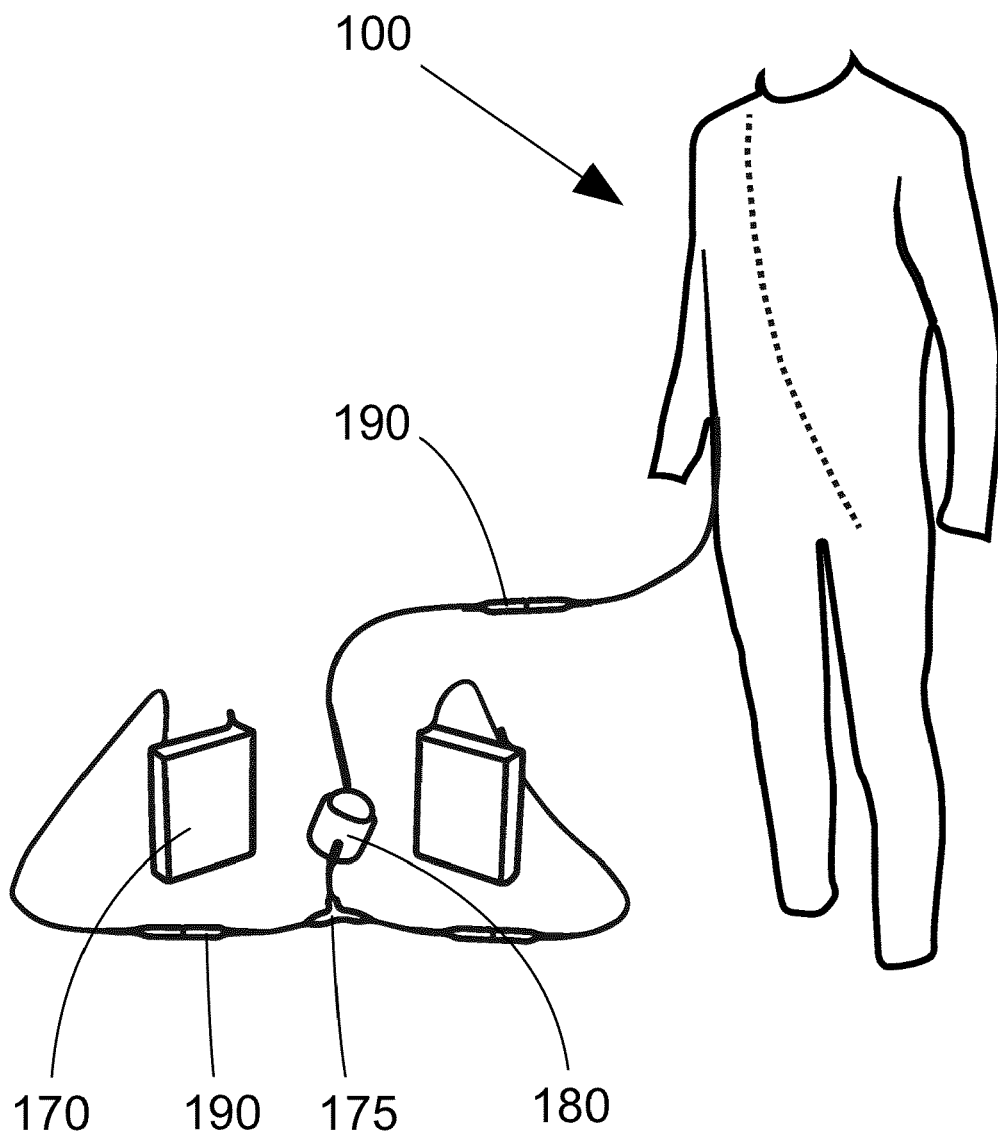


Fig. 1

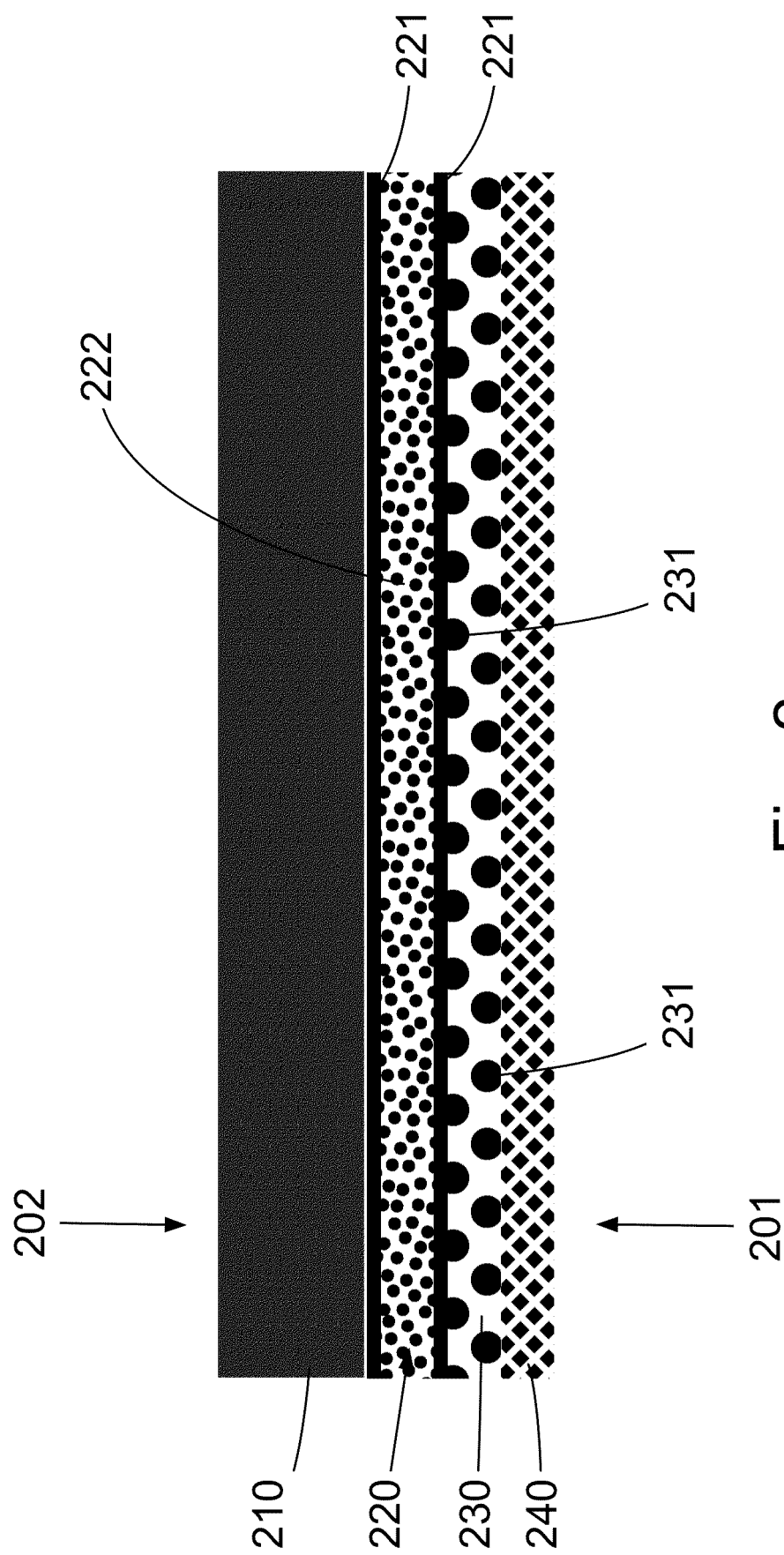


Fig. 2

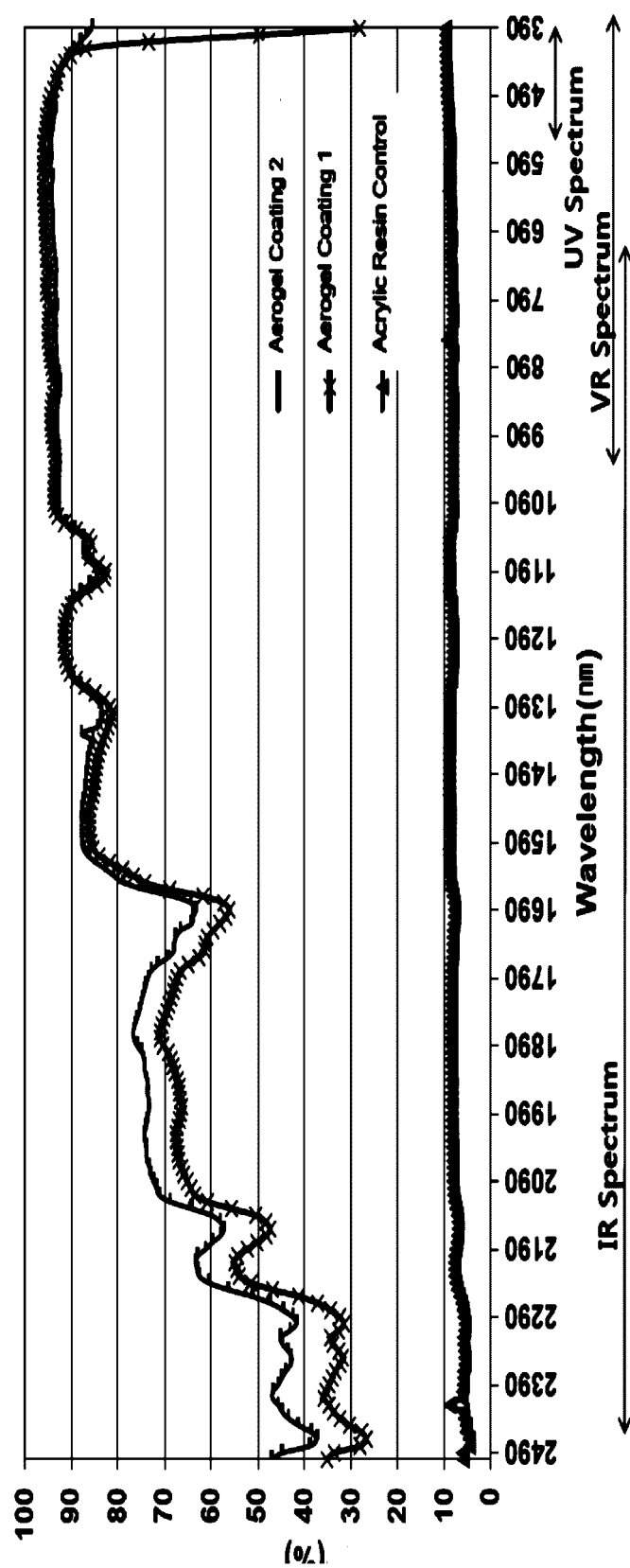


Fig. 3A

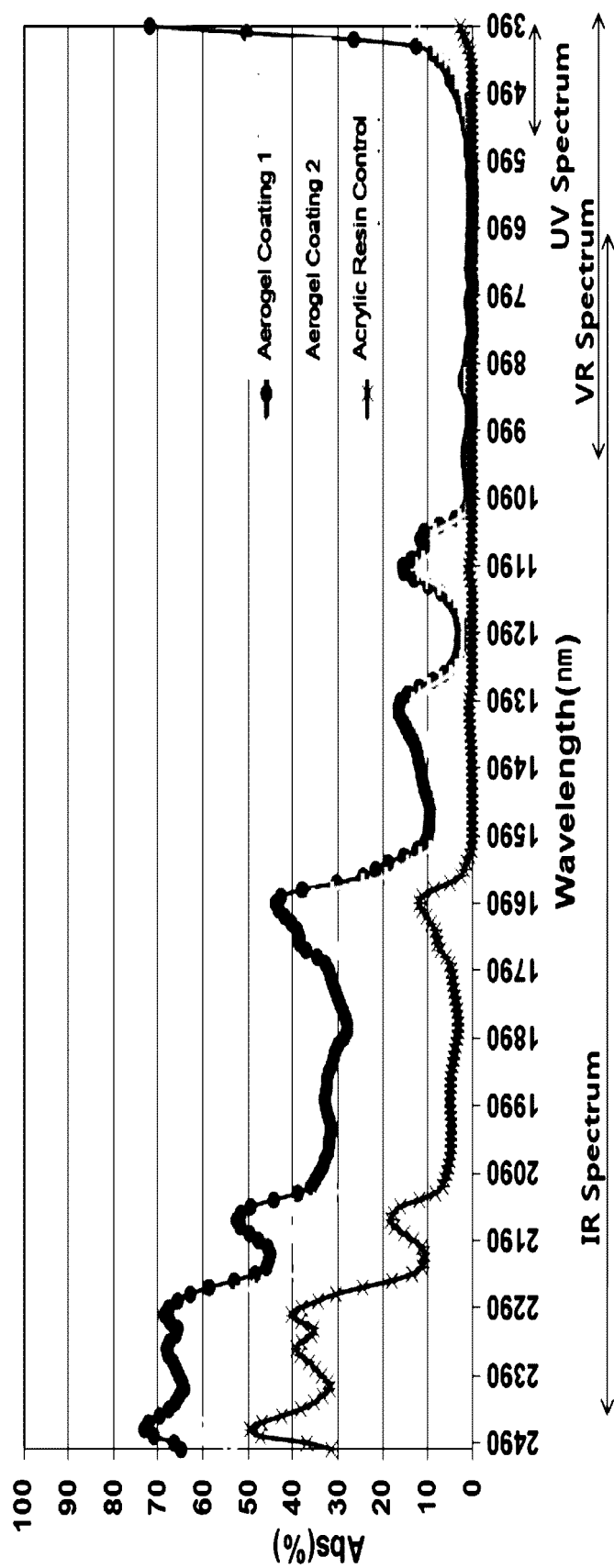


Fig. 3B

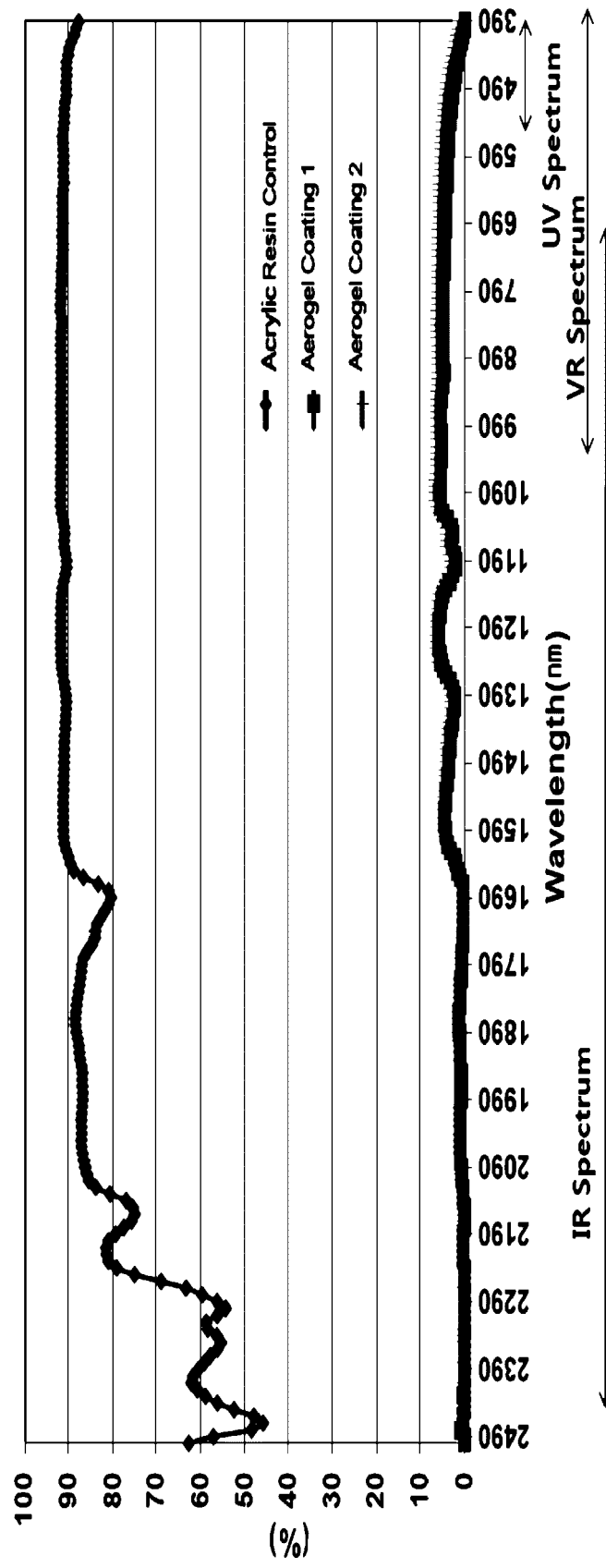


Fig. 3C



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Application Number
EP 19 16 2863

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The Hague		17 June 2019	Monné, Eric
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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