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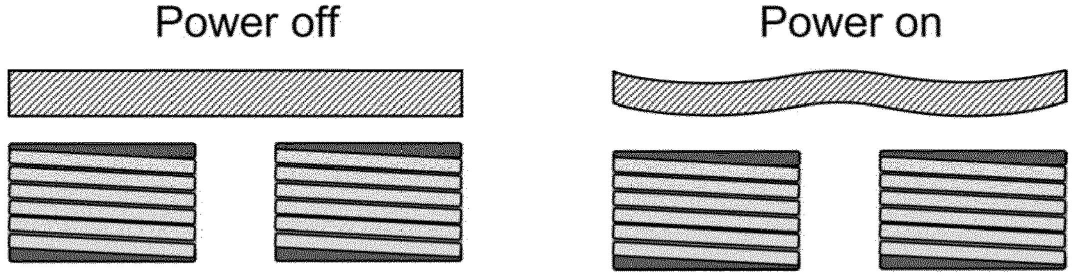
(54) **COMPONENT COMPRISING A DEFORMABLE FOIL AND A MAGNETIC MEMBER**

(57) A component comprising a foil and magnetic member, wherein the foil is based on a polymer and is reversibly deformable to form a protrusion or indentation by the interaction of a magnetic field with the magnetic member; and the use of the component as a haptic surface element and/or an artificial leather in the interior of a vehicle.

Figure 1



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Description

Field of the invention

[0001] The present invention relates to a component comprising a deformable foil and a magnetic member and the use of the component as a surface material in the interior of a vehicle.

Background art

[0002] WO 2019/115053 A1 discloses a component comprising a support and a deformable film, wherein the support comprises displaceable stamps or actuators that move partial surfaces of the support for a deformation of the film.

[0003] EP 3 851 325 A1 discloses a morphing surface apparatus comprising a support, movable projection members, sensors, and a deformable film, wherein the sensor is configured to sense the proximity of a device and the projection members can stretch the deformable film away from the support to create a pocket for retaining the device.

Problem to be solved by the invention

[0004] The prior art components require a movable member as an actuator to deform surface foils.

[0005] The problem underlying the present invention was to provide surface foils that are deformable without the use of a movable member as an actuator and without the necessity of an actuator being in direct contact with the foil.

Summary of the invention

[0006] The problem underlying the present invention was solved by replacing the mechanical interaction in the prior art products with a magnetic interaction. Specifically, the problem was solved by providing a component comprising a reversibly deformable foil and a magnetic member, wherein the foil is deformable by using a magnetic field as an actuator.

[0007] The present application covers the following aspects.

[1] A component comprising a foil and a magnetic member, wherein the foil is based on a polymer and is reversibly deformable to form a protrusion and/or indentation by the interaction of a magnetic field with the magnetic member.

[1-1] The component according to aspect [1], wherein the foil is reversibly stretchable to at least 120 % of its initial length, preferably both in a first direction and in a second direction perpendicular to the first direction.

[1-2] The component according to any of the preceding aspects, wherein the foil shows an elongation of at least 20 % at an elongation force of 50 N, preferably at least 50 % at an elongation force of 100 N, in a test according to DIN 53 354, preferably both in a first direction and in a second direction perpendicular to the first direction.

[1-3] The component according to any of the preceding aspects, wherein a partial area of 2 cm x 2 cm of the foil is reversibly deformable to form a deformation, i.e., a protrusion or indentation having a height or depth, respectively, of at least 200 μm in relation to the plane of the foil outside said partial area.

[1-4] The component according to aspect [1-3], wherein the reversible deformation is at least 1 mm, preferably at least 3 mm, at a first position in said partial area in relation to a second position outside said partial area, wherein the distance between the first position and the second position is less than 5 mm.

[1-5] The component according to any of the preceding aspects, wherein the foil contains at least 50 mass% of an elastomer.

[1-6] The component according to any of the preceding aspects, wherein the polymer is selected from the group consisting of a polyolefin, a polyurethane, polyvinylchloride, or a combination thereof, preferably polyvinylchloride.

[1-7] The component according to any of the preceding aspects, wherein the source creating the magnetic field is not part of the component.

[1-8] The component according to any of the preceding aspects, wherein the component consists of the foil and the magnetic member.

[1-9] The component according to any of the preceding aspects, wherein the magnetic member is contained in the foil or arranged outside the foil, preferably on the B-side surface of the foil, more preferably directly attached to the B-side surface of the foil.

[1-10] The component according to any of the preceding aspects, wherein the magnetic member is a printed structure, preferably having a thickness of less than 30 μm.

[1-11] The component according to any of the preceding aspects, wherein the foil contains an optically active surface, wherein the deformation of the foil results in optical effects due to a change of the observation angle upon

deformation.

[2] The component according to aspect [1], wherein the magnetic member is a plurality of magnetic particles.

[2-1] The component according to aspect [2], wherein the magnetic particles are nanoparticles or microparticles.
[2-2] The component according to any of the preceding aspects, wherein the magnetic particles are embedded in the foil.
[2-3] The component according to any of the preceding aspects, wherein the magnetic particles are contained in a layer applied to the foil or a part thereof.
[2-4] The component according to any of the preceding aspects, wherein the content of the magnetic particles in the foil is 1 to 30 mass%.

[3] The component according to any of the preceding aspects, wherein the foil is a multi-layered structure.

[3-1] The component according to a combination of aspect [3] and [2], wherein one or more layer(s) of the foil contain(s) the magnetic particles.
[3-2] The component according to aspect [3-1], wherein the content of the magnetic particles in the one or in each layer is 1 to 30 mass%.
[3-3] The component according to any of aspects [3] to [3-2], wherein the foil contains a textile layer and/or a foam layer covered by a cover layer.
[3-4] The component according to aspect [3-3], wherein the magnetic member is contained in the cover layer and/or the foam layer.
[3-5] The component according to any of aspects [3] to [3-3], wherein the magnetic member is contained in the lowermost layer or is arranged on the B-side surface thereof.

[4] The component according to any of the preceding aspects, wherein the foil is a multi-layered structure containing a lacquer layer as the uppermost layer, and the lowermost layer contains magnetic particles.

[4-1] The component according to aspect [4], wherein the foil consists of a layer containing the magnetic particles and the lacquer layer.
[4-2] The component according to aspect [4] or [4-1], wherein the lacquer layer consists of two or three or four sublayers.
[4-3] The component according to any of aspects [4] to [4-2], wherein the lacquer layer contains magnetic particles.

[5] The component according to any of the preceding aspects, wherein the foil is a multi-layered structure and a layer containing the magnetic particles has a thickness of at least 100 μm.
[5-1] The component according to aspect [5], wherein the layer containing the magnetic particles is the lowermost layer of the foil.

[6] The component according to any of the preceding aspects, wherein the foil contains a sensor, preferably a touch sensor.

[6-1] The component according to aspect [6], wherein the sensor is for actuating the magnetic field or for actuating a device.
[6-2] The component according to aspect [6] or [6-1], wherein the component contains a first sensor for actuating the magnetic field and a second sensor for actuating a device.
[6-3] The component according to any of aspects [6] to [6-2], wherein the sensor or at least one of the first and second sensor, respectively, is contained in the reversibly deformable part of the foil.

[7] The component according to any of the preceding aspects, wherein the foil is translucent.

[7-1] The component according to aspect [7], wherein the foil contains a light source.
[7-2] The component according to aspect [7] or [7-1], wherein the foil contains an opaque area, preferably arranged on the B-side surface of the foil or between layers of the multi-layered foil.
[7-3] The component according to aspect [7-2], wherein the opaque area is printed.

[8] The component according to any of the preceding aspects, wherein the component comprises the foil on a support, wherein the foil comprises a first portion not bonded to the support and a second portion bonded to the support, wherein the first portion is reversibly deformable to form a protrusion or indentation by the interaction of a magnetic field with the magnetic member and the support is not deformable by said interaction.

[8-1] The component according to aspect [8], wherein the second portion is bonded to the support by thermal bonding or using an adhesive and, optionally, by additional irradiation curing.
[8-2] The component according to aspect [8] or [8-1], wherein the support comprises a support sheet, wherein the first portion of the foil is in direct contact with but not bonded to the support sheet, and the second portion of the foil is bonded to the support sheet to form a composite structure containing the support sheet as a support layer and the foil as a cover layer.
[8-3] The component according to aspect [8-2], wherein the support sheet is a compact layer, a foam layer, or a textile layer.
[8-4] The component according to any of aspects [8] to [8-3], wherein the magnetic member is arranged, preferably only, on the B-side surface of the first portion of the foil.
[8-5] The component according to aspect [8-4], wherein the magnetic member is printed.

[9] The component according to any of the preceding aspects, wherein the magnetic field is created by a magnet, wherein the component comprises the magnet.

[9-1] The component according to aspect [9], wherein the magnet is an electromagnet, a coil, a printed coil, a permanent magnet or combination thereof.
[9-2] The component according to aspect [9] or [9-1], wherein the magnet is in direct contact with the foil.
[9-3] The component according to any of aspects [9] to [9-2], wherein the magnet is in direct contact with the magnetic member or the structure or layer containing the magnetic member.
[9-4] The component according to any of aspects [9] to [9-3], wherein the foil is a multi-layered structure containing the magnet, wherein the magnet is arranged below the magnetic member.
[9-5] The component according to aspect [9-4], wherein the magnet is contained in or arranged on a textile layer.
[9-6] The component according to aspect [9-4] or [9-5], wherein the component contains an additional magnet arranged below the magnet.

[10] The component according to aspect [9], wherein the component comprises a carrier comprising the magnet.

[10-1] The component according to aspect [10], wherein the carrier is a carrier foil.
[10-2] The component according to aspect [10] or [10-1], wherein the magnet is embedded in the carrier and is in direct contact with magnetic member of the structure or layer containing the magnetic member.
[10-3] The component according to any of aspects [10] to [10-2], wherein the magnet is a planar coil electromagnet.
[10-4] The component according to any of aspects [10] to [10-3], wherein the support as described in any of aspects [8] to [8-5] is arranged on the carrier.

[11] The component according to aspect [9] or [10], wherein the magnet is configured to be activated by an external stimulus.
[11-1] The component according to aspect [11], wherein the external stimulus is a change in temperature, pressure, or electromagnetic signal.

[12] The component according to any of aspects [9] to [11], wherein the magnet is printed on the carrier.
[12-1] The component according to aspect [12], wherein the thickness of the magnet is less than 40 μm.

[13] The component according to any of aspects [10] to [12], wherein the component comprises the foil on a support as described in any of aspects [8] to [8-5], wherein the support of the foil is the carrier comprising the magnet and wherein the magnet is capable of causing the deformation of the first portion of the foil.

[13-1] The component according to aspect [13], wherein the component contains the composite structure of aspect [8-2] or [8-3] and the support layer of the composite structure is the carrier comprising the magnet.
[13-2] The component according to aspect [13] or [13-1], wherein the magnet is arranged in the carrier or on the A-side surface of the carrier facing the B-side of the first portion of the foil.
[13-3] The component according to aspect [13-2], wherein the magnet is printed on the A-side surface of the support layer.

[13-4] The component according to a combination of aspects [13-2] and [8-4], preferably according to a combination of aspects [13-3] and [8-5].

[14] The component according to any of aspects [8] to [13], wherein the first portion of the foil is translucent, and the component additionally comprises a light source configured to illuminate the first portion of the foil.

[14-1] The component according to aspect [14], wherein the light source is arranged in or below the foil, preferably in the carrier or the support or on the A-side surface of the support or the carrier.
[14-2] The component according to aspect [14] or [14-1], wherein the component contains an opaque area for selectively illuminating parts of the first portion of the foil from below.
[14-3] The component according to aspect [14-2], wherein the first portion of the foil or the support of the foil comprises the opaque area.
[14-4] The component according to aspect [14-2] or [14-3], wherein the opaque area is provided by a mask, which is preferably printed on a layer of the foil or a layer of the support.
[14-5] The component according to any of aspects [14-2] to [14-4], wherein the opaque area contains the magnetic particles.
[14-6] The component according to any of aspects [14] to [14-5], wherein the A-side of the foil is the visible side of the component, and the foil is selected to render the B-side elements of the component invisible when looking at the A-side of the foil from above in the absence of light emitted from the light source.
[14-7] The component according to any of aspects [14] to [14-6], wherein the A-side of the foil is the visible side of the component and the component contains translucent layer(s) and/or element(s) as well as an opaque area arranged between the foil and the light source, wherein the opaque area is selected to inhibit transmittance of visible light emitted from the light source and the translucent layer(s) and/or element(s) are selected to allow transmittance of visible light emitted from the light source from below to illuminate the A-side surface of the foil.

[15] The use of a component according to any one of aspects [1] to [14] as a haptic surface element, an optic surface element, a sound element, or an artificial leather in the interior of a vehicle.

Advantages of the invention

[0008] The component of the present invention not comprising movable members as actuators has the advantage of a simple design of morphing foils requiring fewer parts than conventional products.
[0009] The use of planar parts enables a thin and very compact design.
[0010] Since the foil stretched away from a support, there is no solid movable member below the deformed foil. Hence, the soft feel (haptics) and the visual and tactile appearance are improved in comparison to conventional products.

Description of the drawings

[0011] Figure 1 shows a component according to the present application and illustrates the deformation of the foil by the interaction with a magnet. The foil contains magnetic particles.

Embodiments of the invention

[0012] The component of the present invention mandatorily contains a magnetic member and additionally contains various structural elements resulting in the following embodiments (i) to (v):

(i) The component contains the foil (aspects [1] to [7]).
(ii) The component contains the foil on a support (aspect [8]).
(iii) The component contains the foil and a magnet (aspects [9] to [12]).
(iv) The component contains the foil on a support and a carrier-based magnet (aspects [10] to [12]).
(v) The component contains the foil on a support and a carrier-based magnet, wherein the support is the carrier of the magnet (aspect [13]).

[0013] In embodiments (i) and (ii), the magnetic field may be provided by an internal or external unit, i.e., the unit is part of the component or the unit is not part of the component. In embodiment (iii), the magnet is a mandatory part of the component. In embodiment (iv), the foil and the magnet may be contained in two separate units, which may be combined to obtain the component. In embodiment (v), the component may be a single unit. The description of the present invention relates to all embodiments, unless explicitly stated otherwise.

[0014] Herein, terms such as "the component", "the foil", "the magnetic member", or "the magnetic field" refer to "the component according to the present invention", "the foil contained in the component according to the present invention", "the magnetic member contained in the component according to the present invention", "the magnetic field used in the present invention", respectively, unless explicitly stated otherwise.

[0015] The foil is a planar structure and may be a layer of a multi-layered structure. Each layer and the component as whole may be a planar structure. A planar structure is defined by a length x, a width y, and a depth or thickness z. In a planar structure, the values of x and y are each at least 5 times higher than the value of z, preferably at least 10 times or at least 20 times. The plane of a planar structure is defined by x and y. In the component of the present invention, the planes of the layers are parallel to each other, and the values of x and y are each preferably at least 2 cm, more preferably at least 5 cm.

[0016] In the component, elements such as the magnet are arranged at the B-side and the foil is arranged at the A-side of the component. Herein, the terms "A-side" and "B-side" either refer to the component as a whole or to an individual layer or element. The terms "above" and "on" a structure or layer define a position at the A-side of the structure or layer; accordingly, the term "below" defines a position at the B-side. In this sense, the uppermost layer and the lowermost layer form the A-side finish and B-side finish, respectively, of the component. The terms "above" and "below" do not require that the two structures or layers or elements are in direct contact with each other. In the specific context of structural elements, the terms "above" and "below" define a position perpendicular to the layer plane, hence superimposition in vertical direction. In other words, an element (e.g., a touch sensor) arranged below an element of a layer (e.g., below the deformable part of the foil) means that the two elements are arranged at the same position in a plan view of the layer. The A-side surface of a layer is the upper side surface, and the B-side surface of a layer is the underside surface. An element arranged on an A-side surface or B-side surface, respectively, of a layer is in direct contact with said layer.

[0017] Whenever this description mentions that individual compositions or structures are based on or made of a certain material, this should be interpreted as the respective material forming the main constituent of the composition or structure, wherein other constituents may also be present in small quantities. In embodiments, the terms "based on" or "made of" a certain material means a content of more than 50 % by weight, preferably 90 % by weight, and more preferably 95 % by weight.

[0018] As used herein, the singular forms "a," "an," and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. For instance, structural elements are generally described in the singular form, e.g., "a" magnetic member or "containing a" magnetic member. Such singular form formulations are meant to include more than one of the indicated structural element, unless indicated otherwise. Similarly, the terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of stated structural elements or compounds, but do not preclude the presence or addition of one or more other structural elements or compounds.

[0019] The term "and/or" includes any and all combinations of one or more of the associated listed items.

[0020] In the present invention, the standards and norms mentioned herein refer to the latest version available at the time this application was filed, unless indicated otherwise.

[0021] In the present invention, percentages (%) are percentages by mass (% by mass) unless explicitly indicated otherwise.

Foil

[0022] The component comprises or consists of the foil. The foil may be a multi-layered structure. Typically, the foil, optionally coated with a lacquer layer, forms the uppermost structure of the component. The thickness of the foil is preferably 50 μm to 3 mm, more preferably 100 μm to 2 mm.

[0023] The foil is reversibly deformable. Hence, it can be deformed from an initial state und returned to the initial state without showing any visible damage or change. In the present invention, "deformation" of a structure excludes the mere bending, kinking, or folding of the structure. The deformation is a protrusion or indentation in relation to the plane of the foil, which means a deformation in z-direction in relation to the x-y plane of the surrounding area, i.e., the area outside the partial area. For instance, the foil may be stretched away from a magnet to form a protrusion.

[0024] At least a part of the foil or the whole foil is deformable. Hence, in this regard the term "the foil" is to be understood to mean "the foil or at least the reversibly deformable part(s) thereof", unless indicated otherwise. For instance, the properties such as the stretchability or the elastomeric or particle content may relate to the foil as a whole or only to the relevant part(s) thereof, i.e., the reversibly deformable part(s).

[0025] The deformable part of the foil is adjacent to or surrounded by a non-deformable part. The whole or at least a part of the reversibly deformable part is stretchable. If the whole deformable part is stretchable, the whole deformable part take part in forming a curved structure. The stretchable part may surround a non-stretchable part, which is moved away or towards the magnet upon stretching. The non-stretchable part may be flexible or rigid. If flexible, the non-stretchable part may form a curved structure within the stretched structure. If rigid, the non-stretchable part forms a planar structure within the stretched structure. Hence, the protrusion or indentation may contain stretchable, only flexible (i.e., non-stretchable) and/or rigid (i.e., non-stretchable and non-flexible) elements. In this way, the reversibly deformable part may contain functional elements of very different properties in terms of stretchability and flexibility. Specifically, non-stretchable and non-flexible elements may be incorporated into the reversibly deformable part of a foil. For instance, a rigid functional element may be applied to the stretchable part of the foil and may thus render this part non-stretchable. Nevertheless, said functional element may be contained in the deformed part by stretching the surrounding foil. If not expressly stated otherwise, each functional element that is disclosed herein as a potential part of the reversibly deformable foil, e.g., a magnetic member, a magnet, a sensor, a light source, or an opaque area, does not necessarily have to be stretchable, but may be stretchable, flexible, or rigid.

[0026] The foil may have a grained surface to imitate natural leather. In that case the sheet structure of the present invention may be used as an artificial leather. The depth of the grain is less than the thickness of the cover layer and is preferably 10 to 500 μm, more preferably 50 to 500 μm, still more preferably 50 to 300 μm.

[0027] The foil or at least the deformable part thereof may contain modifications to improve properties of the foil. The foil may be a haptic element by containing an element such as a touch sensor. As an alternative or in addition to being a haptic element, the foil may be an optic element by containing an optically active surface, wherein the deformation of the foil results in optical effects due to a change of the observation angle upon deformation. Optical activity may be caused by light diffraction and/or reflexion. For instance, an optical effect may be achieved by different reflection angles of external light or by different emittance angles of internal light, e.g., light emitted from the light source described herein. The optically active surface may be an embossed structure. Furthermore, the foil may contain a sound element. The component may be used as a loudspeaker for various applications from automotive interiors to indoor walls or fashion applications. The component can function as a compact speaker, only needing a resonance box on the back, which can be easily obtained on, for example, a door panel, an instrument panel, headrest, headliner, pillars, a house fake wall, and other non-common construction elements. Moreover, this possibility enables the creation of clean walls/panels and hidden speakers, since the material covering the wall/panel would be the sound-emitting element. Other additional features may include electromagnetic interference (EMI) shielding inside the vehicle, house, or other applications originated by electrical devices placed on both sides of the material.

[0028] The foil may need to be highly flexible for some applications such as the use in car seats. For instance, the foil may enhance the comfort of the user by adjusting the seat contact surfaces to the occupant or by massaging the occupant. The foil needs to be flexible for the application in car seats. Preferably, the foil shows no damages and changes after 100,000 flexing cycles, more preferably after 1,000,000 flexing cycles in a test according to DIN 53 351. Furthermore, the foil is preferably suitable for being used in a cut and sew process. The foil is preferably flexible and elastic and can preferably be folded reversibly, i.e., folded from an original state and then unfolded to its initial state. Preferably, the foil can be folded to form a double-layer structure, in which two A-sides or B-sides of the composite structure are layered on each other and contact each other at the folding edge, and the double-layer structure can be unfolded to its original state. Preferably, the foil, in particular the folding edge, shows no visible damage or change after folding and unfolding. The criterion of "visible damage or change" as mentioned herein may be measured at room temperature in accordance with the criteria described in DIN 53 351. The considerations regarding the application in car seats equally apply to the composite structure described below.

[0029] The polymer contained in the foil confer the desired properties of stretchability, softness, flexibility, and elasticity. The properties such as elasticity are determined by its content of elastomers. Examples of elastomers are styrene-butadiene rubber (SBR), silicone rubber, polyurethane rubber (PU), or a styrene based thermoplastic elastomer (STPE). In particular, the elastomer may be selected from the group comprising ethylene/α-olefin copolymer rubber (EAM) as well as ethylene/α-olefin/diene terpolymer rubber (EADM). The diene in the ethylene-α-olefin-diene rubber may be a nonconjugated diene. In preferred embodiments, the rubber component comprises an ethylene-α-olefin-diene rubber. The ethylene-α-olefin-diene rubber may comprise an α-olefin. The α-olefin in an EAM or EADM rubber is preferably propylene, hence EP(D)M. EPDM is made from ethylene, propylene and a diene comonomer that enables crosslinking via sulphur vulcanization systems. EPDM contains crosslinks and may be fully cured. EPM is similar to EPDM but contains no diene units. It is also possible to use a mixture of the rubbers mentioned above, e.g., a mixture of EPDM and EPM.

[0030] The foil may be thermoplastic or contain thermoplastic polymers such as thermoplastic polyolefin (TPO) and/or thermoplastic polyvinyl chloride (PVC). This property allows thermal bonding of the foil to a support layer without the use of an adhesive. The thermoplastic property requires that the overall degree of crosslinking is not too high.

[0031] TPO is a polymer produced from alkenes and is a semi-crystalline thermoplastic polymer. Examples of TPO are polyethylene (PE), polypropylene (PP), polymethylpentene (PMP), polyisobutylene (PIB) and polybutylene (PB, polybutene-1). Polyethylene (PE) is defined here as polymers or copolymers whose proportion by weight of ethylene is more than 50 %. Polypropylene (PP) is defined here as polymers or copolymers whose proportion by weight of propylene is more than 50 %. Examples of TPO are blends of polyethylene (PE) and polypropylene (PP).

[0032] The thermoplastic polymer may be thermoplastic polyvinyl chloride (PVC). Each layer may be based on PVC. A plasticizer may be contained in the PVC to adjust the properties of the layer and is selected independently for each layer. The properties of PVC are adjusted by adding plasticizers. The addition of plasticizers gives the polymer plastic properties such as yielding and softness. For example, PVC without plasticiser can have an elongation at break/tensile strength at break of 10 to 50 %, while PVC can have an elongation at break/tensile strength at break of 170 to 400 %, depending on the structure and quantity of plasticizer. The amount of plasticizer is preferably 20 to 60 % based on the total amount of PVC in the foil or layer, respectively. Plasticizers include phthalic acid esters, chloroparaffins and the like. Bio-based such as glycerol triacetate (Triacetin) and acetyltributylcitrate or bioplasticizers derived from natural oils may be used. Epoxidized soybean oil may be used as a secondary plasticizer. The plasticizers may be used singly or as a combination of two or more. PVC can be mixed with additives to improve its physical properties, such as toughness and elasticity, and to enhance processability.

[0033] In an embodiment, the foil is both elastic and thermoplastic. To achieve these properties, the foil may contain a thermoplastic elastomer (TPE), which is an elastomer showing thermoplastic behaviour, in particular thermoreversibility. TPE behaves rubber-elastically in the range of usual service temperatures. TPE is a copolymer or an elastomer alloy, which is, a physical mix of polymers that consists of materials with both thermoplastic and elastomeric properties. The desired properties can be obtained by varying the mixing ratios. Generally, there are the following generic classes of TPEs (designations according to ISO 18064): Styrenic block copolymer (TPS), thermoplastic polyolefin elastomer (TPO), thermoplastic vulcanizate (TPV), thermoplastic polyurethane (TPU), thermoplastic copolyester (TPC), melt processing rubbers, and thermoplastic polyamide (TPA). The TPE may belong to one generic class or may be a blend of TPEs from two or more classes. Also, the TPE may be selected from one class and may be one kind of TPE of one class or a blend of two or more kinds of TPEs of one class.

[0034] The TPE may be a TPV, which combines the characteristics of vulcanized rubber with the processing properties of thermoplastics. The rubber particles are encapsulated in a thermoplastic matrix. The rubber particles are made of the rubber described herein, and the thermoplastic matrix is made of TPO described herein. Examples of blends of rubber with TPO are EPDM with PE and/or PP, blends of EPM with PP and/or PE and ethylene propylene blends, and blends of styrene ethylene butadiene styrene (SEBS) with TPO such as PE and/or PP.

[0035] The foil may contain usual additives such as plasticizers, stabilizers, anti-aging agent (e.g. antioxidants), fillers, flame retardants (e.g. antimony trioxide or zinc hydroxystannate), pigments (e.g. carbon black, titanium dioxide) and other auxiliary substances (e.g. viscosity aids, adhesion promoters, etc.). An example of an additive is a UV stabiliser. The UV stabiliser may be selected from one or more members of the group consisting of benzotriazole or hindered amine light stabilizers. Other additives are emulsifiers such as carboxymethylcellulose or polyethylene glycol.

Layers of the foil

[0036] The foil may be a single-layered or multi-layered structure.

[0037] The multi-layered foil may comprise one or more compact layers, textile layers, foam layers, and/or a lacquer layers. In a preferred embodiment, the uppermost layer of the foil is a compact cover layer, whose A-side surface is optionally coated with a lacquer layer, and the other layers are arranged below the cover layer. The properties of each layer are preferably adjusted to meet the requirement of reversible deformability of the foil. The polymer material for each layer may be independently selected from the materials of the foil disclosed above. If the magnetic particles are contained in the foil, they may be contained in one or several or all layers of the foil. In one embodiment, the foil consists of a compact layer coated with a lacquer layer having two sublayers.

[0038] The optional compact layer has a density, excluding optionally contained magnetic particles, of more than 0.80 g/cm^3. The thickness of the compact layer is preferably 50 to 3000 μm, or 100 to 2000 μm.

[0039] The optional foam layer has a density, excluding optionally contained magnetic particles, of less than 0.80 g/cm^3. Preferably, the foam layer has a density of 0.05 to 0.5 g/cm^3 or 0.1 to 0.3 g/cm^3. The thickness of the foam layer is preferably 30 to 3000 μm or 500 to 2000 μm. The foam layer may consist of or contain polyolefin foam, PVC foam, TPE based foams, PUR based foams and/or EVA/EMA foams. Preferably, the foam layer consists of or contains polyolefin foam such as a polypropylene foam (PP foam).

[0040] The lacquer layer, if present, is the uppermost layer and may contain several sublayers. The thickness of the lacquer layer may preferably be 1 to 30 μm, more preferably 3 to 10 μm. The lacquer layer is applied directly on top of the cover layer as a finish of the composite structure and a protection against chemical agents, physical damage such as scratches or abrasion, and UV radiation. Conventional lacquers can be employed, such as a lacquer layer based on a silicone-containing aliphatic polyurethane. The lacquer layer usually consists of one or more, preferably up to four, transparent layers of lacquer. Alternatively, the surface coating may be coloured by adding colour pigments.

[0041] The optional textile layer preferably has a thickness of 0.1 to 3.0 mm, more preferably 0.1 to 2.0 mm. Examples of a textile layer are knitted fabrics, woven textiles, non-woven textiles, glass fiber textiles, or spunlace. A knitted fabric is a flexible material made by creating an interlocking bundle of yarns or threads, which are produced by spinning raw fibers into long and twisted lengths. The textile layer is not compact and comprises a large volume ratio of hollow spaces that are usually filled with air. The density of the textile layer is preferably 100 to 500 kg/m^3, more preferably 100 to 300 kg/m^3. The textile layer may contain elastic fibers. The elastic fibers may be one or more kinds of fibers selected from the group consisting of polyurethane fibers, polyurea fibers diene elastomeric fibers, polyether ester elastomer fibers, polyolefin elastomeric fibers, composite elastomer fibers, and rigid elastic fibers or a combination thereof. The non-elastic fibers of the textile layer may be one or more kinds of fibers selected from the group consisting of polyester, polypropylene, polyamide, cotton and natural fibers. The fibers of the textile may contain or consist of PVC. The fibers may have a core-sheath structure, wherein the core may be any polymer such as a polyester or polyether and the sheath may cover the core and may be a material containing or consisting of PVC.

Translucency

[0042] The structures and elements of the component may be translucent. For instance, the foil, the support, the carrier, and/or the touch sensor may be translucent or may contain translucent parts.

[0043] A "translucent" structure allows the transmittance of more visible light than an "opaque" structure, when light is emitted from the same light source and hits the structures. The light transmittance of the opaque structures may be less than 1%, preferably less than 0.1% and preferably 0%. The values preferably relate to the wavelength range of 400 to 700 nm. In a preferred embodiment, the term "opaque" means a light transmittance of less than 1% in the wavelength range of 380 to 700 nm (visible region).

[0044] Generally, the light transmittance of a translucent structure is at least 2%, and the light transmittance of an opaque structure is less than 2%.

[0045] The light transmittance of the foil may be low to achieve the desired property of hiding the other elements when the light source is deactivated, i.e. the other elements are hidden-until lit. When the light source is deactivated, the upper side of the composite structure has the appearance of a conventional structure such as a conventional artificial leather. To enable the property of hiding the elements arranged under the foil, the light transmittance of the foil is preferably 2 to 50%, more preferably 2 to 30% in the wavelength range of 380 to 700 nm.

[0046] The light transmittance of the structures described herein, i.e., the foil or individual layers or the whole component, respectively, is determined as follows: Equipment: Datacolor, model 850; Lamp: Xenon. The total transmittance is measured according to the user's guide provided by the manufacturer. A white plaque (e.g., Spectralon® plaque) is used as an optical standard for transmission calibration and measurement. The white plaque is placed at the front aperture plate. The sample to be measured is placed against the sphere opening. The transmittance is determined within the range of 380 to 700 nm at the wavelength λ_{max} of the maximum transmittance peak for the sample. The light transmittance [%] of a sample is defined as 100% x (transmittance value measured at λ_{max} in the presence of the sample)/(transmittance value measured at λ_{max} in the absence of the sample).

[0047] The component may contain an opaque area or an opaque layer containing the opaque area to prevent elements of the component from being visible or the create optical effects. The opaque layer contains a translucent area and an opaque area. The opaque area may be discontinuous and thus the parts of the opaque area do not have to be connected to each other. The opaque area may be a large opaque area and/or relatively thin opaque graphics such as letters, symbols or frames or the like to draw the user's attention or simplify their orientation. The opaque layer may be a film, preferably made of a polymer, that is applied onto another layer. The translucent area may simply be a void area surrounded by an opaque part, i.e. an area where no opaque part is arranged, e. g. a mask. Preferably, the opaque area is a mask printed on the B-side surface of the foil or cover layer, respectively. Since the magnetic particles may be dark or black, the opaque area may be based on them.

Sensor

[0048] The component may contain a sensor. The sensor may be sensitive to any changes such as changes in pressure, temperature, light exposure and/or electromagnetic waves. Thus, it is for instance possible to sense the proximity of a user's finger or an external subject such as a device. Typically, the sensor is a touch sensor that is preferably sensitive to changes in pressure or temperature or both pressure and temperature. It is preferred that a sensor signal can be affected by the touch of a finger of a human user. The function of the touch sensor may be that of a switch or a push button to actuate an electric device such as a lamp or a motor or the deformation of the foil via the actuation of an electromagnet interacting with the magnetic member. The component may contain a first sensor, e.g., a touch sensor, actuating the deformation of the foil and a second touch sensor actuating other devices. The second touch sensor is preferably arranged in or below the deformable part of the foil. The first touch sensor and the second touch sensor may be arranged in or at the same structural element or in or at different structural elements of the component. For instance, the first touch sensor may be arranged on the support layer and the second touch sensor may be arranged on the B-side surface of the deformable part of the foil.

[0049] The sensor may be functionally connected to other electric or electronic parts and may contain elements to connect it to other electric parts. Therefore, the sensor is preferably contained in a layer that comprises at least electric conductors or contacts.

[0050] The sensor may be a membrane touch switch, which may be manufactured by printing conductive silver, copper, tin, or carbon ink onto a polymer foil. It can also be used conductive polymers such polyacetylene (PA), polyaniline (PANI), polypyrrole (PPy), polythiophene (PTH), poly(para-phenylene) (PPP), poly(phenylenevinylene) (PPV), and polyfuran (PF). Membrane touch switches such as stretchable silver conductors are commercially available. The sensor may be a capacitive sensor, preferably a capacitive layer sensor comprising a first electrically conductive layer, a ferroelectric polymer, and a second electrically conductive layer in this order. The electrically conductive layer may be a basic electrode and a cover electrode and may each be made of PEDOT-PSS (PEDOT:PSS: Poly(3,4-ethylenedioxythiophen) polystyrolsulfonat), polyacetylene (PA), polyaniline (PANI), polypyrrole (PPy), polythiophene (PTH), poly(para-phenylene) (PPP), poly(phenylenevinylene) (PPV), and polyfuran (PF), carbon, silver, aluminum, chromium, gold or copper. A preferred example of electrode materials is PEDOT:PSS having a thickness of about 1 μm. Poly-3,4-ethylendioxythiophen (PEDOT) is an electrically conductive polymer based on thiophene. The ferroelectric layer may be a copolymer PVDF-TrFE (polyvinylidene fluoride-trifluoro ethylene), which may show strong piezo or pyroelectric activity and have a thickness of about 1 μm. Other examples of the ferroelectric polymer layer a terpolymer of PVDF-TrFE-CFE- or PVDF-TrFE-CTFE.

[0051] The sensor may be arranged at least partly in or above or below the translucent area of an opaque layer. Alternatively, the sensor may be arranged below an opaque area such as a mask to render the sensor invisible.

[0052] The sensor may be applied by inkjet printing of screen printing onto the B-side surface of the foil or cover layer, respectively, preferably after an opaque layer has been applied onto the B-side surface of the foil or cover layer, respectively. The sensor layer may additionally contain a light source.

Light source

[0053] The component may contain a light source. A light source may serve the purpose of illuminating the translucent areas of the composite structure to indicate the location of the sensors. Thus, the light source simplifies the user's orientation or draws the user's attention to the illuminated area when the light source is activated.

[0054] The light source may be contained in the deformable part of the foil. In that case, the light source is preferably flexible and is more preferably both flexible and reversibly stretchable. The light source may be arranged below of the foil. The light source may be contained in the support or adhered to the support. The beams of light source may pass the layers and elements of the component in vertical direction. Therefore, it is essential that the translucent areas and elements are aligned to allow the vertical light transmission.

[0055] The light source may be superimposed by the structure to be illuminated, e.g. the touch sensor. In that case, the light beams emitted from the light source pass the layers of the composite structure in vertical direction. If the light source is contained in a layer and is not superimposed by the structure to be illuminated, the light beams emitted from the light source pass the layer in horizontal direction, e.g., through a light conductor, to illuminate the structure. Then, the light beams are deflected, e.g., by means of light scattering elements contained in the layer, to exit the component in vertical direction.

[0056] The technology for the light source is not limited and may comprise the following: Light-conducting panels of PMMA or other optically effective polymers that are coupled to one or more LEDs, optionally including edge lighting; polyoptic fibers, for example, of PMMA or glass that are woven, knitted or otherwise processed into fabrics in order to form flexible, ductile room lighting that is subsequently coupled to one or more LEDs; background lighting integrated into the support with integral optical structures that are produced, for example, by means of molding or laser printing, optionally including a reflector and possibly coupled to one or more LEDs; OLEDs, i.e. organic LEDs; electroluminescent components such as films or panels. The light source may preferably be an LED or an electroluminescence element. An LED such as a Pico-LED or an electroluminescence element may have thicknesses of less than 100 μm. An LED module may be arranged below the support and coupled to a background lighting device. The LED module and the background lighting device may jointly form the light source. The background lighting device may be in the form of a textile layer of PMMA, a light-conducting panel or light-conducting film, a light box or a background lighting device that may be integrated into the support. The LED may be arranged in a structure such as the foil or the support layer or cover layer of the composite structure and may be connected to the area to be illuminated via an optical conductor, which may be a transparent foil and may contain a POF (plastic optical fiber).

Magnetic member and magnetic field

[0057] The deformation of the foil is based on the magnetic interaction between the magnetic member and the magnetic field. To achieve this functional relationship, the magnetic member and the unit creating the magnetic field are suitable selected to the effect that the magnetic member is responsive to the magnetic field serving as an actuator.

[0058] The magnetic member is defined by its capability of magnetically interacting with a magnetic field. Generally, the magnetic member may be ferromagnetic, paramagnetic, superparamagnetic, or diamagnetic.

[0059] Examples of the magnetic member are (a) a magnet and (b) a plurality of magnetic particles.

(a) The magnet may be a permanent magnet or, preferably, an electromagnet. The electromagnet may be controlled through the electric current and can thus provide a greater or lesser attraction to the magnetic material and a controllable deformation of the foil. Since this control includes turning off the electromagnet in the absence of an electric current, the electromagnet is not always in its functional state. In this case, the interaction with the magnetic member and terms such as "the magnet is capable of causing the deformation" mean that the magnetic member is convertible to the desired functional state by an electric current. The electromagnet may be a planar coil and may be placed or printed on the surface of a structure of the component, e.g., on the B-side surface of the foil.

(b) The magnetic member may be a plurality of magnetic particles. Whenever the present invention refers to magnetic particles, they are particles serving as the magnetic member or at least a part thereof. Their size may be in the range of 10 nm to 100 μm, preferably less than 50 μm, as determined by scanning electron microscopy (SEM). Whenever the present invention mentions magnetic particles, they are preferably magnetic nanoparticles or microparticles and more preferably nanoparticles. The size of microparticles is less than 1000 μm, preferably 1 to 100 μm, and the size of nanoparticles is less than 1000 nm, preferably 10 to 500 nm, as determined by scanning electron microscopy (SEM). The magnetic particles are preferably superparamagnetic, more preferably superparamagnetic nanoparticles. The magnetic particles may be embedded in the foil or may be applied to the surface of the foil. The content of the magnetic particles in the foil may be 1 to 40 mass%, preferably 1 to 30 mass%, more preferably 5 to 30 mass%. Preferably, the layer containing the magnetic particles has a thickness of at least 100 μm. The magnetic particles may be applied to the surface of the foil, preferably to the B-side surface of the foil, and more preferably to the B-side surface at a portion of the foil that is to be deformed by a magnet. The magnetic particles may be contained in a liquid or pasty composition that is applicable to the foil and, after solidification, the area or the layer containing the magnetic particles is preferably stretchable. Examples of the magnetic particles are alloys of Fe-Co, Fe-Cu, Ni-Fe, $A_xB_yC_Z$ with A=Fe, Mn, Co, Ni, Zn, Bi, Mg, Y, Cr, Cu, V, Ti, Ag, Mo, Nb, Zr, Ru, Rh, B=A=Fe, Mn, Co, Ni, Zn, Bi, Mg, Y, Cr, Cu, V, Ti, Ag, Mo, Nb, Zr, Ru, Rh, C= O, S, Se, with x, y and z ranging between 0-5, any type of steel, Tb, Gd, Dy, complex alloys such Gd-Si-Ge, La-Fe-Si, Gd-Y, Gd-Tb. The application potential of $MnFe_2O_4$ nanoparticles with respect to the magnetic properties was demonstrated by superconducting quantum interference device (SQUID) magnetometry.

[0060] The magnetic field is defined by its function of being capable of interacting with the magnetic member. The source of the magnetic field is not limited. Typically, the magnetic field is created by a magnet. The magnet may be a permanent magnet or, preferably, an electromagnet. The electromagnet may be a planar coil and may be placed or printed on the surface of a structure of the component, e.g., on the A-side surface of the carrier. The magnet may be an embroidery of the coil or magnetic wires in a textile layer, wherein the textile layer may be part of the moving foil or may be the non-moving support. Alternatively, the magnet may be placed in a cutout of the carrier. The magnetic field of the electromagnet may be controlled through the electric current. In addition to an electromagnet, a permanent magnet may be used to enhance the magnetic interaction. The electromagnet may be attached to the A-side surface of the carrier, and the permanent magnet may be arranged directly below the electromagnet or at a distance of, e.g., 1 to 2 mm. Alternatively, the permanent magnet may be attached to the A-side surface of the carrier, and the electromagnet may be arranged directly below the permanent magnet or at a distance of, e.g., 1 to 2 mm.

Support-based foil and/or the carrier-based magnet

[0061] Embodiments (ii) to (v) relate to a component, wherein the foil is arranged on a support and/or the magnet is part of the component and based on a carrier.

Embodiment (ii)

[0062] The foil is arranged on a support. The basic difference between the foil and the support is that the support is not deformable by a magnet. Hence, the interaction of a magnet with the magnetic particles resulting in the deformation of the foil as defined herein does not result in a deformation of the support. The reason is that the support does not contain a magnetic member responsive to magnetic field and/or the support is non-deformable, e.g., rigid. The foil may comprise a first portion and a second portion, the first portion being deformable to form a protrusion and a second portion being bonded to the support and thus non-deformable. As a result, the first portion of the foil moves away from the support upon magnetic actuation.

[0063] The support may have any structure and may be composed of any material. The support may or may not be translucent, and it may be a flexible and/or soft or a rigid and/or hard material. The material and the thickness of the material has to be selected depending on the desired property such as translucency of the layer. In some embodiments, the support is translucent only in areas thereof. For instance, a translucent support may be provided with an opaque area in an area not to be illuminated, for example, by providing a support with an opaque coating or paint layer. Alternatively, a cut-out is produced in the support at the location at which the illuminated area is to be arranged, and a translucent insert is fitted into this cutout.

[0064] Preferably, the support is a support sheet. Preferably, the support sheet and the foil are layered on each other, the first portion of the foil directly contacts the support sheet but is not bonded to the support sheet and is deformable to form a protrusion, and the second portion of the foil is bonded to the sheet to form a composite structure containing the support sheet as a support layer and the foil as a cover layer.

[0065] The support layer and the cover layer may be layered on each other either directly, e.g., the B-side surface of the cover layer contacts the A-side surface of the support layer without any material such as an adhesive disposed between them, or indirectly, i.e., having an adhesive disposed between them. Preferably, the support layer and the cover layer are bonded to each other directly to form the composite structure. This structure may be formed by thermal bonding. The bonding may be enforced, e.g., by treating the composite structure with irradiation or electron beams to form chemical bonds between the layers. A selective treatment of the parts covered by second portion of the foil not only enforces the bonding but also modifies the physical properties such as softness and stretchability of the second portion of the foil, while keeping the initial properties of the foil in its first portion unchanged.

[0066] Except for being non-deformable by a magnet, the support sheet may fall under the same definitions as the foil. For instance, the support sheet is made of a polymer and may be a single-layer or multi-layer structure. The layers may be one or more compact layers, foam layers, and/or textile layers, as defined above in relation to the layers of the foil. Similarly, the support sheet may contain functional elements such as a touch sensor, a light source, an opaque mask, and the like, as described above. Furthermore, the physical properties such as flexibility and light-transmittance may be the same or similar in the foil and the support sheet.

Embodiment (iii)

[0067] The component comprises a magnet on a carrier. The carrier may have any structure and may be composed of any material. The magnet may be embedded in the carrier and fully covered by the carrier material. Alternatively, the magnet is embedded in the carrier, wherein a surface of the magnet is exposed and faces the foil. Alternatively, the magnet may be applied on the surface of the foil, preferably printed on the surface facing the foil. In the latter two alternatives, a direct contact of magnet and foil is possible.

Embodiment (iv)

[0068] The component comprises the foil arranged on a support (as described in embodiment (ii)) and the magnet arranged in or on a carrier (as described in embodiment (iii)) and may thus be based on two separate structural units. For instance, the component of the present invention may be obtainable by applying a composite structure consisting of the foil and the support sheet on a structural member containing the magnet and the carrier.

Embodiment (v)

[0069] The foil is arranged on a support (as described in embodiment (ii)), and the support also serves as the carrier of the magnet. Thus, embodiment (v) allows a very compact design. The magnet may be arranged on the support or in a cutout of the support. Preferably, the support is a support sheet having the magnet printed thereon. More preferably, the foil and the support form the composite described above and the magnet is printed on the support layer at a position facing the first portion of the cover layer.

Examples

Example 1

[0070] Foils S1 to S10 as shown in Table 1 were produced. The foils were based on PVC, contained $MnFe_2O_4$ as the magnetic particles, and were optionally coated with a lacquer layer consisting of two sublayers, each having a thickness of 10 μm.

[0071] Thermal stability was measured at 200 °C after exposure times of 0, 5, 10, 15, 20, 25, and 30 minutes. The tests showed that increasing concentrations of magnetic particles resulted in an increasing thermal stability of the foil. Other preliminary tests showed the suitability of the samples for the use as surface materials. Since $MnFe_2O_4$ particles have a dark brown/black color, the samples containing 2 mass% or more of the particles were not translucent but opaque and had a dark or black appearance.

[0072] $MnFe_2O_4$ show superparamagnetic behavior, hence their magnetization without an external magnetic field is zero. However, they only need a small field applied to them to reach saturation magnetization. The superparamagnetic behavior was evaluated by measuring the hysteresis loop saturation magnetization using superconducting quantum interference device (SQUID) magnetometry.

[0073] The magnetic attraction was measured at a distance of 2 mm from a magnet. Test were carried out using two magnets differing in their magnetic fields.

Table 1

<table>
<tr><th rowspan="2">Sample No.</th><th colspan="2">Content [mass%] of magnetic particles in the</th><th rowspan="2">Total thickness [μm]</th><th rowspan="2">Saturation magnetization [emu/g]</th><th colspan="2">Magnetic attraction at a distance of 2 mm from a</th></tr>
<tr><th>foil</th><th>lacquer layer</th><th>weak magnet</th><th>strong magnet</th></tr>
<tr><td>S1</td><td>0</td><td>0</td><td>320</td><td></td><td rowspan="8">Insufficient attraction</td><td rowspan="2">Insufficient attraction</td></tr>
<tr><td>S2</td><td>0</td><td>1.8</td><td>320</td><td></td></tr>
<tr><td>S3</td><td>2</td><td>No lacquer layer</td><td>300</td><td>1.0</td><td rowspan="8">Good attraction</td></tr>
<tr><td>S4</td><td>2</td><td>0</td><td>320</td><td>1.0</td></tr>
<tr><td>S5</td><td>2</td><td>1.8</td><td>320</td><td>1.9</td></tr>
<tr><td>S6</td><td>4</td><td>No lacquer layer</td><td>300</td><td>2.4</td></tr>
<tr><td>S7</td><td>4</td><td>0</td><td>320</td><td>2.4</td></tr>
<tr><td>S8</td><td>4</td><td>1.8</td><td>320</td><td>2.8</td></tr>
<tr><td>S9</td><td>13</td><td>No lacquer layer</td><td>300</td><td>6.1</td><td rowspan="2">Good attraction</td></tr>
<tr><td>S10</td><td>13</td><td>No lacquer layer</td><td>550</td><td>5.7</td></tr>
</table>

Example 2

[0074] The following Table 1 shows a comparison between a prior art product using movable elements and a component according to the present application.

[0075] The component of the present invention was PVC layer containing magnetic particles. The results show that similar deformations can be obtained in both systems at an operation voltage of 12V.

Table 2

	Prior art	Present invention
Peak deformation (mm)	0.5-1	0.5-1
Transition time	Few ms	Few ms
Minimum magnetic field (mT)*	-	<150
Operation voltage (V)	12	12
*Values for a minimum distance of 2 mm between the actuator and the magnetic material.		

Example 3:

[0076] The component having the following structure was prepared:

Three lacquer layers
PVC compact layer (270 g/m^2)
PVC foam layer with 25 mass% of FeCo nanoparticles (D_{50} of 45 μm) (310 g/m^2)
PVC adhesive layer with 27 mass% of FeCo nanoparticles (D_{50} of 45 μm) (120 g/m^2)
Textile support

[0077] The final concentration of FeCo particles in the component was 15.5 mass% resulting in a material having a saturation magnetization above 25 emu/g, which reduces the need for external permanent magnets.

[0078] The following two embodiments of the component were prepared:

(i) a permanent magnet for enhancing the magnetic interaction was attached to the B-side of the textile layer and a 3D coil was arranged 1 to 2 mm below the permanent magnet;
(ii) a 2D coil was printed on the B-side of the textile support and a permanent magnet for enhancing the magnetic interaction was arranged 1 to 2 mm below 2D coil.

[0079] Tests showed that the inclusion of the magnetic particles did not negatively impact the elongation, aging (240 h at 100 °C), and flexing endurance (100k cycles at room temperature; 10k cycles at -15 °C, 1 h) of the material when compared to the reference version (without particles).

[0080] The component was used as a loudspeaker. The sound feature of the component was proven in a laboratory experiment.

Claims

1. A component comprising a foil and a magnetic member, wherein the foil is based on a polymer and is reversibly deformable to form a protrusion and/or indentation by the interaction of a magnetic field with the magnetic member.

2. The component according to claim 1, wherein the magnetic member is a plurality of magnetic particles.

3. The component according to any of the preceding claims, wherein the foil is a multi-layered structure.

4. The component according to any of the preceding claims, wherein the foil is a multi-layered structure containing a lacquer layer as the uppermost layer, and the lowermost layer contains magnetic particles.

5. The component according to any of the preceding claims, wherein the foil is a multi-layered structure and a layer containing the magnetic particles has a thickness of at least 100 μm.

6. The component according to any of the preceding claims, wherein the foil contains a sensor.

7. The component according to any of the preceding claims, wherein the foil is translucent.

8. The component according to any of the preceding claims, wherein the component comprises the foil on a support, wherein the foil comprises a first portion not bonded to the support and a second portion bonded to the support, wherein the first portion is reversibly deformable to form a protrusion or indentation by the interaction of a magnetic field with the magnetic member and the support is not deformable by said interaction.

9. The component according to any of the preceding claims, wherein the magnetic field is created by a magnet, wherein the component comprises the magnet.

10. The component according to claim 9, wherein the component comprises a carrier comprising the magnet.

11. The component according to claim 9 or 10, wherein the magnet is configured to be activated by an external stimulus.

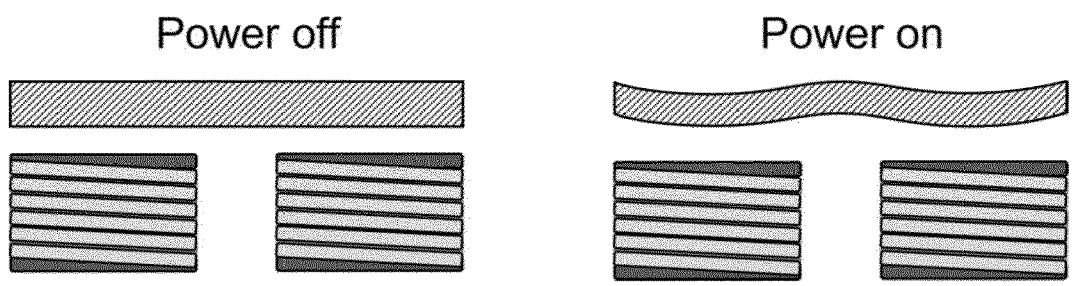
12. The component according to any of claims 9 to 11, wherein the magnet is printed on the carrier.

13. The component according to any of claims 10 to 12, wherein the component comprises the foil on a support as described in claim 8, wherein the support of the foil is the carrier comprising the magnet and wherein the magnet is capable of causing the deformation of the first portion of the foil.

14. The component according to any of claims 8 to 13, wherein the first portion of the foil is translucent and the component additionally comprises a light source configured to illuminate the first portion of the foil.

15. The use of a component according to any one of claims 1 to 14 as a haptic surface element, an optic surface element, a sound element, or an artificial leather in the interior of a vehicle.

Figure 1



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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 0997

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 699 801 B1 (FOND ST ITALIANO TECNOLOGIA [IT]) 15 November 2017 (2017-11-15) * figure 5 * * corresponding description * -----	1-13,15	INV. H01F7/06 H01F7/16 H01F3/08 G09B21/00
X	EP 3 309 802 A1 (IMMERSION CORP [US]) 18 April 2018 (2018-04-18) * figure 1 * * corresponding description * -----	1-15	
X	US 2014/104047 A1 (BOLZMACHER CHRISTIAN [FR] ET AL) 17 April 2014 (2014-04-17) * figures 1-7 * * corresponding description * -----	1,2,4, 6-11,13, 15	
X	DE 100 57 918 A1 (KERAFOL KERAMISCHE FOLIEN GMBH [DE]) 6 June 2002 (2002-06-06) * figure 5 * * corresponding description * -----	1-5,7	TECHNICAL FIELDS SEARCHED (IPC)
X	DE 202 19 788 U1 (KURZ LEONHARD FA [DE]) 24 April 2003 (2003-04-24) * figure 2 * * corresponding description * -----	1-4,7,15	H01F G09B

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
Munich	26 March 2024	Weisser, Wolfgang

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 23 20 0997

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26-03-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2699801 B1	15-11-2017	EP 2699801 A1	26-02-2014
		US 2014035708 A1	06-02-2014
		WO 2012143887 A1	26-10-2012
EP 3309802 A1	18-04-2018	CN 107943277 A	20-04-2018
		EP 3309802 A1	18-04-2018
		JP 2018064450 A	19-04-2018
		KR 20180040506 A	20-04-2018
		US 2018102030 A1	12-04-2018
US 2014104047 A1	17-04-2014	EP 2715497 A1	09-04-2014
		FR 2976109 A1	07-12-2012
		US 2014104047 A1	17-04-2014
		WO 2012164209 A1	06-12-2012
DE 10057918 A1	06-06-2002	DE 10057918 A1	06-06-2002
		WO 0243146 A1	30-05-2002
DE 20219788 U1	24-04-2003	AT 9442 U1	15-10-2007
		DE 20219788 U1	24-04-2003
		JP 3097077 U	15-01-2004

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2019115053 A1 **[0002]**
- EP 3851325 A1 **[0003]**