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(54) SPEAKER AND FILM FOR USE IN SPEAKER DIAPHRAGM

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Description

[0001] The present invention pertains to a speaker, to the use of tapes with certain properties in a speaker diaphragm, and to a method for manufacturing such speaker diaphragm.

Audio speakers comprise a magnet, a voice coil, and a diaphragm. The properties of the diaphragm are of importance in determining the quality of the sound exiting from the speaker. Key features in a diaphragm with good properties include light weight, a high sound velocity, and a high rigidity.

[0002] Many materials have been described for diaphragms in the art.

JP laid-open 58-182994 describes the use of non-woven materials comprising polyethylene shortcut in a speak diaphragm.

EP322587 describes a diaphragm which includes a layer formed by reinforcing a woven cloth of a high strength and high elasticity fiber with a resin. The high strength and high elasticity fiber may be a gel-spun polyethylene fiber.

EP424841 describes a diaphragm formed essentially of a polyolefin composition produced by multi-stage polymerization from an ultra-high molecular weight polyolefin with specified viscosity and a low to high molecular weight polyolefin having a specified viscosity, with the ultrahigh molecular weight polyolefin having its molecular chain oriented in a predetermined direction, specifically in the radial direction of the diaphragm. This configuration is obtained by injection molding the polymer, wherein the polymer is injected in the center of the mold, so that it radially flows outward.

[0003] There is need in the art for diaphragms for use in speakers which show improved properties. There is especially need in the art for diaphragms which allow the use of cones with a lower steepness, as this will provide the possibility of making flatter speakers, without compromising on sound quality. There is also need in the art for a diaphragm which shows a high degree of internal damping, or loss factor, as this improves the suppression of undesired resonances.

[0004] The present invention provides such a speaker. The invention pertains to a speaker comprising a magnet, a voice coil, and a diaphragm, wherein the diaphragm comprises tapes of ultra-high molecular weight polyethylene (UHMWPE), the tapes film having an uniplanar orientation parameter of at least 3.

[0005] WO2010/003971 describes a method for manufacturing high molecular weight polyethylene fibers which comprises subjecting a polyethylene tape with a weight average molecular weight of at least 500 000 gram/mole, an Mw/Mn ratio of at most 6, and a 200/110 uniplanar orientation parameter of at least 3 to a force in the direction of the thickness of the tape over the whole width of the tape. It is indicated that the polyethylene fiber can be used in ballistic applications, ropes, cables, nets, fabrics, and protective applications.

WO2013/120983 describes a process for enhancing the color intensity of a colored molded UHMWPE article comprising the steps of a) providing an UHMWPE, a coloring agent and a color enhancer, b) molding the UHMWPE into a molded UHMWPE article, c) adding the color enhancer to the UHMWPE before or during the molding step and d) adding the coloring agent to the UHMWPE before, during or after the molding step, wherein the color enhancer is of a material with a hardness higher than the hardness of the molded article measured in the absence of the color enhancer.

[0006] The uniplanar orientation parameter gives information about the extent of orientation of the 200 and 110 crystal planes with respect to the film surface. For a sample with a high uniplanar orientation the 200 crystal planes are highly oriented parallel to the surface. The ratio between the 200 and 110 peak areas for a specimen with randomly oriented crystallites is around 0.4. However, the crystallites with indices 200 are preferentially oriented parallel to the film surface according to the invention, resulting in a higher value of the 200/110 peak area ratio and therefore in a higher value of the uniplanar orientation parameter. As indicated above, the tapes used in the invention have a uniplanar orientation parameter of at least 3. It may be preferred for this value to be at least 4, more in particular at least 5, or at least 7. Higher values, such as values of at least 10 or even at least 15 may also be obtained. The theoretical maximum value for this parameter may be as high as infinite if the peak area 110 equals zero. This parameter can be determined as described in WO2009/109632. It is preferred for the tapes used in the present invention to have a uniplanar orientation parameter of least 4, more in particular at least 5, or at least 7, or at least 10 or even at least 15, as this is believed to contribute to the quality of the diaphragm.

[0007] It has been found that the use of UHMWPE tapes having a uniplanar orientation parameter of at least 3 in diaphragms for audio speakers. In particular, it has been found that the use of these tapes results in diaphragms with a high degree of internal damping in combination with a high rigidity, which allows the manufacture of shallow speakers, and a good sound quality. It should be noted that polyolefin processed by injection moulding will not show the required high degree of orientation.

[0008] A further advantage of the present invention is that use of tapes makes it possible to obtain diaphragms which contain large amounts of highly oriented polyethylene, and relatively low amounts of further components such as resins. This is in contrast with the situation where fibers are used which have to be impregnated with a resin. Further, in some embodiments the use of a tapes makes it possible to obtain long range orientation, in contrast with the situation where shortcut fibers are used in the form of a non-woven paper.

[0009] The invention pertains to subject matter as described in the claims which are to be considered inserted herein.

[0010] In one embodiment, the diaphragm comprises

at least one, generally 1 to 20, in some embodiments 2-10, layers of woven tapes, wherein at least part of the tapes are tapes of ultra-high molecular weight polyethylene, the tapes having an uniplanar orientation parameter of at least 3.

[0011] It is preferred for the tapes with a uniplanar orientation parameter of at least 3, wherein preferably part of the tapes in the diaphragm (preferably 10-90%, in particular 40-60%) are in a first direction, and part of the tapes in the diaphragm (preferably 90-10%, in particular 60-40%) are in a second direction which is at an angle of at least 30°, preferably perpendicular, with the first direction.

[0012] In one embodiment, the layer of woven tapes comprises 10-90 wt.% of tapes of ultra-high molecular weight polyethylene, the tapes having an uniplanar orientation parameter of at least 3 and 10-90 wt.% of polymer tapes which are not of ultra-high molecular weight polyethylene with an uniplanar orientation parameter of at least 3. It may be preferred for the polymer tapes which are not of ultra-high molecular weight polyethylene with an uniplanar orientation parameter of at least 3 are polyolefin tapes, in particular tapes of polyethylene, polypropylene, or combinations thereof.

[0013] Where a layer of woven tapes is used, it may be preferred for the layer of woven tapes to comprise more than 90 wt.% of tapes of ultra-high molecular weight polyethylene the tapes having an uniplanar orientation parameter of at least 3, in particular at least 95 wt.%, more in particular at least 98 wt.%, still more in particular 100 wt.%.

[0014] In one embodiment of the present invention, the diaphragm comprises a layer comprising tapes of ultra-high molecular weight polyethylene, said tapes having an uniplanar orientation parameter of at least 3, wherein the tapes are arranged in parallel within the layer.

It may be preferred for the diaphragm to comprise at least two layers comprising tapes of ultra-high molecular weight polyethylene, said tapes having an uniplanar orientation parameter of at least 3, wherein the tapes are arranged in parallel within the layer, wherein the direction of the tapes of ultra-high molecular weight polyethylene in a first layer is at an angle of at least 30° of the direction of the tapes of ultra-high molecular weight polyethylene in a second layer. It is particularly preferred for the direction of the tapes in a first layer to be perpendicular to the direction of the tapes in a second layer.

[0015] In general, 1-50, in particular wherein 2-20 layers of tapes are used, in some embodiments 2-10. It may be preferred for the direction of the tapes between adjacent layers to differ with at least 30°, in particular 90°.

[0016] In one embodiment of the invention, at least some of the layers consist of a single layer of parallel tapes. In this embodiment it is preferred for at least some of the layers to consist of at least two, in particular two, sub-layers of parallel tapes, wherein the tapes in the first sublayer are arranged in parallel with the tapes in the second sublayer, and offset thereto.

[0017] In one embodiment of the present invention the diaphragm comprises a non-woven fiber layer comprising tapes of ultra-high molecular weight polyethylene, the tapes having an uniplanar orientation parameter of at least 3, wherein the tapes are microtapes with a length of 2-20 mm and a thickness of 8-150 microns, and a width which is narrower than the length. The microtapes are generally present in an amount of 1-90 wt.%, in particular 1-70 wt.%, more in particular 2-50 wt.%, still more in particular 2-20 wt.%. The non-woven fiber layer of this embodiment preferably comprises cellulose, in particular in the form of shortcut with a length of 2-20 mm and/or pulp. The non-woven fiber layer may be obtained by methods known in the art for manufacturing non-wovens. In one embodiment it is obtained from a wet laid cellulose paper process.

[0018] The invention also pertains to the use of tapes of ultra-high molecular weight polyethylene, the tapes having an uniplanar orientation parameter of at least 3, in a diaphragm of a speaker comprising a magnet, a voice coil, and a diaphragm. The particular embodiments described herein for the speaker and the diaphragm also apply to this use.

[0019] The diaphragm may be manufactured, e.g., by the following method. One or more layers as described herein are shaped by placing the layers, where there are more than one layers in the form of a stack, in a mold suitable to obtain a diaphragm shape, and heating the material under such conditions that a molded shape is obtained, but at a temperature which is below the melting temperature of the UHMWPE tapes. It will be clear to the skilled person how this process is to be carried out in practice.

[0020] The tapes used in the present invention are objects of which the length is larger than the width and the thickness, while the width is in turn larger than the thickness. In the tapes used in the present invention, the ratio between the width and the thickness generally is more than 10:1, in particular more than 20:1, more in particular more than 50:1, still more in particular more than 100:1. The maximum ratio between the width and the thickness is not critical to the present invention. It generally is at most 1000:1, depending on the tape width.

[0021] The width of the tape used in the present invention may vary within wide ranges, generally between 0.5 mm and 500 mm, in particular between 0.5 and 150 mm. When layers of woven tapes are used, it may be preferred to use relatively narrow tapes, e.g., in the range of 0.5-20 mm, in particular in the range of 0.5-10 mm, more in particular in the range of 0.5-5 mm. The use of narrower tapes results in a material with better drapability. On the other hand, where the diaphragm comprises a layer comprising tapes arranged in parallel, the use of wider tapes may be preferred, e.g., tapes with a width of at least 10 mm, more in particular at least 20 mm.

The thickness of the tape is generally at least 8 microns, in particular at least 10 microns. The thickness of the tape is generally at most 150 microns, more in particular

at most 100 microns, still more in particular at most 80 microns.

[0022] In some embodiments of the present invention, the tapes may be microtapes, which have a length of 2-20 mm, in some embodiments 2-10 mm, and a thickness of 8-150 microns, and a width which is narrower than the length. The ranges given above for the thickness of the tapes also apply to the microtapes.

[0023] The tapes used in the present invention are tapes of ultra-high molecular weight polyethylene. It is preferred for the tapes used in the present invention sheet to be high-drawn tapes of ultra-high-molecular weight linear polyethylene. Linear polyethylene here means polyethylene having fewer than 1 side chain per 100 C atoms, preferably fewer than 1 side chain per 300 C atoms. The polyethylene may also contain up to 5 mol % of one or more other alkenes which are copolymerisable therewith, such as propylene, butene, pentene, 4-methylpentene, octene.

Ultra-high molecular weight polyethylene (UHMWPE) is defined as polyethylene with a weight average molecular weight of at least 500 000 g/mol. The use of tapes with a molecular weight of at least $1 \cdot 10^6$ g/mol may be particularly preferred. The maximum molecular weight of the UHMWPE tapes suitable for use in the present invention is not critical. As a general value a maximum value of $1 \cdot 10^8$ g/mol may be mentioned. The molecular weight distribution and molecular weight averages (Mw, Mn, Mz) can be determined as described in WO2009/109632.

[0024] In one embodiment, the tensile strength of the tapes is at least 1.2 GPa, more in particular at least 1.5 GPa, still more in particular at least 1.8 GPa, even more in particular at least 2.0 GPa. In one embodiment, the tensile strength of these tapes is at least 2.0 GPa, in particular at least 2.5 GPa, more in particular at least 3.0 GPa, still more in particular at least 4 GPa. Tensile strength is determined in accordance with ASTM D7744-11.

[0025] In one embodiment, the tapes have a tensile modulus of at least 50 GPa. More in particular, the tapes may have a tensile modulus of at least 80 GPa, more in particular at least 100 GPa, still more in particular at least 120 GPa, even more in particular at least 140 GPa, or at least 150 GPa, or even at least 170 GPa. The modulus is determined in accordance with ASTM D7744-11.

[0026] In one embodiment, the tapes have a tensile energy to break of at least 20 J/g, in particular at least 25 J/g. In another embodiment, the tapes have a tensile energy to break of at least 30 J/g, in particular at least 35 J/g, more in particular at least 40 J/g, still more in particular at least 50 J/g. The tensile energy to break is determined in accordance with ASTM D7744-11. It is calculated by integrating the energy per unit mass under the stress-strain curve.

[0027] In one embodiment, the UHMWPE tapes used in the present invention have a narrow molecular weight distribution have an Mw/Mn ratio of at most 6. More in particular the Mw/Mn ratio is at most 5, still more in par-

ticular at most 4, even more in particular at most 3. The use of materials with an Mw/Mn ratio of at most 2.5, or even at most 2 is envisaged in particular.

[0028] In one embodiment of the present invention, the UHMWPE tapes, in particular UHMWPE tapes have a DSC crystallinity of at least 74%, more in particular at least 80%. The DSC crystallinity can be determined as described in WO2009/109632.

[0029] The polyethylene used in the present invention can be a homopolymer of ethylene or a copolymer of ethylene with a co-monomer which is another alpha-olefin or a cyclic olefin, both with generally between 3 and 20 carbon atoms. Examples include propene, 1-butene, 1-pentene, 1-hexene, 1-heptene, 1-octene, cyclohexene, etc. The use of dienes with up to 20 carbon atoms is also possible, e.g., butadiene or 1-4 hexadiene. The amount of non-ethylene alpha-olefin in the ethylene homopolymer or copolymer used in the process according to the invention preferably is at most 10 mole%, preferably at most 5 mole%, more preferably at most 1 mole%. If a non-ethylene alpha-olefin is used, it is generally present in an amount of at least 0.001 mol.%, in particular at least 0.01 mole%, still more in particular at least 0.1 mole%. The use of a material which is substantially free from non-ethylene alpha-olefin is preferred. Within the context of the present specification, the wording substantially free from non-ethylene alpha-olefin is intended to mean that the only amount non-ethylene alpha-olefin present in the polymer are those the presence of which cannot reasonably be avoided. In general, the UHMWPE tapes have a polymer solvent content of less than 0.05 wt.%, in particular less than 0.025 wt.%, more in particular less than 0.01 wt.%.

[0030] In one embodiment of the present invention, the polyethylene tapes are tapes manufactured by a process which comprises subjecting a starting polyethylene with a weight average molecular weight of at least 100 000 gram/mole, an elastic shear modulus G_N^0 , determined

directly after melting at 160°C of at most 1.4 MPa to a compacting step and a stretching step under such conditions that at no point during the processing of the polymer its temperature is raised to a value above its melting point.

The starting material for said manufacturing process is a highly disentangled UHMWPE. This can be seen from the combination of the weight average molecular weight and the elastic modulus. For further elucidation. As indicated above, the starting polymer has an elastic shear modulus G_N^0 determined directly after melting at 160°C of at most 1.4 MPa, more in particular at most 1.0 MPa, still more in particular at most 0.9 MPa, even more in particular at most 0.8 MPa, and even more in particular at most 0.7. The wording "directly after melting" means that the elastic modulus is determined as soon as the polymer has melted, in particular within 15 seconds after the polymer has melted. For this polymer melt, the elastic

modulus typically increases from 0.6 to 2.0 MPa in several hours.

The elastic shear modulus directly after melting at 160°C is a measure for the degree of entangledness of the polymer. G_N^0 is the elastic shear modulus in the rubbery plateau region. It is related to the average molecular weight between entanglements M_e , which in turn is inversely proportional to the entanglement density. In a thermodynamically stable melt having a homogeneous distribution of entanglements, M_e can be calculated from

G_N^0 via the formula $G_N^0 = g_N \rho R T / M_e$, where g_N

is a numerical factor set at 1, ρ is the density in g/cm³, R is the gas constant and T is the absolute temperature in K. A low elastic modulus thus stands for long stretches of polymer between entanglements, and thus for a low degree of entanglement. The adopted method for the investigation on changes in with the entanglements formation is the same as described in publications (Rastogi, S., Lippits, D., Peters, G., Graf, R., Yefeng, Y. and Spiess, H., "Heterogeneity in Polymer Melts from Melting of Polymer Crystals", Nature Materials, 4(8), 1st August 2005, 635-641 and PhD thesis Lippits, D.R., "Controlling the melting kinetics of polymers; a route to a new melt state", Eindhoven University of Technology, dated 6th March 2007, ISBN 978-90-386-0895-2). The disentangled polyethylene for use in this embodiment may be manufactured by a polymerisation process wherein ethylene, optionally in the presence of other monomers as discussed above, is polymerised in the presence of a single-site polymerisation catalyst at a temperature below the crystallisation temperature of the polymer, so that the polymer crystallises immediately upon formation. Suitable methods for manufacturing polyethylenes used in the present invention are known in the art. Reference is made, for example, to WO01/21668 and US20060142521.

[0031] In some embodiments, tapes used in the present invention have a high strength in combination with a high linear density. In the present specification the linear density is expressed in dtex. This is the weight in grams of 10.000 metres of film. In one embodiment, the tapes used in the present invention have a denier of at least 500 dtex, in particular at least 1000 dtex, more in particular at least 3000 dtex, even more in particular at least 5000 dtex, more in particular at least 10000 dtex, even more in particular at least 15000 dtex, or even at least 20000 dtex, in combination with strengths of at least 1.0 GPa, in particular at least 1.5 GPa, more in particular at least 2.0 GPa, still more in particular at least 2.5 GPa, more in particular at least 3.0 GPa, still more in particular at least 3.5 GPa, and even more in particular at least 4 GPa.

[0032] The UHMWPE tapes which may be used in the present invention may be manufactured by solid state processing of the UHMWPE, which process comprises compacting UHMWPE powder, and stretching the resulting compacted sheets to form tapes. Suitable methods

for solid state processing UHMWPE are known in the art, and described, e.g., in WO2009/109632, WO2009/153318 and WO2010/079172 and require no further elucidation here.

5 Suitable tapes and layers comprising these tapes are commercially available, e.g., from Teijin under the trademark Endumax.

[0033] The diaphragm may further comprise a matrix material, in addition to the polyethylene tapes. If a matrix material is present, it is generally present in an amount of 0.2-20 wt.%, in particular 2-15 wt.%, calculated on the weight of the diaphragm.

[0034] Preferably, the matrix is selected from the group of high density polyethylene (HDPE) and thermoplastic elastomer. Combinations of matrix materials may also be used.

[0035] If used, HDPE generally has a density in the range of 0.930 to 0.970 g/cm³, determined in accordance with ASTM D792. Suitable HDPEs generally have a molecular weight M_w in the range of $1 \cdot 10^4$ to $1 \cdot 10^8$ g/mol, in particular $1 \cdot 10^5$ to $1 \cdot 10^7$ g/mol.

The HDPE which may be used as matrix in the present invention is an isotropic material and can therewith be distinguished from the tapes which show orientation. This can be seen, e.g., from the ratio between the strength of the material in a first direction and the strength of the material in a direction perpendicular thereto. For the matrix, which is an isotropic material, the ratio between the strength of the material determined in the direction where it strength is highest (machine direction) and the strength in the direction perpendicular thereto is generally at most 5:1. In contrast, for the elongate bodies, the ratio between the strength of the material determined in the direction where it strength is highest (machine direction) and the strength in the direction perpendicular thereto is generally at least 50:1. This parameter can e.g. be determined from the breaking tenacity as determined in accordance with ASTM-D 7744-11.

[0036] Thermoplastic elastomers (TPE), sometimes referred to as thermoplastic rubbers which can be used as matrix material in the present invention are a class of copolymers or a physical mix of polymers (usually a plastic and a rubber) which consist of materials with both thermoplastic and elastomeric properties, i.e., it shows plastic flow above its T_g (glass transition temperature), T_m (melting point), or T_s (softening point) (thermoplastic behavior) and shows resilient properties below the softening point. In one embodiment, the material has an elongation at break of at least 100%, in particular at least 200%. The upper limit is not critical to the present invention. A value of 600% may be mentioned in general. Preferably the elongation at break of the elastomer is higher than the elongation at break of the fiber or tape that may be manufactured from the composition of the present invention, as will be discussed in more detail below. In one embodiment, the thermoplastic elastomer has a tensile modulus (at 25°C) of at most 40 MPa (ASTM D7744-11). Suitable thermoplastic elastomers include

polyurethanes, polyvinyls, polyacrylates, block copolymers and mixtures thereof. In one embodiment, the thermoplastic elastomer is a block co-polymer of styrene and an alpha-olefin comonomer. Suitable comonomers include C4-C12 alpha-olefins such as ethylene, propylene, and butadiene. The use of polystyrene - polybutadiene - polystyrene polymer or polystyrene - isoprene - polystyrene is considered preferred at this point in time. These kind of polymers are commercially available, e.g., under the trade name Kraton or Styroflex.

[0037] Matrix material may be provided within the layers themselves, where it may serve to adhere tapes to each other. This can be of interest at least in the embodiment where at least some of the layers consist of at least two, in particular two, sub-layers of parallel tapes, wherein the tapes in the first sublayer are arranged in parallel with the tapes in the second sublayer, and offset thereto. In another embodiment of the present invention, matrix material is provided on the layer, where it acts as a glue or binder to adhere layers together. Obviously, the combination of these two embodiments is also envisaged.

[0038] In one embodiment of the present invention the matrix material is applied in the form of a web, wherein a web is a discontinuous polymer film, that is, a polymer film with holes. This allows the provision of low weights of matrix materials. Webs can be applied during the manufacture of the layers, but also between the layers.

In another embodiment of the present invention, the matrix material is applied in the form of strips, yarns, powder, pellets, or fibres of polymer material, the latter for example in the form of a woven or non-woven yarn of fibre web or other polymeric fibrous web. Again, this allows the provision of low weights of matrix materials. Strips, yarns, powder, pellets or fibres can be applied during the manufacture of the layers, but also between the layers.

In a further embodiment of the present invention, the matrix material is applied in the form of a liquid material, as described above, where the liquid material may be applied homogeneously over the entire surface. However, it is also possible to apply the matrix material in the form of a liquid material inhomogeneously. For example, the liquid material may be applied in the form of dots or stripes, or in any other suitable pattern.

[0039] In the present invention the direction of tapes within the diaphragm generally is not unidirectional. This means that in the diaphragm as a whole, tapes are oriented in different directions.

In one embodiment of the present invention the tapes in a layer are unidirectionally oriented, and the direction of the tapes in a layer is rotated with respect to the direction of the tapes of other layers in the diaphragm, more in particular with respect to the direction of the tapes in adjacent layers. Good results are achieved when the total rotation within the diaphragm amounts to at least 30 degrees, in particular at least 45 degrees. Preferably, the total rotation within the diaphragm amounts to approximately 90 degrees. In one embodiment of the present invention, the diaphragm comprises adjacent layers

wherein the direction of the tapes in one sheet is perpendicular to the direction of tapes in adjacent layers.

[0040] The speaker according to the invention comprises a magnet, a voice coil, and a diaphragm. The diaphragm may be connected to a frame via a flexible suspension that constrains the voice coil to move axially through a cylindrical magnetic gap. When the electrical signal is applied to the voice coil, a magnetic field is created by electric current in the voice coil, making it a variable electromagnet. The coil and the magnetic system interact, generating a mechanical force that causes the coil and thus the attached diaphragm to move back and forth, thereby reproducing sound. Speaker structures, magnets, and voice coils are known to the skilled person, and require no further elucidation.

[0041] It will be evident that various embodiments described in the claims and in this specification can be combined, unless they are presented as alternatives, or it is clear to the skilled person that they cannot be combined.

Claims

1. Speaker comprising a magnet, a voice coil, and a diaphragm, wherein the diaphragm comprises tapes of ultra-high molecular weight polyethylene, the tapes having an uniplanar orientation parameter of at least 3.
2. Speaker according to claim 1, wherein the diaphragm comprises at least one layer of woven tapes, wherein at least part of the tapes are tapes of ultra-high molecular weight polyethylene, the tapes having an uniplanar orientation parameter of at least 3, wherein preferably part of the tapes in the diaphragm (preferably 10-90%, in particular 40-60%) are in a first direction, and part of the tapes in the diaphragm (preferably 90-10%, in particular 60-40%) are in a second direction which is at an angle of at least 30°, preferably perpendicular, with the first direction.
3. Speaker according to claim 2, wherein the layer of woven tapes comprises 10-90 wt.% of tapes of ultra-high molecular weight polyethylene, the tapes having an uniplanar orientation parameter of at least 3 and 10-90 wt.% of polymer tapes which are not of ultra-high molecular weight polyethylene with an uniplanar orientation parameter of at least 3, wherein the polymer tapes which are not of ultra-high molecular weight polyethylene with an uniplanar orientation parameter of at least 3 preferably are polyolefin tapes, in particular tapes of polyethylene, polypropylene, or combinations thereof.
4. Speaker according to claim 2, wherein the layer of woven tapes comprises more than 90 wt.% of tapes of ultra-high molecular weight polyethylene the tapes having an uniplanar orientation parameter of at least

- 3, in particular at least 95 wt.%, more in particular at least 98 wt.%, still more in particular 100 wt.%.
5. Speaker according to any one of the preceding claims 2 to 4, wherein the diaphragm comprises 1 to 20 layers of woven tapes, in particular 2-10 layers of woven tapes.
 6. Speaker according to any one of the preceding claims, wherein the diaphragm comprises at least one layer comprising tapes of ultra-high molecular weight polyethylene, said tapes having an uniplanar orientation parameter of at least 3, wherein the tapes are arranged in parallel within the layer.
 7. Speaker according to claim 6, wherein the diaphragm comprises at least two layers, in particular 2 to 20 layers, more in particular 2 to 10 layers, comprising tapes of ultra-high molecular weight polyethylene, said tapes having an uniplanar orientation parameter of at least 3, wherein the tapes are arranged in parallel within the layer, wherein the direction of the tapes of ultra-high molecular weight polyethylene in a first layer is at an angle of at least 30° of the direction of the tapes of ultra-high molecular weight polyethylene in a second layer, the direction of the tapes in a first layer preferably being perpendicular to the direction of the tapes in a second layer, wherein preferably the direction of the tapes between adjacent layers differs with at least 30°, in particular 90°.
 8. Speaker according to claim 6 or 7, wherein at least some of the layers consist of a single layer of parallel tapes.
 9. Speaker according to any one of claims 6 to 8, wherein at least some of the layers consist of at least two, in particular two, sub-layers of parallel tapes, wherein the tapes in the first sublayer are arranged in parallel with the tapes in the second sublayer, and offset thereto.
 10. Speaker according to claim 1, wherein the diaphragm comprises a non-woven fiber layer comprising tapes of ultra-high molecular weight polyethylene, the tapes having an uniplanar orientation parameter of at least 3, wherein the tapes are microtapes with a length of 2-20 mm and a thickness of 8-150 microns, and a width which is narrower than the length, the microtapes preferably being present in an amount of 2-50 wt.%, in particular 2-20 wt.%.
 11. Speaker according to claim 10, wherein the non-woven fiber layer comprises cellulose, in particular in the form of shortcut with a length of 2-20 mm and/or pulp, the non-woven fiber layer preferably being obtained from a wet laid cellulose paper process.
 12. Speaker according to any one of the preceding claims wherein the diaphragm further comprises a matrix material, which is preferably present in an amount of 0.2-20 wt.%, in particular 2-15 wt.%, the matrix preferably being selected from the group of high density polyethylene and thermoplastic elastomer.
 13. Speaker according to any one of the preceding claims, wherein the tapes have a uniplanar orientation parameter of at least 4, more in particular at least 5, or at least 7, or at least 10 or even at least 15.
 14. Use of tapes of ultra-high molecular weight polyethylene, the tapes having an uniplanar orientation parameter of at least 3, in particular at least 4, more in particular at least 5, or at least 7, or at least 10 or even at least 15, in a diaphragm of a speaker comprising a magnet, a voice coil, and a diaphragm.
 15. Method of manufacturing a diaphragm suitable for use in a speaker according to any one of claims 1-13, wherein one or more layers comprising tapes of ultra-high molecular weight polyethylene are shaped by placing the layers in a mold suitable to obtain a diaphragm shape, and heating the layers under such conditions that a molded shape is obtained, but at a temperature which is below the melting temperature of the UHMWPE tapes.

Patentansprüche

1. Lautsprecher, der einen Magneten, eine Schwingspule und eine Membran umfasst, wobei die Membran Bänder aus ultrahochmolekularem Polyethylen umfasst, wobei die Bänder einen Uniplanare-Orientierung-Parameter von mindestens 3 aufweisen.
2. Lautsprecher nach Anspruch 1, wobei die Membran zumindest eine Schicht aus gewebten Bändern umfasst, wobei zumindest ein Teil der Bänder aus ultrahochmolekularem Polyethylen ist, wobei die Bänder einen Uniplanare-Orientierung-Parameter von mindestens 3 aufweisen, wobei vorzugsweise ein Teil der Bänder in der Membran (vorzugsweise 10-90%, insbesondere 40-60%) in einer ersten Richtung verläuft und ein Teil der Bänder in der Membran (vorzugsweise 90-10%, insbesondere 60-40%) in einer zweiten Richtung verläuft, die zu der ersten Richtung in einem Winkel von mindestens 30°, vorzugsweise senkrecht, liegt.
3. Lautsprecher nach Anspruch 2, wobei die Schicht aus gewebten Bändern 10-90 Gew.-% Bänder aus ultrahochmolekularem Polyethylen, wobei die Bänder einen Uniplanare-Orientierung-Parameter von mindestens 3 aufweisen, und 10-90 Gew.-% nicht

- aus ultrahochmolekularem Polyethylen bestehende Polymerbänder mit einem Uniplanare-Orientierungs-Parameter von mindestens 3 umfasst, wobei die nicht aus ultrahochmolekularem Polyethylen bestehenden Polymerbänder mit einem Uniplanare-Orientierungs-Parameter von mindestens 3 vorzugsweise Polyolefinbänder, insbesondere Bänder aus Polyethylen, Polypropylen oder Kombinationen derselben, sind.
4. Lautsprecher nach Anspruch 2, wobei die Schicht aus gewebten Bändern mehr als 90 Gew.-% Bänder aus ultrahochmolekularem Polyethylen, wobei die Bänder einen Uniplanare-Orientierungs-Parameter von mindestens 3 aufweisen, insbesondere mindestens 95 Gew.-%, mehr insbesondere mindestens 98 Gew.-%, noch mehr insbesondere 100 Gew.-%, umfasst.
 5. Lautsprecher nach einem der vorstehenden Ansprüche 2 bis 4, wobei die Membran 1 bis 20 Schichten aus gewebten Bändern, insbesondere 2 bis 10 Schichten aus gewebten Bändern, umfasst.
 6. Lautsprecher nach einem der vorstehenden Ansprüche, wobei die Membran zumindest eine Schicht umfasst, die Bänder aus ultrahochmolekularem Polyethylen umfasst, wobei die Bänder einen Uniplanare-Orientierungs-Parameter von mindestens 3 aufweisen, wobei die Bänder innerhalb der Schicht parallel angeordnet sind.
 7. Lautsprecher nach Anspruch 6, wobei die Membran mindestens zwei Schichten, insbesondere 2 bis 20 Schichten, mehr insbesondere 2 bis 10 Schichten, umfasst, die Bänder aus ultrahochmolekularem Polyethylen umfassen, wobei die Bänder einen Uniplanare-Orientierungs-Parameter von mindestens 3 aufweisen, wobei die Bänder innerhalb der Schicht parallel angeordnet sind, wobei die Richtung der Bänder aus ultrahochmolekularem Polyethylen in einer ersten Schicht in einem Winkel von mindestens 30° zu der Richtung der Bänder aus ultrahochmolekularem Polyethylen in einer zweiten Schicht liegt, wobei die Richtung der Bänder in einer ersten Schicht vorzugsweise senkrecht zu der Richtung der Bänder in einer zweiten Schicht liegt, wobei vorzugsweise die Richtung der Bänder zwischen benachbarten Schichten um mindestens 30°, insbesondere 90°, abweicht.
 8. Lautsprecher nach Anspruch 6 oder 7, wobei zumindest einige der Schichten aus einer einzelnen Schicht aus parallelen Bändern bestehen.
 9. Lautsprecher nach einem der Ansprüche 6 bis 8, wobei zumindest einige der Schichten aus zumindest zwei, insbesondere zwei, Teilschichten aus parallelen Bändern bestehen, wobei die Bänder in der ersten Teilschicht parallel zu den Bändern in der zweiten Teilschicht, und zu diesen versetzt, angeordnet sind.
 10. Lautsprecher nach Anspruch 1, wobei die Membran eine nicht gewebte Faserschicht umfasst, die Bänder aus ultrahochmolekularem Polyethylen umfasst, wobei die Bänder einen Uniplanare-Orientierungs-Parameter von mindestens 3 aufweisen, wobei die Bänder Mikrobänder mit einer Länge von 2-20 mm und einer Dicke von 8-150 Mikrometern und einer Breite, die schmaler als die Länge ist, sind, wobei die Mikrobänder vorzugsweise zu einem Gehalt von 2-50 Gew.-%, insbesondere 2-20 Gew.-%, vorliegen.
 11. Lautsprecher nach Anspruch 10, wobei die nicht gewebte Faserschicht Zellulose, insbesondere in Form von Kurzschnitt mit einer Länge von 2-20 mm und/oder Pulpe, umfasst, wobei die nicht gewebte Faserschicht vorzugsweise aus einem Nassvlies-Zellulosepapierprozess gewonnen wird.
 12. Lautsprecher nach einem der vorstehenden Ansprüche, wobei die Membran weiter ein Matrixmaterial umfasst, das vorzugsweise zu einem Gehalt von 0,2-20 Gew.-%, insbesondere 2-15 Gew.-%, vorliegt, wobei die Matrix vorzugsweise aus der Gruppe aus Polyethylen hoher Dichte und thermoplastischem Elastomer ausgewählt wird.
 13. Lautsprecher nach einem der vorstehenden Ansprüche, wobei die Bänder einen Uniplanare-Orientierungs-Parameter von mindestens 4, mehr insbesondere mindestens 5 oder mindestens 7 oder mindestens 10 oder sogar mindestens 15, aufweisen.
 14. Verwendung von Bändern aus ultrahochmolekularem Polyethylen, wobei die Bänder einen Uniplanare-Orientierungs-Parameter von mindestens 3, insbesondere mindestens 4, mehr insbesondere mindestens 5 oder mindestens 7 oder mindestens 10 oder sogar mindestens 15 aufweisen, in einer Membran eines Lautsprechers, der einen Magneten, eine Schwingspule und eine Membran umfasst.
 15. Verfahren zum Herstellen einer Membran, die zur Verwendung in einem Lautsprecher nach einem der Ansprüche 1 bis 13 geeignet ist, wobei eine oder mehrere Schichten, die Bänder aus ultrahochmolekularem Polyethylen umfassen, durch Platzieren der Schichten in einer Form, die dazu geeignet ist, ein Membranformstück zu erhalten, und Erwärmen der Schichten unter solchen Bedingungen, dass ein geformtes Formstück erhalten wird, jedoch bei einer Temperatur, die unterhalb der Schmelztemperatur der UHMWPE-Bänder liegt, geformt werden.

Revendications

1. Haut-parleur comprenant un aimant, une bobine acoustique, et une membrane, dans lequel la membrane comprend des bandes de polyéthylène ultra haute masse moléculaire, les bandes présentant un paramètre d'orientation uniplanaire d'au moins 3. 5
2. Haut-parleur selon la revendication 1, dans lequel la membrane comprend au moins une couche de bandes tissées, dans lequel au moins une partie des bandes sont des bandes de polyéthylène ultra haute masse moléculaire, les bandes présentant un paramètre d'orientation uniplanaire d'au moins 3, dans lequel de préférence une partie des bandes dans la membrane (de préférence 10-90%, en particulier 40-60%) sont dans une première direction, et une partie des bandes dans la membrane (de préférence 90-10%, en particulier 60-40%) sont dans une seconde direction qui est à un angle d'au moins 30°, de préférence perpendiculaire, avec la première direction. 10 15 20
3. Haut-parleur selon la revendication 2, dans lequel la couche de bandes tissées comprend 10-90 % en poids de bandes de polyéthylène ultra haute masse moléculaire, les bandes présentant un paramètre d'orientation uniplanaire d'au moins 3 et 10-90 % en poids de bandes en polymères qui ne sont pas du polyéthylène ultra haute masse moléculaire avec un paramètre d'orientation uniplanaire d'au moins 3, dans lequel les bandes en polymères qui ne sont pas du polyéthylène ultra haute masse moléculaire avec un paramètre d'orientation uniplanaire d'au moins 3 sont de préférence des bandes en polyoléfine, en particulier des bandes de polyéthylène, polypropylène, ou des combinaisons de ceux-ci. 25 30 35
4. Haut-parleur selon la revendication 2, dans lequel la couche de bandes tissées comprend plus de 90 % en poids de bandes de polyéthylène ultra haute masse moléculaire les bandes présentant un paramètre d'orientation uniplanaire d'au moins 3, en particulier au moins 95 % en poids, plus particulièrement au moins 98 % en poids, encore plus particulièrement 100 % en poids. 40 45
5. Haut-parleur selon l'une quelconque des revendications précédentes 2 à 4, dans lequel la membrane comprend 1 à 20 couches de bandes tissées, en particulier 2-10 couches de bandes tissées. 50
6. Haut-parleur selon l'une quelconque des revendications précédentes, dans lequel la membrane comprend au moins une couche comprenant des bandes de polyéthylène ultra haute masse moléculaire, lesdites bandes présentant un paramètre d'orientation uniplanaire d'au moins 3, dans lequel les bandes 55
7. Haut-parleur selon la revendication 6, dans lequel la membrane comprend au moins deux couches, en particulier 2 à 20 couches, plus particulièrement 2 à 10 couches, comprenant des bandes de polyéthylène ultra haute masse moléculaire, lesdites bandes présentant un paramètre d'orientation uniplanaire d'au moins 3, dans lequel les bandes sont disposées en parallèle au sein de la couche, dans lequel la direction des bandes de polyéthylène ultra haute masse moléculaire dans une première couche est à un angle d'au moins 30° de la direction des bandes de polyéthylène ultra haute masse moléculaire dans une seconde couche, la direction des bandes dans une première couche étant de préférence perpendiculaire à la direction des bandes dans une seconde couche, dans lequel de préférence la direction des bandes entre des couches adjacentes diffère d'au moins 30°, en particulier 90°. 5
8. Haut-parleur selon la revendication 6 ou 7, dans lequel au moins certaines des couches consistent en une couche unique de bandes parallèles.
9. Haut-parleur selon l'une quelconque des revendications 6 à 8, dans lequel au moins certaines des couches consistent en au moins deux, en particulier deux, sous-couches de bandes parallèles, dans lequel les bandes dans la première sous-couche sont disposées en parallèle des bandes dans la seconde sous-couche, et décalées de celles-ci.
10. Haut-parleur selon la revendication 1, dans lequel la membrane comprend une couche de fibres non tissées comprenant des bandes de polyéthylène ultra haute masse moléculaire, les bandes présentant un paramètre d'orientation uniplanaire d'au moins 3, dans lequel les bandes sont des microbandes avec une longueur de 2-20 mm et une épaisseur de 8-150 microns, et une largeur qui est plus étroite que la longueur, les microbandes étant présentes de préférence dans une quantité de 2-50 % en poids, en particulier 2-20 % en poids.
11. Haut-parleur selon la revendication 10, dans lequel la couche de fibres non tissées comprend de la cellulose, en particulier sous la forme de coupée courte avec une longueur de 2-20 mm et/ou de pulpe, la couche de fibres non tissées étant de préférence obtenue à partir d'un procédé de papier de cellulose déposé par voie humide.
12. Haut-parleur selon l'une quelconque des revendications précédentes dans lequel la membrane comprend en outre un matériau à matrice, qui est de préférence présent dans une quantité de 0,2-20 % en poids, en particulier 2-15 % en poids, la matrice

étant de préférence sélectionnée parmi le groupe consistant en du polyéthylène haute densité et de l'élastomère thermoplastique.

13. Haut-parleur selon l'une quelconque des revendications précédentes, dans lequel les bandes présentent un paramètre d'orientation uniplanaire d'au moins 4, plus particulièrement au moins 5, ou au moins 7, ou au moins 10 ou même au moins 15. 5
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14. Utilisation de bandes de polyéthylène ultra haute masse moléculaire, les bandes présentant un paramètre d'orientation uniplanaire d'au moins 3, en particulier au moins 4, plus particulièrement au moins 5, ou au moins 7, ou au moins 10 ou même au moins 15, dans une membrane d'un haut-parleur comprenant un aimant, une bobine acoustique, et une membrane. 15
15. Procédé de fabrication d'une membrane adaptée pour une utilisation dans un haut-parleur selon l'une quelconque des revendications 1-13, dans lequel une ou plusieurs couches comprenant des bandes de polyéthylène ultra haute masse moléculaire sont formées en plaçant les couches dans un moule adapté pour obtenir une forme de membrane, et en chauffant les couches dans des conditions telles qu'une forme moulée est obtenue, mais à une température qui est inférieure à la température de fusion des bandes UHMWPE. 20
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REFERENCES CITED IN THE DESCRIPTION

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