Claims

1. Flexible composite body having, on a porous substrate and in the interstices of the substrate that includes fibres of an electrically nonconductive material, a porous layer (1) composed of oxide particles bonded to one another and partly to the substrate that include at least one oxide selected from oxides of the elements Al, Zr and Si, preferably selected from Al_2O_3, ZrO_2 and SiO_2, and having, at least on one side, a further porous layer (2) including oxide particles bonded to one another and partly to the porous layer (1) that include at least one oxide selected from oxides of the elements Al, Zr and Si, preferably selected from Al_2O_3, ZrO_2 and SiO_2,
where the oxide particles present in the porous layer (1) have a greater median particle size than the oxide particles present in the further porous layer (2), and where the median particle size (d50) of the oxide particles in the porous layer (1), determined as specified in the description, is from 0.5 to 4 µm and the median particle size (d50) of the oxide particles in the further porous layer (2), determined as specified in the description, is from 0.015 to 0.15 µm, preferably 0.04 to 0.06 µm,
wherein a polymer coating (PB) containing one or more polysiloxanes is present atop or above the further porous layer (2) and wherein the substrate is a nonwoven fabric, wherein “flexible” means that the composite body can be wound without damage around a bar or around a tube having a diameter of down to 15 mm and wherein
the composite body, on the surface of the further porous layer (2), has a surface roughness Sdq, determined as specified in the description, of less than 10 µm, more preferably of less than 8 µm,
wherein
the composite body has a toluene flow rate at 130°C and transmembrane pressure 30 bar (30 $*10^5$ Pa), determined as specified in the description, of greater than 130 L/m²h, preferably greater than 250 L/m²h, more preferably greater than 300 L/m²h and most preferably greater than 400 L/m²h.

2. Composite body according to Claim 1,
wherein
the composite body has a thickness of 100 to 400 µm, preferably 125 to 200 µm and more preferably of 130 to 170 µm.

3. Composite body according to at least one of Claims 1 to 2,
wherein
the fibres have a dimension of 1 to 200 g/km of fibre and are preferably composed of polyacrylonitrile, polyamide, polyester and/or polyolefin.

4. Composite body according to at least one of Claims 1 to 3,
wherein
the substrate has a thickness of 50 to 150 µm, preferably 100 to 130 µm, and a basis weight of 40 to 150 g/m^2, preferably 50 to 120 g/m^2, preferably 50 to 100 g/m^2 and most preferably 60 g/m^2.

5. Composite body according to at least one of Claims 1 to 4,
wherein
the composite body has an average pore size of 60 to 140, preferably 75 to 130 nm, wherein the average pore size is determined by means of gas flow porometry as described in the description.

6. Process of producing a flexible composite body according to at least one of Claims 1 to 5,
wherein the process has the following steps:

(a) applying a first coating composition (BM1) to and into a substrate having fibres and interstices between the fibres, where the coating composition is produced by combining

(a1) a first dispersion (D1) of oxide particles produced by mixing oxide particles selected from the oxides of the elements Al, Zr and/or Si and having a median particle diameter (d50) of 0.5 to 4 µm with water, an inorganic acid, preferably nitric acid, and a dispersing aid,

(a2) a second dispersion (D2) of oxide particles produced by mixing oxide particles selected from the oxides of the elements Al, Zr and/or Si and having a median particle diameter (d50) of 15 to 150 nm, preferably 40 to 60 nm, with water,

(a3) a first binder formulation (BF1), produced by mixing at least two organofunctional silanes with an alkanol, preferably ethanol, an inorganic acid, preferably boric acid, and water,

(b) consolidating the first coating composition (BM1) at a temperature of 100°C to 275°C, preferably 120 to 240°C, in order to create a first layer (S1‘),

(c) optionally applying a second coating composition (BM2) to at least the first layer (S1‘), where the second coating composition (BM2) is produced by combining

(c1) a third dispersion (D3) of oxide particles produced by mixing oxide particles selected from the oxides of the elements Al, Zr and/or Si and having a median particle diameter (d50) of 0.5 to 4 µm with water, an inorganic acid, preferably nitric acid, and a dispersing aid,

(c2) a fourth dispersion (D4) of oxide particles produced by mixing oxide particles selected from the oxides of the elements Al, Zr and/or Si and having a median particle diameter (d50) of 15 to 150 nm, preferably 40 to 60 nm, with water,

(c3) a second binder formulation (BF2), produced by mixing at least two organofunctional silanes with an alkanol, preferably ethanol, an inorganic acid, preferably boric acid, and water,

(d) optionally consolidating the second coating composition (BM2) at a temperature of 100°C to 275°C, preferably 120 to 240°C, in order to create a second layer (S2‘),

(e) applying a third coating composition (BM3) to the first layer (S1‘) or, if present, the second layer (S2‘), where the third coating composition (BM3) has been produced by combining water and an inorganic acid with an

(e1) a fifth aqueous dispersion (D5) including oxide particles selected from the oxides of the elements Al, Zr and/or Si and having a median particle diameter (d50) of 15 to 150 nm, preferably 40 to 60 nm, and with ethanol and with a

(e2) a third binder formulation (BF3) comprising at least two organofunctional silanes,

(f) consolidating the coating composition at a temperature of 100°C to 275°C, preferably 120 to 240°C, in order to create a third layer (S3‘),

(g) optionally applying a fourth coating composition (BM4) to the third layer (S3‘), where the fourth coating composition (BM4) has been produced by combining water and an inorganic acid with an

(g1) a sixth aqueous dispersion (D6) including oxide particles selected from the oxides of the elements Al, Zr and/or Si and having a median particle diameter of 15 to 150 nm, preferably 40 to 60 nm, and with ethanol and with a

(g2) a fourth binder formulation (BF4) comprising at least two organofunctional silanes,

(h) optionally consolidating the coating composition at a temperature of 100°C to 275°C, preferably 120 to 240°C, in order to create a fourth layer (S4‘), and

(i) applying a polymer coating containing polysiloxanes to the third layer (S3’) or, if present, to the fourth layer (S4’),

wherein

the organofunctional silanes used are 3-glycidyloxytriethoxysilane, methyltriethoxysilane and tetraethoxysilane, and

wherein the substrate used is a polymer nonwoven including fibres selected from polyacrylonitrile, polyester, polyamide and/or polyolefin, wherein “flexible” means that the composite body can be wound without damage around a bar or around a tube having a diameter of down to 15 mm.

7. Process according to Claim 6,

wherein

3-glycidyloxytriethoxysilane, methyltriethoxysilane and tetraethoxysilane are used in the first binder formulation (BF1) and the second binder formulation (BF2) in a mass ratio of 2 to 4:0.5 to 1.5:1, more preferably of 2.5 to 3.5:0.75 to 1.25:1, most preferably 3:1:1.

8. Process according to at least one of Claims 6 or 7,

wherein

3-glycidyloxytriethoxysilane, methyltriethoxysilane and tetraethoxysilane are used in the third binder formulation (BF3) and the fourth binder formulation (BF4) in a mass ratio of 0.5 to 1.5:1.5 to 2.5:1, more preferably of 0.75 to 1.25:1.75 to 2.25:1, most preferably 1:2:1.

9. Process according to at least one of Claims 6 to 8,
wherein
the third coating composition (BM3) and the fourth coating composition (BM4) are of identical composition.

10. Process according to at least one of Claims 6 to 9,
wherein
the first coating composition (BM1) and the second coating composition (BM2) are of identical composition.

11. Process according to at least one of Claims 6 to 10,
wherein
the consolidating is effected by passage through a hot air oven, an IR oven or another oven.

12. Use of a flexible composite body according to at least one of Claims 1 to 5 in organophilic nanofiltration, preferably as organophilic nanofiltration membrane, more preferably for separation of organic compounds from organic solvent-containing streams of matter.

13. Use according to Claim 12, wherein the separation is performed at temperatures of greater than 100°C, preferably greater than 120°C and more preferably greater than 150°C.

14. Separation apparatus comprising a flexible composite body according to at least one of Claims 1 to 5.