

Claims

1. A corrosion-resistant permanent magnet comprising

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- a magnet body, and
- a composite coating provided on and covering surfaces of the magnet body, the composite coating comprising a first layer structure on the magnet body, and optionally a second layer structure on the first layer structure, each layer structure comprising, in the order recited,

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- an inorganic layer,
- a linker layer on the inorganic layer,
- an organic layer formed from poly(2-chloro-p-xylylene) on the linker layer,

wherein

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- the inorganic layer of the first layer structure either comprises an aluminum layer on the magnet body, or comprises an aluminum layer on the magnet body and an aluminum oxide layer on the aluminum layer, and
- the inorganic layer of the second layer structure comprises at least one of an aluminum layer or an aluminum oxide layer, and

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- the composite coating has at least one aluminum oxide layer having a thickness of at least 50 nm.

2. The magnet of claim 1, wherein a linker layer is provided between the first layer structure and the second layer structure.

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3. The magnet of claim 1 or 2, wherein the inorganic layer of the second layer structure is an aluminum oxide layer.

4. The magnet of any one of claims 1 to 3, wherein the magnet body is a sintered magnet body.

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5. The magnet of any one of claims 1 to 4, wherein the magnet body is a rare-earth metal iron boron permanent magnet.

6. The magnet of any one of claims 1 to 5, wherein the magnet body is rod-shaped with all edges being rounded.
7. The magnet of any one of claims 1 to 6, wherein the linker forming at least one of the linker layers is selected from silanes, and silanes having a thiol, phosphine or disulfide group.
8. The magnet of claim 7, wherein the linker is selected from 3-(2-pyridylethyl)thiopropyl trimethoxysilane, 3-(4-pyridylethyl)thiopropyl trimethoxysilane, and 2-(diphenylphosphino)ethyl triethoxysilane.
9. The magnet of any one of claims 1 to 8, wherein the thickness of the aluminum layer of the first layer structure and/or the second layer structure is from 0.5 μm to 15 μm , or from 1 μm to 10 μm , or from 1 μm to 5 μm .
10. The magnet of any one of claims 1 to 9, wherein the thickness of the aluminum oxide layer of the first layer structure and/or the second layer structure is from 50 nm to 200 nm, or from 80 nm to 120 nm.
11. The magnet of any one of claims 1 to 10, wherein the combined thickness of the aluminum layer and the aluminum oxide layer of the first layer structure and/or the second layer structure is in a range from 5 μm to 15 μm .
12. The magnet of any one of claims 1 to 11, wherein at least one of the linker layers is a monolayer, or wherein the linker layer has a thickness in a range from 20 nm to 50 nm.
13. The magnet of any one of claims 1 to 12, wherein the thickness of the layer formed from poly(2-chloro-p-xylylene) of the first layer structure and/or the second layer structure is in a range from 5 μm to 20 μm .
14. The magnet of any one of claims 1 to 13, wherein the thickness of the composite coating is no more than 200 μm , preferably no more than 50 μm .
15. The magnet of any one of claims 1 to 14, wherein all layers of the composite

coating completely extend over all surfaces of the magnet body.

16. A method for producing a corrosion-resistant permanent magnet, the method comprising

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- providing a non-magnetized magnet body,
- forming a first layer structure on the magnet body by depositing an inorganic layer on surfaces of the magnet body, depositing a linker layer on the inorganic layer, and depositing a layer of poly(2-chloro-p-xylylene) on the linker layer, and optionally
- forming a second layer structure on the first layer structure by depositing an inorganic layer on the first layer structure, depositing a linker layer on the inorganic layer, and depositing a layer of poly(2-chloro-p-xylylene) on the linker layer, and
- magnetizing the magnet body,

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wherein

- depositing of the inorganic layer of the first layer structure either comprises depositing an aluminum layer on the magnet body, or comprises depositing an aluminum layer on the magnet body and an aluminum oxide layer on the aluminum layer,
- depositing of the inorganic layer of the second layer structure comprises depositing an aluminum layer on the first layer structure, or comprises depositing an aluminum oxide layer on the first layer structure, or comprises depositing an aluminum layer on the first layer structure and an aluminum oxide layer on the aluminum layer,
- at least one aluminum layer is deposited by a physical vapor deposition process, and
- at least one aluminum oxide layer is deposited by an atomic layer deposition process to a thickness of at least 50 nm.

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17. The method of claim 16, wherein a linker layer is deposited on the first layer structure.

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18. The method of claim 16 or 17, wherein an aluminum oxide layer is deposited

as the inorganic layer of the second layer structure.

19. The method of any one of claims 16 to 18, wherein the magnet body is a magnet body as defined in any one of claims 4 to 6.

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20. The method of any one of claims 16 to 19, wherein the aluminum oxide layer of the first layer structure and/or the second layer structure is formed from AlX_3 as a first precursor compound and H_2O as a second precursor compound, with X representing lower alkyl groups, which may be the same or different, or
10 representing a hydrogen atom and lower alkyl groups, which may be the same or different, or representing halogen atoms, which may be the same or different.

21. The method of claim 20, wherein AlX_3 is selected from the group consisting of trimethyl aluminum (TMA), triethyl aluminum (TEA), triisobutyl aluminum (TIBA),
15 dimethyl aluminum (DMAIH) and $AlCl_3$.

22. The method of any one of claims 16 to 21, wherein at least one of the linker layers is formed by applying a linker by physical vapor deposition using plasma, or by physical vapor deposition without using plasma, or from a solution.

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23. The method of any one of claims 16 to 22, wherein the linker of at least one of the linker layers is a linker as defined in claim 7 or 8.

24. The method of any one of claims 16 to 23, wherein the layer of poly(2-chloro-
25 p-xylylene) of the first layer structure and/or the second layer structure is formed by plasma deposition of dichloro[2.2]paracyclophane.

25. The method of any one of claims 16 to 24, wherein the layers of the first layer structure and/or the second layer structure have thicknesses as defined in any one
30 of claims 9 to 14.

26. An intravascular blood pump comprising an electric motor, wherein the electric motor comprises a permanent magnet as claimed in any one of claims 1 to 15.