A seal arrangement and a method for manufacturing a sealing body for a seal arrangement for a turbine engine is disclosed. The seal arrangement seals a gap between a rotor and a stator, and has at least one first seal body preferably assigned to the stator and at least one blade-shaped second seal body preferably assigned to the rotor which co-acts with the or each first seal body. The or each first seal body has a main body and a porous wear component, where the main body and the wear component have a graduated material composition.
SEAL ARRANGEMENT AND METHOD FOR MANUFACTURING A SEALING BODY FOR A SEAL ARRANGEMENT


BACKGROUND AND SUMMARY OF THE INVENTION

[0002] The invention relates to a seal arrangement and a method for manufacturing a sealing body for a seal arrangement. The invention further relates to a turbine engine and a gas turbine.

[0003] Gas turbines consist of several subassemblies, for example, of at least a compressor, a combustion chamber and at least one turbine. The or each compressor as well as the or each turbine has a rotor which rotates relative to a stationary stator. In the case of the stator, it is specifically a stationary housing to which stationary guide vanes are assigned. Rotor blades are assigned to the rotor which rotate together with the rotor relative to the stationary guide vanes and the stationary housing.

[0004] To optimize the efficiency and thus to increase the power of gas turbines, it is important to optimize all components and subsystems. This includes the seal arrangements to minimize leakage flow between the rotating rotor and the stationary stator. In particular, a gap between radially inner ends of the fixed guide vanes and the rotating blade must be sealed. A seal arrangement to seal the gap between the radially inner ends of the stationary guide vanes and the rotating rotor is designated as an inner air seal. A further gap to be sealed is located, for example, between the radially outer end of the rotating blade and the stationary housing. A seal arrangement for sealing the gap between the radially outer ends of the rotating blade and the housing is designated as an outer air seal.

[0005] It is already known from the prior art to configure seal arrangements for providing an inner air seal or an outer air seal as well as labyrinth seals, where such labyrinth seals are formed by a first, porous sealing body and a blade-shaped second sealing body co-acting with the first sealing body. The first porous sealing body can, for example, be configured as a honeycomb sealing body. It is also already known to configure the first sealing body as a porous layer of material. The blade-shaped second sealing body which co-acts with the first sealing body is also designated as a seal fin. The seal fins are preferably assigned to the rotor or rotating blade in the area of an outer shroud of the blades. The porous sealing body is, on the other hand, preferably assigned to the housing or the stationary guide vanes in the area of an inner shroud of the guide vanes.

[0006] Labyrinth seal systems known from the prior art are not suitable for high temperatures that are consistently above 500°C, since they are exposed to great wear at high operating temperatures, for example from oxidation. Furthermore, they are subject to vibrational load or deformation load. Labyrinth seals known from the prior art consequently have a limited operating life at temperatures of more than 500°C. However, due to the increasing improvements in gas turbines, higher operating temperatures are found more frequently within the turbines so that the labyrinth seals known from the prior art must be improved.

[0007] With this as the starting point, the problem underlying the present invention is to create a novel seal arrangement and a method of manufacturing a sealing body for a seal arrangement.

[0008] In accordance with the invention the or each first sealing body has a main body and a porous wear component wherein the main body and the wear component have a graduated material composition.

[0009] In the sense of the present invention, a seal arrangement is provided in which the porous sealing body consists of a main body and a porous wear component, wherein the main body and the porous wear component have a graduated material composition. The preference is for the main body and the porous wear component to be graduated in their surface area with respect to aluminum and/or chromium. As a result, the oxidation resistance of the wear component and the main body is clearly improved so that the seal arrangements can be used at temperatures of more than 600°C. Furthermore, the rigidity of the part is increased and at the same time the ductility of the porous wear component is preserved.

[0010] In accordance with an advantageous enhancement of the invention, the main body and the wear component have an aluminum content of 15% to 35% by weight in the area of their surfaces or edge zones.

[0011] The method comprises at least the following steps: a) preparation of a main body; b) preparation of a porous wear component; c) bonding the main body and the wear component; d) colorizing and/or chronizing the main body and wear component which have been bonded.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Preferred enhancements of the invention derive from the following description. An embodiment of the invention is explained more exactly using the drawings, without being restricted thereto.

[0013] FIG. 1 shows a schematized section from a seal arrangement in accordance with the invention;

[0014] FIG. 2 shows a detail of the seal arrangement from FIG. 1;

[0015] FIG. 3 shows an alternative detail of the seal arrangement from FIG. 1; and

[0016] FIG. 4 shows a schematized section from a further seal arrangement in accordance with the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0017] In what follows, the present invention is described in greater detail with reference to FIGS. 1 to 4.

[0018] FIG. 1 shows a seal arrangement 10 in accordance with a first embodiment of the invention to seal a gap 11 between a rotor 12 and a stator 13 of a gas turbine, in particular a low-pressure turbine of an aero engine. The seal arrangement shown in FIG. 1 may be, for example, an outer air seal, wherein the stator 13 is formed by a housing and the rotor 12 by rotating rotor blades, that is to say an outer shroud for the rotor blades.

[0019] The seal arrangement of FIG. 1 is formed by a first sealing body 14 assigned to the stator 13 and a second sealing body 15 co-acting with the first sealing body 14. FIG. 2 shows the first sealing body 14 in a separate view.
[0020] The first sealing body 14 is formed by a carrier or main body 16 and a porous wear component 17. The main body 16 and the wear component 17 are solidly bonded, by high-temperature soldering for example. In the embodiment from FIGS. 1 and 2, the porous wear component 17 is configured as a honeycomb sealing body. FIG. 3 shows an alternative configuration of the first sealing body 14, in which the porous wear component 17 is composed of a porous material layer, specifically a powder metal sintered body.

[0021] In the sense of the present invention, the main body 16 and the porous wear component 17 are both formed from a ferrous alloy or a nickel based alloy which have a graduated material composition in the area of their surfaces, or edge zones, with respect to aluminum and/or chromium. The aluminum content and/or chromium content in the area of the surface, or edge zone, of main body 16 and wear component 17 lies in a range between 15 and 35% by weight. As a result, an intermetallic alloy compound is created in the area of the surfaces or edge zones which exhibits optimized oxidation resistance for applications at temperatures above 600°C.

[0022] FIG. 4 shows a further seal arrangement according to the invention 18 which is essentially the same as the embodiment from FIG. 1. So identical reference numerals are used for identical assemblies. The seal arrangement 18 from FIG. 4 differs from the seal arrangement 10 in accordance with FIG. 1 only in that the wear component 17 has a stepped configuration and co-acts with two second blade-shaped sealing bodies 15 which have different radial extensions. With respect to the remaining details, reference can be made to the above explanations.

[0023] To manufacture the first sealing body 14 for the seal arrangements shown in the drawings, the process begins with the preparation of a main body 16 and a porous wear component 17 for the seal arrangements, wherein the main body and the wear element are made from a ferrous based alloy or a nickel based alloy. In the case of the wear component 17, it can be a honeycomb sealing body or a sealing body of a layer of porous material, specifically a powder metal sintered body.

[0024] Following this, the wear component 17 and the main body 16 are solidly bonded together. Bonding the main body 16 to the wear component 17 is preferably performed by means of high-temperature soldering, in which the soldering temperature is higher than approximately 80% of the melting temperature of the base material of the wear component 17 and the main body 16 to be bonded. If, for example, a wear component 17 of Hastelloy is used in a honeycomb structure, the soldering temperature can be 1180°C. Alternatively, the bonding of wear component 17 and main body 16 can also be carried out by diffusion bonding.

[0025] After bonding the main body 16 to the porous wear component 17, the bonded components are calorized and/or chromized. The calorizing and/or chromizing is preferably performed with the aid of a Chemical Vapor Deposition (CVD) process, in which an alloy gradient with respect to aluminum and/or chromium results on the surface or in the edge zone of main body 16 and porous wear component 17 through calorizing and/or chromizing. Calorizing is preferably carried out at 1050°C over a 4 hour period.

[0026] During the calorizing and/or chromizing, a coating thickness of 40 µm to 100 µm, preferably 80 µm is created on the carrier or main body 16; on the porous wear component on the other hand, a coating thickness of 20 µm to 60 µm, preferably of 40 µm is created. An aluminum content and/or chromium content of 15% to 35% by weight, preferably of 30% by weight, is thereby created on the surface or on the edge zone of wear component 17 and main body 16. Furthermore, the oxidation resistance of the sealing body 14 is thereby improved and the rigidity of the wear component 17 is increased without negatively influencing its ductility.

[0027] The seal arrangement in accordance with the invention is preferably used in turbine engines, gas turbines or aero engines. It is especially suitable for use in a low-pressure compressor of an aero engine.

1-15. (canceled)

16. A seal arrangement for a turbine engine to seal a gap between a rotor and a stator, having a first sealing body assigned to the stator and having a blade-shaped second sealing body assigned to the rotor co-acting with the first sealing body, wherein the first sealing body has a main body and a porous wear component and wherein the main body and the wear component have a graduated material composition.

17. The seal arrangement according to claim 16, wherein the main body and the wear element consist of a ferrous based alloy or a nickel based alloy which have an alloy gradient in a region of their surfaces or edge zones with respect to aluminum (Al) and/or chromium (Cr).

18. The seal arrangement according to claim 16, wherein the sealing body and the wear component have an aluminum content of 15% to 35% by weight in a surface area or an edge zone.

19. The seal arrangement according to claim 16, wherein the main body and the wear component have a chromium content of 15% to 35% by weight in a surface area or an edge zone.

20. The seal arrangement according to claim 16, wherein the wear component is configured as a honeycomb sealing body.

21. The seal arrangement according to claim 16, wherein the wear component is configured as a porous material layer.

22. The seal arrangement according to claim 21, wherein the wear component is configured as a powder metal sintered body.

23. The seal arrangement according to claim 16, wherein the blade-shaped second sealing body is configured as a seal from a solid metal material.

24. A turbine engine having at least one seal arrangement according to claim 16.

25. A gas turbine engine having at least one seal arrangement according to claim 16.

26. A method for manufacturing a sealing body for a seal arrangement, wherein the sealing body has a main body and a porous wear component, comprising the steps of:

- preparation of the main body;
- preparation of the porous wear component;
- bonding the main body and the porous wear component; and
- calorizing and/or chromizing of the bonded main body and porous wear component.

27. The method according to claim 26, wherein the main body and the porous wear component are prepared from a ferrous based alloy or a nickel based alloy.

28. The method according to claim 26, wherein the main body and the porous wear component are bonded by soldering.
29. The method according to claim 28, wherein the main body and the porous wear component are bonded by high-temperature soldering under vacuum.

30. The method according to claim 26, wherein the main body and the porous wear component are bonded by diffusion bonding.

31. The method according to claim 26, wherein the calorizing and/or chromizing is carried out through a CVD process.

32. The method according to claim 26, wherein a layer of 40 µm to 100 µm is created on the main body and a layer of 20 µm to 60 µm is created on the porous wear component in the calorizing and/or chromizing step.

33. A seal arrangement for a turbine engine, comprising: a first sealing body; and a blade-shaped second sealing body engageable with the first sealing body;

wherein the first sealing body includes a main body and a porous wear component and wherein the main body and the porous wear component have a graduated material composition in a surface area that includes a ferrous alloy or a nickel based alloy, and aluminum and/or chromium in a range of 15-35% by weight.

34. The seal arrangement according to claim 33, wherein the main body has a graduated material composition coating thickness of between 40 µm-100 µm on the surface area and the porous wear component has a graduated material composition coating thickness of between 20 µm-60 µm on the surface area.

35. A method for manufacturing a sealing body for a seal arrangement, comprising the steps of:

bonding a main body of the sealing body to a porous wear component of the sealing body; and

calorizing and/or chromizing of the bonded main body and the porous wear component such that a graduated material composition results in a surface area of the bonded main body and the porous wear component that includes a ferrous alloy or a nickel based alloy, and aluminum and/or chromium in a range of 15-35% by weight.

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