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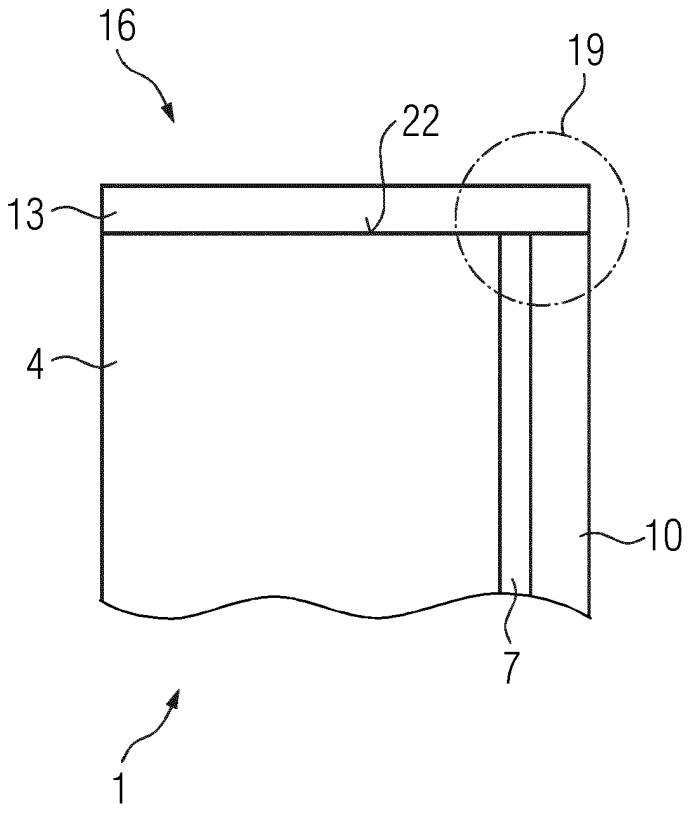
(54) **POWDER, CERAMIC WEAR-PROTECTIVE COATING FOR A SEAL, BLADE AND METHOD**

(57) With a new composition comprising Zirconia and Alumina a good tip seal (16) of a turbine blade (1) is reached.



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Description

[0001] The invention relates to a ceramic coating which is used against corrosion especially of the tip seal of a turbine blade.

[0002] The first stages blades of a gas turbine are exposed to an extreme high temperature and a continuous degradation of their tip seal, which rub against stator components like ring segments or platforms of turbine vanes during rotation. These stationary components are normally coated with Thermal Barrier Coatings (TBC's). The degradation of the turbine-blade tip-seal occurs due to its poor mechanical properties against those of the TBC ceramic coating at high-temperatures. This induces an increase of the gap between the rotor with a blade tip seal and stator components, e.g. a ring segment or vane platform, and by this diminishing the efficiency of the gas turbine.

[0003] The use of a soft abradable ceramic coating deposited on the TBC surface of the stator components has proof to be a technology that diminishes the efficiency lost due to the gap opening. However, the tip seal of first stage turbine blades is still unprotected against wear-oxidation damage of its metallic material.

[0004] It is therefore aim of the invention to improve a seal in hot corrosion areas.

[0005] The problem is solved by a powder according to claim 1, a coating according to claim 2, a turbine blade according to claim 6, a seal system according to claim 10 and a method according to claim 11.

[0006] Up to now the use of an abrasive coating composed by cBN particles embedded in a metal matrix is under investigation. This coating system is expected to be thermal unstable during long-term operation of a turbine due to the high temperature at the blade tip seal. The standard concept is to use a soft abradable ceramic coating at the surface of the stator and a MCrAlY coated blade tip seal, which is not wear resistant at the given high-temperature conditions.

[0007] The figure shows a schematic view of the invention.

[0008] The figure shows a turbine blade 1 with a tip coating 13 on his tip 22.

[0009] A substrate 4 of the blade 1 is metallic and comprises especially a nickel or cobalt based superalloy.

[0010] The airfoil (where the reference 4 is also showing to) of the blade 1 is coated with a metallic bond coat 7, which is especially NiCoCrAl based e.g. NiCoCrAlY, NiCoCrAlYTa, NiCoCrAlYRe,... and a ceramic coating 10 (TBC), especially an Yttria stabilized Zirconia and preferably not containing Alumina Al_2O_3 inside the coatings 7, 10; despite the Alumina which is formed during use (or after coating the TBC) by the NiCoCrAl base alloy as oxidation protection, mostly as an interlayer.

[0011] The proposal is to use a tip coating 13 to protect it additionally against high-temperature wear, wherein especially a NiCoCrAl base is bonded or coated on the tip 22 directly.

[0012] A NiCoCrAl based coating on the tip 22 below the tip coating 13 has preferably the same composition as on the airfoil of the blade 1.

[0013] This is considered to be a part of a seal technology using abradable coatings on stator components.

[0014] The ceramic material of the powder, this tip coating 13 or seal system 16 is composed by a Zirconia toughened ceramic composed by:

- 30wt.% - 70wt.% ZrO_2 or
- 30wt.% - 70wt.% Y_2O_3 - ZrO_2, or a combination thereof and
- 70wt.% - 30wt.% Al_2O_3, e.g. a mixture of stabilized and non-stabilized Zirconia can be used for the mixture in a total amount of 30wt.%-70wt.%.

[0015] Preferably Zirconia (ZrO_2) with amount of 40wt.% to 60wt.% and Alumina (Al_2O_3) with a content 60wt.% to 40wt.% is used.

[0016] The ceramic material can be deposited using laser powder cladding or spray coating processes like High-Velocity Oxygen Fuel (HVOF), plasma spraying, especially Air Plasma Spray (APS) .

[0017] The thickness of the tip coating 13 of the seal 16 lies between 20μm to 200μm.

[0018] The interface 19 between tip coating 13 of the tip 22 and airfoil coatings 7, 10 can be adapted, e.g. tip coating 13 can overlap coating 7, 10 (see Figure) of the airfoil or vice versa or there is no overlap or contact.

Claims

1. Powder,
   comprising
   especially consisting of
   Zirconia (ZrO_2)
   with amount of 30wt.% to 70wt.%,
   especially with amount of 40wt.% to 60wt.%,
   and
   Alumina (Al_2O_3)
   with a content of 70wt.% to 30wt.%,
   especially with amount of 60wt.% to 40wt.%.

2. Coating,
   comprising
   especially consisting of
   a composition of
   30 wt. % to 70 wt. % Zirconia (ZrO_2),
   especially with amount of 40wt.% to 60wt.%,
   and
   70 wt.% to 30 wt.% Alumina (Al_2O_3),
   especially with amount of 60wt.% to 40wt.%.

3. Powder or coating according to one or both of the claims 1 or 2,
   which comprises at least stabilized Zirconia (ZrO_2),

especially a partially stabilized Zirconia (ZrO_2),
very especially only stabilized Zirconia (ZrO_2).

4. Powder or coating according to any of the claims 1, 2 or 3,
wherein the Zirconia (ZrO_2) is stabilized with Yttria (Y_2O_3),
especially with 6, 0wt.% to 8,0wt.% Yttria (Y_2O_3) .

5. Powder or coating according to any of the claims 1, 2, 3 or 4,
wherein the Zirconia (ZrO_2) is a mixture of stabilized and non-stabilized Zirconia (ZrO_2).

6. Turbine blade (1),
having a tip coating (13) according to any of the claims 2, 3, 4 or 5 on the tip (22) of the blade (1),
especially only on the tip (22) of the blade (1).

7. Turbine blade according to claim 6,
wherein the substrate (4) of the blade (1) is a nickel- or cobalt-based superalloy.

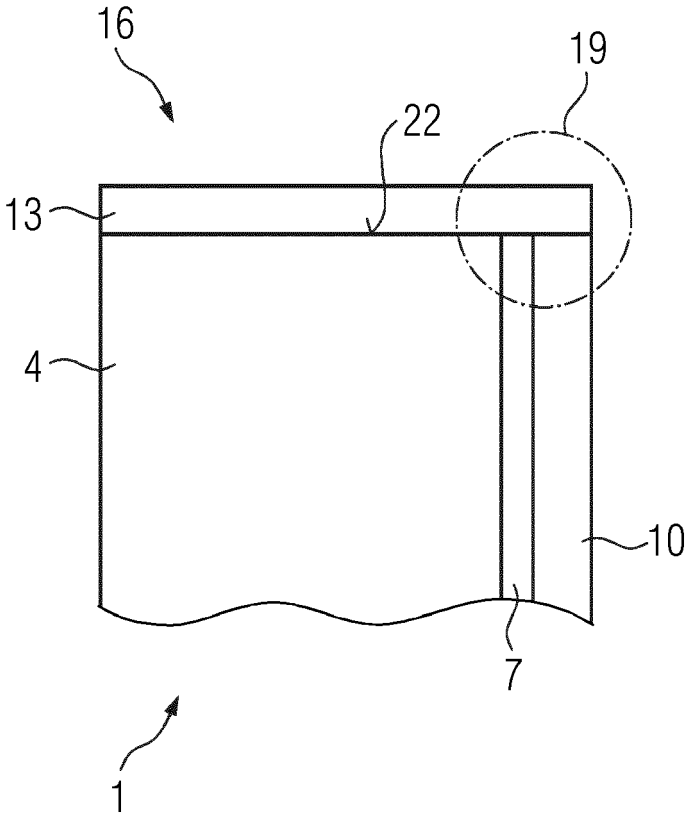
8. Turbine blade according to one or both of the claims 6 or 7,
wherein the turbine airfoil or other regions than the tip (22) of the blade (1) have protective coatings,
especially a metallic bond (7),
very especially NiCoCrAl based coating and
a ceramic coating (10),
which is much different from the tip coating (13) of the tip (22),
especially comprises no Alumina (Al_2O_3) inside the coatings (7, 10).

9. Turbine blade according to one or any of the claims 6, 7 or 8,
wherein on tip (22) of the blade (1) a metallic bond (7), very especially a NiCoCrAl based coating,
is present under the tip coating (13).

10. Seal system (16) of a turbine,
comprising a turbine blade (1) according to any of the claims 6, 7, 8 or 9.

11. Method
to produce
a tip coating (13) according to claim 2
or
a turbine blade (1) according to claim 6, 7, 8 or 9
or
a seal system (16) according to claim 10,
wherein a ceramic powder according to any of the claims 1 to 5
is deposited by laser powder cladding
or
spray coating,
especially HVOF
or APS,
on a tip (22) of the turbine blade (1).

12. Method according to claim 11,
wherein the tip coating (13) of the tip (22) has a coating thickness between 20μm to 200μm.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EUROPEAN SEARCH REPORT

Application Number
EP 20 20 7058

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	US 5 059 095 A (KUSHNER BURTON A [US] ET AL) 22 October 1991 (1991-10-22) * columns 1, 4-6; claims 1-29; examples 1-6 *	1-12	INV. C23C4/11 C23C4/129 C23C4/134 C23C26/00 C23C26/02 C23C28/00 C23C4/02
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TECHNICAL FIELDS SEARCHED (IPC)

C23C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18 January 2021	Chalaftris, Georgios

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82