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(54) **Title:** METHOD FOR MANUFACTURING AN ABRASIVE COATING ON A GAS TURBINE COMPONENT

(57) **Abstract:** The invention relates to a method for manufacturing an abrasive coating on a gas turbine component, especially on a gas turbine rotor blade tip, comprising at least the following steps: a) providing a gas turbine component, especially a gas turbine rotor blade; b) providing a high temperature melting alloy powder; c) providing abrasive particles; d) providing a low temperature melting alloy powder; e) blending at least said high temperature melting alloy powder and said abrasive particles to provide a mixture; f) applying said low temperature melting alloy powder and said mixture to an area of said gas turbine component, especially to a tip of said turbine rotor blade; g) locally heating said area of said gas turbine component to a temperature above the melting point of said low temperature melting alloy powder but below the melting point of said high temperature melting alloy powder.

Method for manufacturing an abrasive coating on a gas turbine component

The invention relates to a method for manufacturing an abrasive coating on a gas turbine component, especially on a gas turbine rotor blade tip.

Background of the Invention

During operation of a gas turbine, the gas turbine rotor blades of e.g. the turbine hot section of the gas turbine are exposed to elevated temperature gases and high rotational velocities. While gas turbine rotor blade tips may be coated as part of the manufacturing process, the tips may be "ground in the rotor" to ensure all the gas turbine rotor blades are the correct height and contoured properly. However during the grinding action, the protective coating is removed and environmentally sensitive base alloy of the gas turbine rotor blades is revealed. With thousands of subsequent hours of operation, the tips of the gas turbine rotor blades will oxidize, causing the gas turbine rotor blades to shorten, and allow for hot gases to escape past the tips instead of being captured by the airfoil for work. The result is a less efficient gas turbine.

The performance of gas turbines can be improved my minimizing clearances between the tips of the gas turbine rotor blades and a stationary shroud or a stationary casing of the gas turbine. In order to maintain the requisite tight tolerances at the gas turbine rotor blade tips, an abrasive coating is applied to the rotor blade tips to preferentially cut into the shroud or the casing of the gas turbine. Cold tolerances between the shroud or casing and the rotor blade tip are designed such that as the rotor blade heats and expands, it contacts the shroud or the casing. During this contact, the rotor blades remove material from the shroud or the casing ensuring the clearance is minimal.

The abrasive coatings comprise abarasive particles embedded in a metal matrix. The present invention relates to a method for manufacturing an abrasive coating on a gas turbine component, especially on a gas turbine rotor blade tip.

Prior Art

Several process to manufacture an abrasive coating on a gas turbine component, especially on a gas turbine rotor blade tip, are known from the prior art.

US 5,359,770 discloses a method for bonding abrasive blade tips to the tip of a rotor bade. This prior art discloses that abrasive blade tips may be applied as a separate step during manufacture, where an abrasive blade tip is brazed to the rotor blade tip at a maximum temperature of 1190°C, the blade tip having been manufactured with a cobalt-based boron containing alloy, and a boron containing braze. The rotor blade is heated uniformly to the processing temperature. For that, high temperatures may not be employed, since the consolidation temperature must be maintained below the temperature at which the base metal properties will be altered. Due to the concentrations of melting point depressants, namely boron, as well as the processing temperature a re-melting temperature of approximately 1200°C may be expected.

US 6,355,086 discloses a method on how to use direct laser processing to apply an abrasive blade tip to a gas turbine rotor blade post manufacture without having to subject the blade to potentially harmful temperature excursions. Due to the melting and re-solidification of the pre-alloyed powder, the material will show coring or a segregated microstructure.

According to US 6,194,086 low pressure plasma spraying and according to US 6,706,319 cold spraying have also been used in the past as a means to apply a metal matrix ceramic composite to tips of gas turbine rotor blades.

Summary of the Invention

The present invention provides a new method for manufacturing an abrasive coating on a gas turbine component, especially on a gas turbine rotor blade tip, comprising at least the following steps: a) providing a gas turbine component, especially a gas turbine rotor blade; b) providing a high temperature melting alloy powder; c) providing abrasive particles; d) providing a low temperature melting alloy powder; e) blending at least said high temperature melting alloy powder and said abrasive particles to provide a mixture; f) applying said low temperature melting alloy powder and said mixture to an area of said gas turbine component, especially to a tip of said turbine rotor blade; g) locally heating said area of said gas turbine component to a temperature above the melting point of said low temperature melting alloy powder but below the melting point of said high temperature melting alloy powder.

The present invention provides a method for manufacturing an abrasive coating in which proporties of areas or regions remote to the coated area, epsecially to the tip, are unaffected in the process.

The present invention provides a method for manufacturing an abrasive coating in which a high re-melt teperature in the coating in achieved.

Brief Description of the Drawings

The present invention will be described in conjuction with the accompanying drawings.

Figure 1 is a schematic cross sectional view of a gas turbine rotor blade tip whereby material for manufacturing an abrasive coating is applied to the gas turbine rotor blade tip.
Figure 2 is a schematic cross sectional view of the gas turbine rotor blade tip whereby the blade tip and the material applied to the blade tip is heated.
Figure 3 is a schematic cross sectional view of the gas turbine rotor blade tip and the manufactured abrasive coating.

Detailed Description of the Drawings

The present invention relates to a new method for manufacturing an abrasive coating on a gas turbine component. The present invention will be decribed in connection with the coating of a tip of a gas turbine rotor blade. However, also other gas turbine components like stator balde tips can be coated according to the present invention.

In a first step of the method according to the present invention a gas turbine rotor blade having a tip 10 is provided.

In a second step of the method according to the present invention a high temperature melting alloy powder 11, and abrasive particles 12, and a low temperature melting alloy powder 13 are provided.

As high temperature melting alloy powder 11 a nickel based superalloy powder, or a cobalt based superalloy powder, or a a MCrAlY powder is preferably provided.

As abrasive particles 12 cubic boron nitride particles, or silicon nitride particles, or silicon aluminium oxynitide particles, or aluminium oxide particles are preferably provided.

As low temperature melting alloy powder 13 a nickel based brazing alloy powder having a melting point below the melting point of said high temperature melting alloy powder 11 and below the melting point on the constituents of the turbine rotor blade tip 10 is preferably provided.

In a third step of the method according to the present invention said high temperature melting alloy powder 11 and said abrasive particles 12 are blended to provide a mixture.

In a fourth step of the method according to the present invention said low temperature melting alloy powder 13 and said mixture are applied to the tip 10 of said turbine rotor blade. As shown in Fig. 1, the low temperature melting alloy powder 13 is applied as a separate layer 14 to the tip 10 of said turbine rotor blade, namely above a layer 15 of said mixture of said high temperature melting alloy powder 11 and said abrasive particles 12. The layer 15 is applied adjacent to the rotor blade tip 10. The layer 14 forms an outer layer.

In a fifth step of the method according to the present invention the tip 10 of said rotor blade is locally heated together with the two layers 14, 15 applied to the tip 10 to a temperature above the melting point of said low temperature melting alloy powder 13 but below the melting point of said high temperature melting alloy powder 11 and below the melting point of the constituents of the rotor blade tip 10, while maintainig the areas or regions remote from the tip 10 at a lower temperature whereby the properties of the blade alloy are unaffected. Preferably, induction heating as a localized heating source is used.

Fig. 2 shows that due to the heating the low temperature melting alloy powder 13 of the layer 14 melts forming a liquid layer 14'. The liquid layer 14' of the melted low temperature melting alloy powder 13 infiltrates according to Fig. 3 the layer 15 comprising the high temperature melting alloy powder 11 and the abrasive particles 12. As a result an abrasive coating 16 is provided on the gas turbine rotor blade tip 10 by bonding the abrasive particles 12 and the high temperature melting alloy powder 11 to the rotor blade tip 10. Preferably, the entire method is carried out in a vacuum environment or an inert environment.

In another embodiement of the present invention, it is also possible that within the fourth step of the method said low temperature melting alloy powder is blended together with said high temperature melting alloy powder and said abrasive particles to provide a mixture, whereby the low temperature melting alloy powder, the high temperature melting alloy powder and the abrasive particles are applied in a single layer to the tip of said turbine rotor blade.

Claims

1. Method for manufacturing an abrasive coating on gas turbine component, especially on a gas turbine rotor blade tip, comprising at least the following steps:
   a) providing a gas turbine component, especially a gas turbine rotor blade;
   b) providing a high temperature melting alloy powder;
   c) providing abrasive particles;
   d) providing a low temperature melting alloy powder;
   e) blending at least said high temperature melting alloy powder and said abrasive particles to provide a mixture;
   f) applying said low temperature melting alloy powder and said mixture to an area of said gas turbine component, especially to a tip of said turbine rotor blade;
   g) locally heating said area of said gas turbine component to a temperature above the melting point of said low temperature melting alloy powder but below the melting point of said high temperature melting alloy powder.

2. Method according to claim 1,
   characterized in that
   said high temperature melting alloy powder is a nickel based superalloy powder.

3. Method according to claim 1,
   characterized in that
   said high temperature melting alloy powder is a cobalt based superalloy powder.

4. Method according to claim 1,
   characterized in that
   said high temperture melting alloy powder is a MCrAlY powder.

5. Method according to one of the previous claims,
   characterized in that
   said abrasive particles are cubic boron nitride particles.

6. Method according to one of the previous claims,
   characterized in that
   said abrasive particles are silicon nitride particles.

7. Method according to one of the previous claims, characterized in that said abrasive particles are silicon aluminium oxynitide particles.

8. Method according to one of the previous claims, characterized in that said low temperature melting alloy powder is nickel based brazing allow powder having a melting point below the melting point of said high temperature melting alloy powder and below the melting point of the constituents of the area of said gas turbine component.

9. Method according to one of the previous claims, characterized in that the locally heating is accomplished by induction heating.

10. Method according to one of the previous claims, characterized in that said low temperature melting alloy powder is applied in a separate layer to the area of said gas turbine component, namely above a layer of said mixture of said high temperature melting alloy powder and said abrasive particles.

11. Method according to one of the previous claims, characterized in that within step e) said low temperature melting alloy powder is blended together with said high temperature melting alloy powder and said abrasive particles to provide a mixture, and that the low temperature melting alloy powder, the high temperature melting alloy powder and the abrasive particles are applied in a single layer to the area of said gas turbine component.

12. Method according to one of the previous claims, characterized in that the method is carried out in a vacuum or inert environment.

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. C23C24/00 C23C24/08 C23C30/00 F01D5/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C23C F01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/183529 A1 (OHARA MINORU [JP] ET AL) 2 October 2003 (2003-10-02) paragraphs [0001], [0011], [0013], [0014], [0023], [0027], [0028], [0035], [0051], [0052]	1-12
X	& GB 2 108 534 A (GEN MOTORS CORP) 18 May 1983 (1983-05-18) page 1, lines 6-76 page 2, lines 7-106 page 3, lines 28-42 -----	1-12
A	US 4 610 698 A (EATON HARRY E [US] ET AL) 9 September 1986 (1986-09-09) column 3, lines 6-38 column 5, line 31 - column 6, line 16 column 7, lines 24-38 ----- -/--	1-12

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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