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(54) **Platinum aluminide coating for cobalt-based superalloys**

(57) A method for enhancing oxidation resistance and hot gas corrosion of a Co-based component for use in a gas turbine engine hot section. The Co-based component is aluminided to form a CoAl layer on the surface

thereof. A Pt layer is then applied on top of the CoAl layer. The Pt layer is diffused into the CoAl layer to form a PtAl imparting oxidation resistance and hot gas corrosion resistance to the component.

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Description

[0001] This invention relates to a PtAl coating and a method for enhancing resistance to oxidation and hot gas corrosion of cobalt-based superalloy gas turbine hot section components such as nozzle airfoils.

[0002] Platinum aluminide coatings have been applied to Ni-based and Co-based gas turbine hot section components by a multi-step process to improve resistance to oxidation and hot gas corrosion. The first step involves application of platinum to the component surface. The Pt is typically applied by electroplating, but other processes such as sputtering may be used. A separate step to diffuse the Pt into the substrate is usually performed prior to aluminiding, although this step is often omitted when coating Ni-based alloys. Aluminiding is then accomplished by pack cementation, above pack, vapor phase, or chemical vapor deposition processing. All of these processes have been used with Ni-based substrates. Pack cementation has typically been used with Co-based substrates in view of the relatively slow rate at which Co-based alloys accept coating and the need to have a high Al activity during the process to promote coating growth.

[0003] Platinum aluminide coatings applied to Co-based gas turbine hot section components suffer from Kirkendall void formation in the coating diffusion zone as Pt diffuses into the Co-based substrate after all of the foregoing process steps are completed. Such voiding occurs regardless of whether a discrete diffusion operation is practiced between Pt plating and aluminiding. Kirkendall voiding occurs when one species in a diffusion couple diffuses faster than a second species in the couple. In the case of Pt applied to a Co substrate, their respective diffusion rates are appreciably different such that the net mass flow rate at the atomic level is not equal. In this situation Pt diffuses faster than Co, the result of which is Kirkendall voiding in the diffusion zone.

[0004] In order to prevent void formation in the Pt/Co diffusion couple surface modification treatments have been attempted prior to Pt application in an effort to dilute the impact of the different diffusion rates for Pt and Co. In particular, there have been surface pretreatments with Rh, Cr and/or Ni to modify the chemistry at the interface between the substrate and the coating.

[0005] A PtAl coating is applied to a Co-based component for use in a gas turbine engine hot section by first aluminiding the Co-based component to form a CoAl layer on the surface thereof, then applying a Pt layer on top of the CoAl layer, and finally diffusing Pt from said Pt layer into the CoAl layer to form a PtAl layer imparting oxidation resistance and hot gas corrosion resistance to the Co-based component.

[0006] In accordance with this invention, an environmentally resistant PtAl coating is applied to Co-based hot section components of gas turbine engines without the problems associated with prior efforts to apply such coatings to Co-based alloys. In a typical embodiment of

the invention a Co-based component such as a nozzle airfoil is provided which is made from an alloy having a chemistry such as one of the following:

Alloy A		Alloy B
C	0.6% by weight	0.1% by weight
Cr	22	22
Ni	10	22
Ti	0.2	--
W	7	14
Ta	3.5	--
Zr	0.5	--
La	--	0.05
Mn	--	1.25
Co Balance		Balance
Plus incidental impurities		

[0007] The component is aluminided to form a CoAl layer on the surface thereof. This aluminiding is carried out by a pack powder process, or suitable vapor aluminiding process. The aluminided layer is on the order of between about 0.0005 inch (0.0013 cm) to about 0.006 inch (0.015 cm) thick. In one preferred embodiment the aluminided layer has a thickness between about 0.002 inch (0.005 cm) and about 0.004 inch (0.01 cm).

[0008] A Pt layer is then applied on top of the CoAl layer by plating or other appropriate method. The Pt layer is deposited to have a thickness of at least about 0.0001 inch (0.00025 cm) thick, preferably between about 0.0001 inch (0.00025 cm) and about 0.0005 inch (0.0013 cm), more preferably between about 0.0002 inch (0.0005 cm) and about 0.0004 inch (0.001 cm). The Pt is then diffused into the CoAl layer by a thermal diffusion technique. After diffusion, the outer surface is a PtAl coating.

[0009] The foregoing process yields a PtAl coating which provides environmental resistance for Co-based components in hot section environments without suffering from void formation problems. It can also be appreciated that prior attempts to apply void-free PtAl coatings to Co-based substrates have involved the four sequential steps of Ni, Rh or Cr pretreatment, Pt plating, Pt diffusion, and aluminiding. The process of this invention, in contrast, involves just the three sequential steps of aluminiding, Pt plating, and Pt diffusion. Substantial engineering and economic advantages are realized, therefore, by the process simplification of this invention.

[0010] As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

Claims

1. A method for enhancing oxidation resistance and hot gas corrosion resistance of a surface of a Co-based component for use in a gas turbine engine hot section, the method comprising the sequential steps of:
 - a) aluminiding the Co-based component to form a CoAl layer on the surface of the Co-based component;
 - b) applying a Pt layer on top of the CoAl layer; and
 - c) diffusing Pt from said Pt layer into the CoAl layer to form a PtAl layer imparting oxidation resistance and hot gas corrosion resistance to the Co-based component.
2. The method of claim 1 wherein said applying said Pt layer comprises electroplating said Pt layer to a thickness of between about 0.0001 inch (0.00025 cm) and about 0.0005 inch (0.0013 cm).
3. The method of claim 1 wherein said aluminiding the Co-based component comprises the formation of a CoAl layer having a thickness between about 0.002 inch (0.005 cm) and about 0.004 inch (0.01 cm).
4. The method of claim 3 wherein said aluminiding is carried out by pack cementation.
5. A method for enhancing oxidation resistance and hot gas corrosion of a surface of a Co-based component for use in a gas turbine engine hot section, the method comprising the sequential steps of:
 - a) aluminiding the Co-based component to form a CoAl layer having a thickness between about 0.002 inch (0.005 cm) and about 0.004 inch (0.010 cm) on the surface of the Co-based component;
 - b) applying a Pt layer having a thickness between about 0.0002 inch (0.0005 cm) and about 0.0004 inch (0.001 cm) on top of the CoAl layer; and
 - c) diffusing Pt from said Pt layer into the CoAl layer to form a PtAl layer imparting oxidation resistance and hot gas corrosion resistance to the Co-based component.



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EUROPEAN SEARCH REPORT

Application Number
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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	PATENT ABSTRACTS OF JAPAN vol. 004, no. 129 (C-024), 10 September 1980 (1980-09-10) & JP 55 082760 A (HITACHI LTD), 21 June 1980 (1980-06-21) * abstract *	1, 4	C23C10/58
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			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27 February 2001	Examiner Elsen, D
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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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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