A cobalt-based superalloy is provided that allows for the production of components that are easy to cast, easy to weld and can be used also at very elevated temperatures.
GAMMA/GAMMA’ HARDENED COBALT-BASED SUPERALLOY, POWDER AND COMPONENT

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to PCT Application No. PCT/EP2014/076352, having a filing date of Dec. 3, 2014, based off of German application No. DE 102013224989.6 having a filing date of Dec. 5, 2013, the entire contents of which are hereby incorporated by reference.

FIELD OF TECHNOLOGY

[0002] The following relates to a γ/γ’ hardening cobalt-based superalloy for high temperature applications, to a powder and to a component.

BACKGROUND

[0003] Using metallic materials in the presence of oxygen at temperatures above 1073 K and under mechanical stress requires the use of what are termed superalloys. These are nickel-based materials which owe their strength to a combination of three solidification mechanisms: mixed crystal solidification, carbide hardening and precipitation of intermetallic phases. Furthermore, use is made of cobalt-based alloys which have only two solidification mechanisms (mixed crystal and carbide hardening). Precipitation hardening by means of intermetallic phases could hitherto not be achieved for the technical application.

[0004] The homologous temperature plays an important role in the high-temperature application of alloys. Diffusion processes, which have a marked influence on the high-temperature resistance, must be taken into account upwards of half of the melting point. Nickel-based superalloys are currently used at temperatures of up to 80% of the melting point (melting point of pure nickel: 1718 K), for which reason it is difficult to further increase the service temperatures of the alloys. The service temperatures are however very important since, in the field of gas turbines, they determine the Carnot efficiency. Another important class of high-temperature alloys is that of conventional cobalt-based alloys (melting point of pure cobalt: 1768 K). These are characterized by the fact that they are easy to cast, easy to weld and have good high-temperature resistance, but cannot withstand high stresses due to a lack of precipitation hardening by intermetallic phases. Due to a lack of suitable cobalt-based superalloys, use has been made on one hand of nickel-based superalloys for high temperatures and stresses and on the other hand of conventional cobalt-based alloys for very high temperatures and low stresses. Conventional cobalt-based alloys are easier to cast and to weld than nickel-based superalloys.

SUMMARY

[0005] An aspect relates to presenting a cobalt-based superalloy, a powder and a component which satisfy the above properties.

DETAILED DESCRIPTION

[0006] The cobalt-based superalloy is easy to cast and to weld and has good mechanical properties at high temperatures.

<table>
<thead>
<tr>
<th>Element</th>
<th>Content in at. %</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co</td>
<td>remainder</td>
<td>alloy base element, intermetallic phase</td>
</tr>
<tr>
<td>W</td>
<td>8.5-9.5</td>
<td>Co23Al18W</td>
</tr>
<tr>
<td>Al</td>
<td>8.5-9.5</td>
<td>intermetallic phase Co23Al18W, oxidation protection</td>
</tr>
<tr>
<td>Ni</td>
<td>18-23</td>
<td>broadens alloying window</td>
</tr>
<tr>
<td>Ti</td>
<td>1.5-2.5</td>
<td>γ-former, analogous to nickel-based superalloy</td>
</tr>
<tr>
<td>Ta</td>
<td>1.5-2.5</td>
<td>γ′-former, analogous to nickel-based superalloy</td>
</tr>
<tr>
<td>Hf</td>
<td>0.05-0.15</td>
<td>grain boundary solidification, optional</td>
</tr>
<tr>
<td>Cr</td>
<td>5-7</td>
<td>carbide former and corrosion protection</td>
</tr>
<tr>
<td>B</td>
<td>0.005-0.015</td>
<td>grain boundary solidification, optional</td>
</tr>
<tr>
<td>C</td>
<td>0.05-0.15</td>
<td>carbide former and corrosion protection, optional</td>
</tr>
</tbody>
</table>

[0007] It is preferably proposed that a cobalt-based superalloy be produced with the following target composition (at. %): Co23Al18W-9Al-2Ti-2Ta-6Cr.

[0008] The proposed alloy composition targets a higher service temperature and/or longer service life at the same service temperatures. This is achieved by combining the advantages of the nickel-based superalloys and those of the conventional cobalt-based superalloys so as to arrive at the new class of cobalt-based superalloys. As base element, cobalt offers a melting point that is 50 K higher than that of nickel.

[0009] Also proposed is an alloy composition which has all three of the above-described solidification mechanisms of the nickel-based superalloys and thus surpasses the conventional cobalt-based superalloys in terms of mechanical properties. In so doing, those properties of the cobalt superalloy which are advantageous in relation to nickel-based superalloys (castability, weldability) are retained. Thus, what is proposed is a high-temperature material in a new alloy class which brings together the good properties of both alloy systems.

[0010] Preferably, such cobalt-based superalloys are used for turbine blades or other gas turbine parts or steam turbine parts.

[0011] For a polycrystalline structure, use is preferably made of boron (B) and/or carbon (C).

[0012] For a directionally solidified structure (single-crystal, columnar solidified), use is made of an alloy without boron (B) and/or without carbon (C).

[0013] Preferably, no further elements are required. Preferably, further elements can be used for castability and/or grain boundary strength.

[0014] Although the present invention has been disclosed in the form of preferred embodiments and variations thereon, it will be understood that numerous additional modifications and variations could be made thereto without departing from the scope of the invention.

[0015] For the sake of clarity, it is to be understood that the use of “a” or “an” throughout this application does not exclude a plurality, and “comprising” does not exclude other steps or elements.

1. A cobalt-based superalloy having at least (in at. %): tungsten (W): 8.5-9.5, in particular 9%, aluminum (Al): 8.5-9.5, in particular 9%, nickel (Ni): 18%-23%, in particular 20%-21%, titanium (Ti): 1.5%-2.5%, in particular 2%, tantalum (Ta): 1.5%-2.5%, in particular 2%, chromium (Cr): 5%-7%, in particular 6%, optionally hafnium (Hf): 0.05%-0.15%, in particular 0.1%, boron (B): 0.005%-0.015%, in particular 0.01%, and carbon (C): 0.05%-0.15%, in particular 0.1%.
2. The cobalt-based superalloy as claimed in claim 1, which consists of tungsten (W), aluminum (Al), nickel (Ni), titanium (Ti), tantalum (Ta), chromium (Cr) and optionally hafnium (Hf), boron (B), and/or carbon (C).

3. The cobalt-based superalloy as claimed in claim 1, which consists of tungsten (W), aluminum (Al), nickel (Ni), titanium (Ti), tantalum (Ta), chromium (Cr), hafnium (Hf), boron (B) and carbon (C).

4. The cobalt-based superalloy as claimed in claim 1, which consists of tungsten (W), aluminum (Al), nickel (Ni), titanium (Ti), tantalum (Ta), chromium (Cr), hafnium (Hf) and carbon (C).

5. The cobalt-based superalloy as claimed in claim 1, which consists of tungsten (W), aluminum (Al), nickel (Ni), titanium (Ti), tantalum (Ta), chromium (Cr) and carbon (C).

6. The cobalt-based superalloy as claimed in claim 1, which consists of tungsten (W), aluminum (Al), nickel (Ni), titanium (Ti), tantalum (Ta), chromium (Cr), hafnium (Hf) and boron (B).

7. The cobalt-based superalloy as claimed in claim 1, which consists of tungsten (W), aluminum (Al), nickel (Ni), titanium (Ti), tantalum (Ta), chromium (Cr) and boron (B).

8. The cobalt-based superalloy as claimed in claim 1, which consists of tungsten (W), aluminum (Al), nickel (Ni), titanium (Ti), tantalum (Ta), chromium (Cr) and hafnium (Hf).

9. The cobalt-based superalloy as claimed in claim 1, which consists of tungsten (W), aluminum (Al), nickel (Ni), titanium (Ti), tantalum (Ta), chromium (Cr), boron (B) and carbon (C).

10. A powder having an alloy as claimed in claim 1.

11. A component, having an alloy as claimed in claim 1, made of a powder as claimed in claim 10.

12. The component as claimed in claim 11, having a columnar or single-crystal structure, in particular columnar structures.

13. The component as claimed in claim 11, having a single-crystal structure.

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