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(54) **Nickel-base superalloy**

(57) The invention relates to nickel-base superalloy comprising in wt%, especially consisting of: Co + Fe + Mn 0 - 20, Al 4 - 6, Cr >12 - 20, Ta >7.5 - 15, Ti 0 - <0.45, V 0 - 1, Nb 0 - <0.28, Mo 0 - 2.5, Mo + W + Re + Rh 2 - 8, Ru + Os + Ir + Pt + Pd 0 - 4, Hf 0 - 1.5, C + B + Zr 0 -

0.5, Ca + Mg + Cu 0 - 0.5, Y + La + Sc + Ce + Actinides + Lanthanides 0 - 0.5 Si 0 - 0.5 Ni balance and unavoidable impurities.

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Description

[0001] The invention relates to nickel-base superalloys and to components containing these alloys.

[0002] Nickel-base superalloys are used in applications where a combination of high strength and a strong resistance to chemical attacks at high temperatures is needed. They are employed for the production of components of gas turbines such as blades and vanes. These parts are arranged in the hot section of a turbine and thus have to withstand high temperatures and an aggressive atmosphere.

[0003] Nickel-base superalloys and components of the above mentioned kind are disclosed for example in US 6,818,077, US 6,419,763, US 6,177,046, EP 0 789 087 and EP 0 637 474.

[0004] It is an object of the present invention to provide a nickel-base superalloy, which combines high strength, high oxidation resistance, high corrosion resistance, microstructural stability and a large heat treatment window. It is a further object of the present invention to provide components, which comprise such a superalloy.

[0005] These objects are solved by the superalloy of claim 1 and the components of claims 7, 8, 9 and 10.

[0006] The nickel-base superalloy of the invention comprises in wt%:

Co + Fe + Mn	0 - 20
Al	4 - 6
Cr	>12 - 20
Ta	>7.5 - 15
Ti	0 - <0.45
V	0 - 1
Nb	0 - <0.28
Mo	0 - 2.5
Mo + W + Re + Rh	2 - 8
Ru + Os + Ir + Pt + Pd	0 - 4
Hf	0 - 1.5
C + B + Zr	0 - 0.5
Ca + Mg + Cu	0 - 0.5
Y + La + Sc + Ce +	
Actinides + Lanthanides	0 - 0.5
Si	0 - 0.5
Ni	balance

[0007] Especially the superalloy consists of these elements.

[0008] It contains significant levels of Al, Cr and Ta to provide a combination of high strength, high oxidation resistance, high corrosion resistance.

[0009] Along Ta with other partial strengtheners like Ti, Nb and V can be added to the superalloy, but since they are detrimental to the oxidation resistance, they should at most be added in limited quantities. The amount of Ti should not exceed 0.45 and the amount of V should not exceed 1 wt% respectively.

[0010] The amount of matrix strengthening elements Mo, W, Re and Rh is between 2 and 8 wt%.

[0011] Other elements like Hf, C, B, Zr, Ca, Mg, Cu, Y, La, Sc, Ce, actinides and lanthanides, and Si can be present in the superalloy in order to adapt its properties to special needs such as grain boundary strengtheners, oxide scale fortification, and compatibility with specific coating systems.

[0012] The content of Ti can be in the range (in wt%) of 0-0.40. Preferably it can be 0-0.35, more preferably 0-0.30 and most preferably 0-0.20.

[0013] It was also found that the content of Nb (in wt%) can be in the range of 0-0.25, preferably 0-0.20, more preferably 0-0.15 and most preferably 0-0.10.

[0014] According to another embodiment of the invention the content of C (in wt%) can be in the range of 0-0.15, preferably 0-0.08, more preferably 0.01-0.06 and most preferably 0.02-0.04.

[0015] The superalloy of the invention can also contain B in the range (in wt%) of 0-0.02, preferably 0-0.01, more preferably 0.001-0.008 and most preferably 0.003-0.007.

[0016] According to one aspect of the invention a conventional cast component, directionally solidified component and a single crystal component, which comprise the super alloy are provided.

[0017] According to another aspect of the invention, a conventional cast or a single crystal component consisting of a superalloy, which comprises in wt%:

	Co + Fe + Mn	0 - 20
	Al	4 - 6
5	Cr	>12 - 20
	Ta	>7.5 - 15
	Ti	0 - 1.5
	V	0 - 1
	Ti + Nb + V	0 - 2
10	Mo	0 - 2.5
	Mo + W + Re + Rh	2 - 8
	Ru + Os + Ir + Pt + Pd	0 - 4
	Hf	0 - 1.5
15	C + B + Zr	0 - 0.5
	Ca + Mg + Cu	0 - 0.5
	Y + La + Sc + Ce + Actinides + Lanthanides	0 - 0.5
	Si	0 - 0.5
20	Ni	balance

is provided.

[0018] Especially the superalloy consists of these elements.

[0019] The components of the invention can especially be part of a gas turbine, for example a turbine blade or vane.

[0020] In the following one preferred embodiment of the invention is described. A superalloy was cast which had the composition given in table 1.

Table 1

Element	wt%
Co	4.12
Cr	14.2
Mo	0.96
W	2.51
Al	5.47
Ta	10.1
Hf	0.41
C	0.04
B	0.005

[0021] In order to characterize the properties of the cast superalloy different experiments were conducted.

[0022] Solutioning experiments for 4h at 1220, 1250, 1260, 1270 and 1300°C followed by water quenching were done. At 1220°C residual particles were seen and at 1250, 1260, 1270 and 1300°C full solutioning without incipient melting was observed.

[0023] Further a heat treatment at 1250°C for 8h, 1100°C for 4h and 850°C for 24h was applied. SEM and TEM analysis showed a very regular microstructure with primary particles of ~0.35 µm side length and a significant amount of secondary particles (see figures 1 and 2).

[0024] No trace of TCP phases were found. The particle content was measured to be ~60 vol%.

[0025] Accordingly it was shown that the superalloy possesses a large heat treatment window and a good microstructural stability.

Claims

1. A nickel-base superalloy comprising in wt%, especially consisting of:

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	Co + Fe + Mn	0 - 20
	Al	4 - 6
5	Cr	>12 - 20
	Ta	>7.5 - 15
	Ti	0 - <0.45
	V	0 - 1
	Nb	0 - <0.28
10	Mo	0 - 2.5
	Mo + W + Re + Rh	2 - 8
	Ru + Os + Ir + Pt + Pd	0 - 4
	Hf	0 - 1.5
15	C + B + Zr	0 - 0.5
	Ca + Mg + Cu	0 - 0.5
	Y + La + Sc + Ce + Actinides + Lanthanides	0 - 0.5
	Si	0 - 0.5
	Ni	balance

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and unavoidable impurities.

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2. The nickel-base superalloy as claimed in claim 1, wherein Ti is in the range (in wt%) of 0 - 0.40, preferably 0 - 0.35, more preferably 0 - 0.30 and most preferably 0 - 0.20.

3. The nickel-base superalloy as claimed in any of the preceding claims, wherein Nb is in the range (in wt%) of 0 - 0.25, preferably 0 - 0.20, more preferably 0 - 0.15 and most preferably 0 - 0.10.

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4. The nickel-base superalloy as claimed in any of the preceding claims, wherein C is in the range (in wt%) of 0 - 0.15, preferably 0 - 0.08, more preferably 0.01 - 0.06 and most preferably 0.02 - 0.04.

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5. The nickel-base superalloy as claimed in any of the preceding claims, wherein B is in the range (in wt%) of 0 - 0.02, preferably 0 - 0.01, more preferably 0.001 - 0.008 and most preferably 0.003 - 0.007.

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6. A conventional cast component comprising a superalloy according to any of the claims 1 to 5.

7. A directionally solidified component comprising a superalloy according to any of the claims 1 to 5.

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8. A single crystal component comprising a superalloy according to any of the claims 1 to 5.

9. A conventional cast or a single crystal component consisting of a superalloy which comprises in wt%, especially consisting of:

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Co + Fe + Mn	0 - 20
Al	4 - 6
Cr	>12 - 20
Ta	>7.5 - 15
Ti	0 - 1.5
V	0 - 1
Ti + Nb + V	0 - 2
Mo	0 - 2.5

(continued)

	Mo + W + Re + Rh	2 - 8
	Ru + Os + Ir + Pt + Pd	0 - 4
5	Hf	0 - 1.5
	C + B + Zr	0 - 0.5
	Ca + Mg + Cu	0 - 0.5
	Y + La + Sc + Ce + Actinides + Lanthanides	0 - 0.5
10	Si	0 - 0.5
	Ni	balance

and unavoidable impurities.

- 15 **10.** The component according to any of the claims 6 to 9,
wherein the component is a part of a gas turbine.

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EUROPEAN SEARCH REPORT

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EP 06 02 1724

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Place of search Munich		Date of completion of the search 19 February 2007	Examiner Zimmermann, Frank
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EPO FORM 1503 03/82 (P04/C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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