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(54) **NEW USE OF A NICKEL-BASED ALLOY**

NEUE ANWENDUNG EINER NICKELBASISLEGIERUNG

NOUVELLE UTILISATION D'UN ALLIAGE À BASE DE NICKEL

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EP 3 899 074 B1

Description

[0001] The present disclosure relates to a use of a component manufactured from a nickel-based alloy in a molten salt mixture environment, especially a carbonate salt mixture environment.

Background

[0002] Within the field of reusable energy, concentrated solar power, CSP, has stayed in development compared with, for example, photovoltaic methods. This is mostly due to the difficulties of obtaining good enough energy efficiency and the lack of supply of a good heat storage medium. Research has however shown that a salt melt could function as a good heat storage medium and one of the proposed medias is sodium-potassium nitrate salt mixtures, commonly known as "solar salts". The most severe problem with these solar salts are that they will decompose at temperatures above about 550 °C, which in turn will lead to corrosion of the components used in the equipment. Due to these corrosion issues, other salt mixtures have recently been developed. These salt mixtures are more stable and are based on carbonate salts, usually lithium- sodium - and potassium carbonates (LiNaK; $\text{Li}_2\text{CO}_3\text{-Na}_2\text{CO}_3\text{-K}_2\text{CO}_3$). Even though these salt mixtures are more stable, it has been shown that they are even more corrosive and the studies regarding corrosion performed so far with these salt mixtures have not provided any promising results.

[0003] US2011/067398 A1 discloses containers for holding thermal storage fluids ("solar salts"), i.e. molten salt, made of alloys on the base of iron, chromium, nickel, molybdenum and manganese, typically made of stainless steel or Inconel.

[0004] WO2017/198831 A1 discloses the use of an object in environments having a high nitrogen concentration and a low oxygen partial pressure and high temperature such as sintering furnaces and muffle furnaces. The object comprising a pre-oxidized nickel-based alloy comprising by weight (wt-%) C 0.05-0.2; Si max 1.5; Mn max 0.5; Cr 15-20; Al 4-6; Fe 15-25; Co max 5; N 0.03-0.15; O max 0.5; one or more elements selected from the group consisting of Ta, Zr, Hf, Ti and b 0.25-2.2; one or more elements selected from the group consisting of the rare earth metals (REM) max 0.5; balance Ni and normally occurring impurities.

[0005] The aspect of the present disclosure is therefore to provide a solution to the above-mentioned problems or to at least reduce them.

Summery

[0006] The present disclosure relates to a use of a component manufactured from a dispersion strengthened nickel-based alloy comprising in weight% (wt%):

C	0.05-0.2;
Si	max 1.5;
Mn	max 0.5;
Cr	15-20;
Al	3-6;
Fe	15-25
Co	max 10;
N	0.03-0.15;
O	max 0.5;

one or more elements selected from the group consisting of Ta, Zr, Hf, Ti and Nb 0.25-2.5;
 one or more elements selected from the group consisting of REM
 max 0.5;
 balance Ni and normally occurring impurities in a molten carbonate salt mixture environment.

[0007] The present inventors have surprisingly found that a component manufactured by an aluminium oxide forming nickel-based alloy comprising certain elements in certain ranges will have corrosion properties superior to other materials in a molten carbonate salt mixture environment, even in temperatures up to 750 °C.

Brief description of the drawings

[0008]

Figure 1 shows a cross-section of sample A after exposure. The cross-section shows the surface layer with the bulk material below. Sample A is an alloy according to the present disclosure;

Figure 2 shows a cross-section of sample B after exposure. The cross-section shows the surface layer of the sample with the bulk material below;

Figure 3 shows a cross-section of sample C after exposure. The cross-section shows the surface layer of the sample with the bulk material below;

Figure 4A shows a cross-section of sample D after exposure. The cross-section shows the surface layer of the sample with the bulk material below;

Figure 4B shows a cross-section of sample D after exposure. The cross-section shows the zone with precipitates in the sample under the surface.

Detailed description

[0009] It has surprisingly been found that a component comprising certain nickel-based alloys which are alloyed with aluminium will not corrode in a salt melt mixture comprising carbonate salts. Hence, the present nickel-based alloy as defined hereinabove or hereinafter is an alumina forming nickel-base alloy which has been proven to be able to form and maintain a protective alumina oxide in a molten carbonate salt mixture, for example a LiNaK carbonate salt mixture under pure CO₂ at a temperature of 750°C.

[0010] The nickel-based alloy has the following composition in weight% (wt%):

C	0.05-0.2;
Si	max 1.5;
Mn	max 0.5;
Cr	15-25;
Al	3-6;
Fe	15-25;
Co	max 10;
N	0.03-0.15;
O	0.03-0.15;

one or more elements selected from the group consisting of Ta, Zr, Hf, Ti and Nb 0.25-2.5;

one or more elements selected from the group consisting of the rare-earth metals (REM) max 0.5;

balance Ni and normally occurring impurities.

[0011] As stated above, it is very surprising that a component comprising the present nickel-based alloy is resistant against corrosion in a molten carbonate salt mixture environment because firstly the temperature in these environments is too low for the formation of aluminum oxide and secondly this environment has proven to be very corrosive to other similar alloys as shown in the SERI-report SERIIPR-255-2561 entitled "The Corrosion of Selected Alloys in eutectic Lithium-Sodium-Potassium Carbonate at 900°C".

[0012] It is believed, without being bound to any theory, that the impact of high creep resistance of the nickel-based alloy as defined hereinabove or hereinafter and the surprising formation of a protective aluminium oxide layer are the keys for this corrosion resistance.

[0013] The present disclosure also relates to a method for storing heat, the method comprises

- Providing a salt melt mixture comprising carbonate salts as defined hereinabove or hereinafter;
- Providing a component comprising a dispersion strengthened nickel-based alloy as defined hereinabove or hereinafter.

[0014] The component could for example be used for storing the salt melt mixture.

[0015] Hence, the present disclosure relates to a component containing a dispersion strengthened nickel-based alloy, the dispersion strengthened nickel-based alloy comprising the following in weight% (wt%):

EP 3 899 074 B1

5	C	0.05-0.2;
	Si	max 1.5;
	Mn	max 0.5;
	Cr	15-20;
	Al	3-6;
	Fe	15-25;
10	Co	max 10;
	N	0.03-0.15;
	O	max 0.5;

one or more elements selected from the group consisting of Ta, Zr, Hf, Ti and Nb 0.25-2.5;
 one or more elements selected from the group consisting of REM max 0.5;
 balance Ni and normally occurring impurities.

[0016] Furthermore, the present disclosure relates to a method for corrosion resistance, the method comprising:
 installing a component in a location to be exposed to a molten carbonate salt mixture environment,
 wherein the component contains a dispersion strengthened nickel-based alloy comprising the following in weight% (wt%):

25	C	0.05-0.2;
	Si	max 1.5;
	Mn	max 0.5;
	Cr	15-20;
	Al	3-6;
	Fe	15-25;
	Co	max 10;
30	N	0.03-0.15;
	O	max 0.5;

one or more elements selected from the group consisting of Ta, Zr, Hf, Ti and Nb 0.25-2.5;
 one or more elements selected from the group consisting of REM
 max 0.5;
 balance Ni and normally occurring impurities; and

[0017] The present disclosure also relates to a method for improving corrosion properties of a component, the method comprising:
 exposing the component to a molten carbonate salt mixture environment,
 wherein the component contains a dispersion strengthened nickel-based alloy comprising the following in weight% (wt%):

45	C	0.05-0.2;
	Si	max 1.5;
	Mn	max 0.5;
	Cr	15-20;
	Al	3-6;
	Fe	15-25;
50	Co	max 10;
	N	0.03-0.15;
	O	max 0.5;

one or more elements selected from the group consisting of Ta, Zr, Hf, Ti and Nb 0.25-2.5;
 one or more elements selected from the group consisting of REM max 0.5;
 balance Ni and normally occurring impurities; and

[0018] According to one embodiment, the component which is exposed to the molten carbonate salt mixture environ-

ment will form an outer layer of aluminum oxide on the component.

[0019] According to another embodiment, the component is preoxidizing prior to exposing the component to the molten carbonate salt mixture environment, wherein preoxidizing forms an outer layer of aluminum oxide on the component.

[0020] The elementary composition of the nickel-based alloy is generally as defined hereinabove or hereinafter and the function of each alloying element is further described below. However, the listing of functions and effects of the respective alloying elements is not to be seen as complete, but there may be further functions and effects of said alloying elements. The terms weight% and wt% are used interchangeably. According to one embodiment, the nickel-based alloy consists of all the elements mentioned hereinabove or hereinafter in the ranges mentioned hereinabove or hereinafter.

Carbon (C)

[0021] Carbon in free form will take interstitial locations in the crystal structure and thereby lock the mobility of dislocations at temperatures up to approximately 400-500°C. Carbon will also form carbides with other elements in the present nickel-based alloy such as Ta, Ti, Hf, Zr and Nb. In a microstructure with finely dispersed carbides, these carbides provide obstacles for the dislocation movement and have effect even at higher temperatures. Carbon is an essential element to improve the present nickel-based alloy's creep strength since the dislocation mobility is the mechanism that generates creep elongation. Too high content of C will however lead to that the present nickel-based alloy will become difficult to cold work due to deteriorated ductility at lower temperatures, such as below 300°C. The present nickel-based alloy therefore comprises 0.05-0.2 wt% C.

Silicon (Si)

[0022] Silicon can be present in the present nickel-based alloy in a content up to 1.5 wt%. Silicon will, in too high contents, lead to an increased risk for precipitations of nickel silicides, which have an embrittling effect on this type of alloys. Results from creep testing of similar alloys have shown that the creep life time, i.e. the time to creep fracture, is reduced with Si contents close to 1.5 wt%. The reason for this is however not known. Because of this, the Si content should preferably be maximally 1 wt%. According to one embodiment, the nickel-based alloy as defined hereinabove or hereinafter only comprises impurity content of Si, i.e. up to 0.3 wt%.

Manganese (Mn)

[0023] Manganese is present in the nickel-based alloy as defined hereinabove or hereinafter as an impurity. It is likely that up to 0.5 wt% Mn can be allowed without negatively influencing the properties of the present nickel-based alloy, whereby the alloy comprises maximally 0.5 wt% Mn. According to one embodiment, the nickel-based alloy as defined hereinabove or hereinafter only comprises an impurity content of Mn, i.e. up to 0.2 wt%.

Chromium (Cr)

[0024] Chromium is an element which during a long period of time has been the leading element when it comes to creating a dense and protective oxide scale. Less than 15 wt% Cr in an austenitic structure tends to render an oxide which is not entirely covering the surface and which is not dense and consequently render an insufficient oxidation resistance to the alloy. There is also a risk that the material closest to the oxide is depleted of Cr such that possible damages to the oxide cannot heal since there is not sufficient Cr to form new oxide.

[0025] A nickel-based alloy as the present alloy comprising at least 3 wt% Al, such as at least 4 wt% Al should however not comprise more than about 20 wt% Cr as higher contents increase the risk of formation of γ' and β phases. Therefore, in order to minimise the presence of γ' and β phases, the nickel-based alloy as defined hereinabove or hereinafter comprises max 20 wt% Cr. At too high Cr contents, there may also be a risk of formation of other unwanted phases, such as σ -phase and chromium rich ferrite and furthermore Cr may also, at high contents, stabilise nickel aluminides. Thus, the alloy as defined hereinabove or hereinafter comprises 15-20 wt% Cr, such as 17-20 wt% Cr, such as 17-19 wt% Cr.

Aluminium (Al)

[0026] Aluminium is an element that generates a much denser and more protective oxide scale compared to Cr. Aluminium can however not replace Cr since the formation of the aluminium oxide is slower than the chromium oxide at lower temperatures. The alloy comprises at least 3 wt% Al, such as at least 4 wt% Al, which will ensure a sufficient oxidation resistance at high temperatures and that the oxide covers the surface entirely. The relatively high content of Al provides excellent oxidation resistance even at temperatures of about 1100 °C. At Al contents above 6 wt%, there is

a risk of formation of such an amount of intermetallic phases in a nickel-based matrix that the ductility of the material is considerably deteriorated. The alloy should therefore comprise 3-6 wt% Al, such as 3.5-5.5 wt%, such as 4 - 5.5 wt% Al.

Iron (Fe)

[0027] It has been shown in accordance with the present disclosure that relatively high contents of Fe in an aluminium oxide forming nickel-based alloy can have positive effects. Additions of Fe generate a metallic structure which is energetically unfavourable for the formation of embrittling γ' , which in turn leads to that the risk of the alloy becoming hard and brittle is reducing considerably. Consequently, the workability is improved. Therefore, the present nickel-based alloy comprises at least 15 wt% Fe. High contents of iron may however lead to formation of unwanted phases. Therefore, the present nickel-based alloy shall not comprise more than 25 wt% Fe.

[0028] Moreover, for certain alloys within the ranges as defined hereinabove or hereinafter, a Fe content over approximately 21-22 wt% may increase the risk of formation of a β -phase (NiAl), which in some cases can be embrittling. According to one embodiment, the present alloy may therefore comprise 16-21.5 wt% Fe. According to another embodiment, the present alloy comprises 17-21 wt% Fe.

Nickel (Ni)

[0029] The alloy according to the present disclosure is a nickel-based alloy. Nickel is an element which stabilises the austenitic structure in present alloys and thereby counteracts the formation of some brittle intermetallic phases, such as σ -phase. The austenitic structure of the present alloy is beneficial, for example, when it comes to welding. The austenitic structure has also shown to contribute to a good creep strength for the present alloy at high temperatures. According to one embodiment, the alloy comprises 52-62 wt% Ni, such as 52-60wt% Ni.

Cobalt (Co)

[0030] In some commercial alloys, a part of the content of Ni may be substituted with Co in order to increase the mechanical strength of the alloy, this may also be done for the present nickel-based alloy. Hence, a part of the Ni content of the present alloy may be replaced with an equal amount of Co. This Co addition must however be balanced against the oxidation properties since the presence of NiAl will reduce the activity of Al and thereby deteriorate the ability to form aluminium oxide. The Co content shall, however, not exceed 10 wt%. According to one embodiment, the Co content does not exceed 8 wt%. According to another embodiment, the Co content does not exceed 5 wt%, according to yet another embodiment, the Co content is less than 1 wt%

Nitrogen (N)

[0031] In the same way as C, free N takes interstitial locations in the crystal structure and thereby locks the dislocation mobility at temperatures up to approximately 400-500°C. Nitrogen also forms nitrides and/or carbon nitrides with other elements in the present nickel-based alloy such as Ta, Ti, Hf, Zr and Nb. In a microstructure where these particles are finely dispersed, they will confer obstacles for the dislocation mobility, especially at higher temperatures. Therefore, N is added in order to improve the creep strength of the present nickel base alloy. However, when adding N to aluminium alloyed alloys, the risk is high for formation of secondary aluminium nitrides and the present nickel-based alloy therefore has a very limited N content. The present alloy comprises 0.03-0.15 wt% N, such as 0.05-0.15 wt% N, such as 0.05-0.10 wt% N.

Oxygen (O)

[0032] Oxygen may be present in the present nickel-based alloy either in the form of an impurity, or as an active addition up to 0.5 wt%. Oxygen may contribute to increasing the creep strength of the present alloy by forming small oxide dispersions together with Zr, Hf, Ta and Ti, which, when they are finely distributed in the alloy, improves its creep strength. These oxide dispersions have higher dissolution temperature than corresponding carbides and nitrides, whereby oxygen is a preferred addition for use at high temperatures. Oxygen may also form dispersions with Al, the elements in group 3 of the periodic table, Sc, Y and La as well as the fourteen lanthanides, and in the same manner as with the above identified elements thereby contribute to higher creep strength of the present alloy. According to one embodiment, the alloy comprises 10 - 2000 ppm O, According to another embodiment, 20 - 2000 ppm O. According to another embodiment, the alloy comprises 10-200 ppm, 200-2000 ppm O or 400-1000 ppm O.

Tantalum, Hafnium, Zirconium, Titanium and Niobium (Ta, Hf, Zr, Ti, Nb)

[0033] The elements in the group consisting of Ta, Hf and Zr forms very small and stable particles with carbon and nitrogen. It is these particles which, if they are finely dispersed in the structure, will help to lock dislocation movement and thereby increase the creep strength, i.e. provides the dispersion strengthening. It is also possible to accomplish this effect with addition of Ti. Additions of Ti can, however, sometimes lead to problems, especially during powder metallurgical production of the alloy, since it will form carbides and nitrides already in the melt before atomisation, which in turn may clog the orifice during the atomisation. Niobium also forms stable dispersions with C and or N and can therefore suitably be added to the present nickel-based alloy.

[0034] The alloy comprises one or more elements selected from the group consisting of Ta, Zr, Hf, Ti and Nb in an amount of 0.25-2.2 wt%, such as 0.3-1.5 wt%, such as 0.6-1.5 wt%.

[0035] The alloy may also comprise such an amount of the elements Ta, Zr, Hf, Ti and Nb that essentially all C and N is bound to these elements. This ensures that for example the risk of formation of chromium carbides during high temperature use of the alloy is significantly reduced.

[0036] According to a preferred embodiment, the nickel-based alloy as defined hereinabove or hereinafter comprises 0.1-0.5wt% Hf. According to another embodiment, the present nickel-based alloy comprises 0.05-0.35 wt% Zr. According to yet another embodiment, the present nickel-based alloy comprises 0.05-0.5 wt% Ta. According to yet another embodiment, the present nickel-based alloy comprises 0.05-0.4 wt% Ti. According to yet another embodiment, the present nickel-based alloy comprises 0.1-0.8 wt% Nb.

Rare earth metals (REM)

[0037] Rare earth metals (REM) relates in this context to the elements of group three of the periodic table, Sc, Y, and La as well as the fourteen lanthanides. REM affects the oxidation properties by doping of the formed oxide. Excess alloying of these elements often gives an oxide which tends to spall of the surface and a too low addition of these elements tends to give an oxide with weaker adhesion to the metal surface. The present nickel-based alloy may comprise one or more elements from the group consisting of REM in a content of up to 0.5 wt% in total, such as 0.05-0.25 wt%. According to a one embodiment, yttrium is added to the alloy as defined hereinabove or hereinafter in an amount of 0.05-0.25 wt%.

[0038] The nickel-based alloy as defined hereinabove or hereinafter may also comprise normally occurring impurities as a result of the raw material used or the selected manufacturing process. Examples of impurities but not limiting to are Ca, S and P. Furthermore, other alloying elements, which will not affect the properties of the alloy may optionally be added in amounts up to 1 wt%.

[0039] When the term "max" is used, the skilled person knows that the lower limit of the range is 0 wt% unless another value is specifically stated.

[0040] The nickel-based alloy as defined hereinabove or hereinafter may be manufactured according to conventional methods, e.g. casting followed by hot working and/or cold working and optional additional heat treatment. The nickel-based alloy as defined hereinabove or hereinafter may also be produced as a powder product. The process used for manufacturing a component thereof may then be for example hot isostatic pressure process (HIP).

[0041] According to the present disclosure, a component may be a tube, a strip, a plate or a wire. It should be noted that the component may also have any shape depending on where and how it will be used. The component could also be a coating which in turn protects another material, e.g. the present nickel-based alloy is a coating on a component manufactured from a stainless steel.

[0042] According to one embodiment of the present disclosure, the component comprising the nickel-based alloy may be preoxidized before use.

[0043] The present disclosure is further illustrated by the following non-limiting examples.

Examples

[0044] The present example was performed in order to investigate the impact of molten salt mixtures on chromia and alumina (i.e. chromium oxide respectively aluminium oxide) forming alloys. The samples (A-D) used is shown in Table 1. The investigation was carried out by isothermal and long-term cyclic exposures up to 750 h and in temperatures up to 750 °C.

[0045] The sample materials were cut into coupons, ground to a 1200 grit finish with SiC paper, cleaned, weighed and placed into alumina crucibles, which were filled with salt mixture. The salt mixtures were prepared freshly for each exposure cycle by careful mixing of the components, LiCO₃, NaCO₃ and KCO₃, in equal amounts using a mortar. The prepared crucibles were placed into a heat constant zone of a horizontal tube furnace. After adjusting the atmosphere and purging with CO₂ for at least 8 h, the heating of the crucibles was activated. Once a week the crucibles were checked

and refilled with the salt mixture. After the targeted dwell time, the furnace was cooled down before removing the crucibles.

[0046] After removing the crucibles from the furnace, the exposed samples were washed with warm water (60°C) and were then treated by using ultrasonic treatment.

[0047] The exposed samples were studied by using optical microscopy and Scanning Electron Microscopy, SEM. SEM was used for identifying surface species, oxide scale formation and internal corrosion processes. The cross-section images from the SEM investigation are shown in figures 1-4 for sample A, B, C and D.

[0048] Figure 1 shows that a thin protective oxide layer has been formed on Sample A, which is a sample of the present nickel-based alloy as defined hereinabove or hereinafter. The formed oxide layer was adherent, had good surface coverage and was only a few microns thick after the exposures. Furthermore, SEM investigations showed that the bulk material under the surface layer was not affected by the molten carbonate salt mixture exposure.

[0049] Figure 2 shows a cross-section image for sample B, which is a typical FeCrAl-alloy. The surface oxide formed was not completely protective. The oxide was relatively thick and not dense.

[0050] Figure 3 shows a cross-section image for sample C, which is a high temperature stainless steel. The formed surface oxide was both thick and porous and non-adherent. Furthermore, SEM investigations showed that the bulk material under the surface had been affected in a zone extending more than 100 microns into the sample.

[0051] Figure 4A shows a cross-section image for sample D, which is an example of a nickel base alloy containing silicon. On this sample, a thick porous and non-adherent oxide was formed on the surface. Closer examination of the bulk material by using SEM showed that the bulk was affected in a zone which extended more than 100 microns into the sample. In this zone, it was found that large number of precipices had been formed as shown in figure 4B.

[0052] Thus, as shown by the results and by Figures 1 to 4, sample A, which is the present nickel-based alloy, had superior corrosion resistance in this aggressive molten carbonate salt mixture environment. The surface oxide formed was thin, dense and adherent and protective. Further, the microstructure of the bulk material under the surface had not been affected by the exposure.

[0053] As has been discussed before, this is a very surprising result, especially if referring to IERI-report SERIIPR-255-2561 entitled "The Corrosion of Selected Alloys in eutectic Lithium-Sodium-Potassium Carbonate at 900°C". This report describes the exposure of various alloys in molten carbonate. The samples exposed are an alumina forming alloy, Cabot 214 (see sample F in Table 1), and a chromia forming alloy, Cabot 800H (see sample E in Table 1). The results of the exposures are that the Cabot 214 coupons had swollen to the extent that they could not be removed from the sample holder after 9 days (216 h) of exposure. The Cabot 800H coupons had after 14 days swollen so much that they could not be removed from the sample holder. Hence, the results of this study indicate that alumina forming alloys will not work in molten LiNaK-carbonates in oxygen free atmosphere (e.g. pure CO₂). This is to be compared with the result of the present disclosure which has shown that certain alumina forming nickel-based alloy (i.e. the alloy according to the present disclosure) will have very good corrosion properties in these carbonate salt melt mixtures, up to 750 °C in pure CO₂.

Table 1. Alloy used

	Alloy	Al	Cr	Fe	Ni	Mn	Ti	Co	Other	
Sample A	Present nickel-based alloy				Bal					
Sample B	FeCrAl-alloy	5	21	Bal	--	0.5	--	--	Y 0.1	
Sample C	High temperature stainless steel with UNS34700 (347H)	--	17.5	Bal	10	1.7	--	--	Nb 0.7	
Sample D	A nickel base alloy containing silicon	0.7	22	32	Bal	--	--	--	Si 1.7	
Sample E	Cabot 800H	0.4	21	Bal	32	1.5	0.4	2		
Sample F	Cabot 214	4.5	16	2.5	77					

Claims

1. Use of a component containing a dispersion strengthened nickel-based alloy comprising the following in weight% (wt%):

C	0.05-0.2;
Si	max 1.5;
Mn	max 0.5;

(continued)

Cr	15-20;
Al	3-6;
Fe	15-25
Co	max 10;
N	0.03-0.15;
O	max 0.5;

one or more elements selected from the group consisting of Ta, Zr, Hf, Ti and Nb 0.25-2.5;
one or more elements selected from the group consisting of REM
max 0.5;
balance Ni and normally occurring impurities in a molten carbonate salt mixture environment.

2. The use according to claim 1, wherein the nickel-based alloy comprises 16-21.5 wt% Fe.
3. The use according to any preceding claims, wherein the nickel-based alloy comprises 17-20 wt% Cr.
4. The use according to any preceding claims, wherein the nickel-based alloy comprises max 0.3 wt% Si.
5. The use according to any preceding claims, wherein the nickel-based alloy comprises one or more elements selected from the group consisting of REM in a total content of 0.05-0.25 wt%.
6. The use according to any preceding claims, wherein the nickel-based alloy comprises one or more elements selected from the group consisting of Ta, Zr, Hf, Ti and Nb in a total content of 0.3-1.5 wt%.
7. The use according to any preceding claims, wherein the nickel-based alloy comprises 52-62 wt% Ni.
8. The use according to any preceding claims, wherein the nickel-based alloy is manufactured from conventional metallurgical processes or from powder technology.
9. The use according to any preceding claims, wherein the carbonate salt mixture is a LiNaK or a $\text{Li}_2\text{CO}_3\text{-Na}_2\text{CO}_3\text{-K}_2\text{CO}_3$ salt mixture.
10. The use according to any preceding claims, wherein the atmosphere of the environment consists of pure CO_2 .
11. The use according to any preceding claims, wherein the component is selected from a tube, a strip, a plate, a wire or a coating.
12. The use according to any preceding claims, wherein the component has any shape depending on where and how it will be used.

Patentansprüche

1. Verwendung einer Komponente, die eine dispersionsverfestigte Nickelbasislegierung enthält, die Folgendes in Gewichts-% (Gew.-%) umfasst:

C	0,05-0,2;
Si	max. 1,5;
Mn	max. 0,5;
Cr	15-20;
Al	3-6;
Fe	15-25
Co	max. 10;
N	0,03-0,15;

EP 3 899 074 B1

(fortgesetzt)

O max. 0,5;

- 5 ein oder mehrere Elemente, ausgewählt aus der Gruppe, bestehend aus Ta, Zr, Hf, Ti und Nb 0,25-2,5;
ein oder mehrere Elemente, ausgewählt aus der Gruppe, bestehend aus REM max. 0,5;
Rest Ni und normalerweise vorkommende Verunreinigungen in einer Umgebung mit geschmolzenem Carbo-
natsalzgemisch.
- 10 2. Verwendung nach Anspruch 1, wobei die Nickelbasislegierung 16 - 21,5 Gew.-% Fe umfasst.
3. Verwendung nach einem der vorstehenden Ansprüche, wobei die Nickelbasislegierung 17-20 Gew.-% Cr umfasst.
- 15 4. Verwendung nach einem der vorstehenden Ansprüche, wobei die Nickelbasislegierung max. 0,3 Gew.-% Si umfasst.
5. Verwendung nach einem der vorstehenden Ansprüche, wobei die Nickelbasislegierung ein oder mehrere Elemente umfasst, ausgewählt aus der Gruppe, bestehend aus REM, in einem Gesamtgehalt von 0,05-0,25 Gew.-%.
- 20 6. Verwendung nach einem der vorstehenden Ansprüche, wobei die Nickelbasislegierung ein oder mehrere Elemente umfasst, ausgewählt aus der Gruppe, bestehend aus Ta, Zr, Hf, Ti und Nb, in einem Gesamtgehalt von 0,3-1,5 Gew.-%.
7. Verwendung nach einem der vorstehenden Ansprüche, wobei die Nickelbasislegierung 52-62 Gew.-% Ni umfasst.
- 25 8. Verwendung nach einem der vorstehenden Ansprüche, wobei die Nickelbasislegierung durch herkömmliche metallurgische Prozesse oder durch Pulvertechnologie hergestellt wird.
9. Verwendung nach einem der vorstehenden Ansprüche, wobei das Carbonatsalzgemisch ein LiNaK- oder ein Li_2CO_3 - Na_2CO_3 - K_2CO_3 -Salzgemisch ist.
- 30 10. Verwendung nach einem der vorstehenden Ansprüche, wobei die Atmosphäre der Umgebung aus reinem CO_2 besteht.
11. Verwendung nach einem der vorstehenden Ansprüche, wobei die Komponente aus einem Rohr, einem Streifen, einer Platte, einem Draht oder einer Beschichtung ausgewählt ist.
- 35 12. Verwendung nach einem der vorstehenden Ansprüche, wobei die Komponente eine beliebige Form aufweist, abhängig davon, wo und wie sie verwendet wird.

Revendications

- 45 1. Utilisation d'un composant contenant un alliage à base de nickel renforcé par dispersion comprenant ce qui suit en % en poids (% pds) :

C	0,05-0,2 ;
Si	au maximum 1,5 ;
Mn	au maximum 0,5 ;
Cr	15-20 ;
Al	3-6 ;
Fe	15-25
Co	au maximum 10 ;
N	0,03-0,15 ;
O	au maximum 0,5 ;

un ou plusieurs éléments sélectionnés parmi le groupe consistant en Ta, Zr, Hf, Ti et Nb 0,25-2,5 ;

un ou plusieurs éléments sélectionnés parmi le groupe consistant en des REM d'au maximum 0,5 ;
le reste étant du Ni et des impuretés habituellement présentes dans un environnement de mélange de sel de carbonate fondu.

- 5 **2.** Utilisation selon la revendication 1, dans laquelle l'alliage à base de nickel comprend 16-21,5 % pds-pds de Fe.
- 3.** Utilisation selon une quelconque des revendications précédentes, dans laquelle l'alliage à base de nickel comprend 17-20 % pds-pds de Cr.
- 10 **4.** Utilisation selon une quelconque des revendications précédentes, dans laquelle l'alliage à base de nickel comprend au maximum 0,3 % pds-pds de Si.
- 5.** Utilisation selon une quelconque des revendications précédentes, dans laquelle l'alliage à base de nickel comprend un ou plusieurs éléments sélectionnés parmi le groupe consistant en des REM selon une teneur totale de 0,05-0,25
15 % pds-pds.
- 6.** Utilisation selon une quelconque des revendications précédentes, dans laquelle l'alliage à base de nickel comprend un ou plusieurs éléments sélectionnés parmi le groupe consistant en Ta, Zr, Hf, Ti et Nb selon une teneur totale de 0,3-1,5 % pds.
20
- 7.** Utilisation selon une quelconque des revendications précédentes, dans laquelle l'alliage à base de nickel comprend 52-62 % pds-pds de Ni.
- 8.** Utilisation selon une quelconque des revendications précédentes, dans laquelle l'alliage à base de nickel est fabriqué
25 à partir de processus métallurgiques classiques ou à partir d'une technologie des poudres.
- 9.** Utilisation selon une quelconque des revendications précédentes, dans laquelle le mélange de sel de carbonate est un LiNaK ou un mélange de sels Li_2CO_3 - Na_2CO_3 - K_2CO_3 .
- 30 **10.** Utilisation selon une quelconque des revendications précédentes, dans laquelle l'atmosphère de l'environnement consiste en du CO_2 pur.
- 11.** Utilisation selon une quelconque des revendications précédentes, dans laquelle le composant est sélectionné parmi un tube, une bande, une plaque, un câble ou un revêtement.
35
- 12.** Utilisation selon une quelconque des revendications précédentes, dans laquelle le composant présente une forme quelconque dépendant de l'endroit où et comment il sera utilisé.

Figures

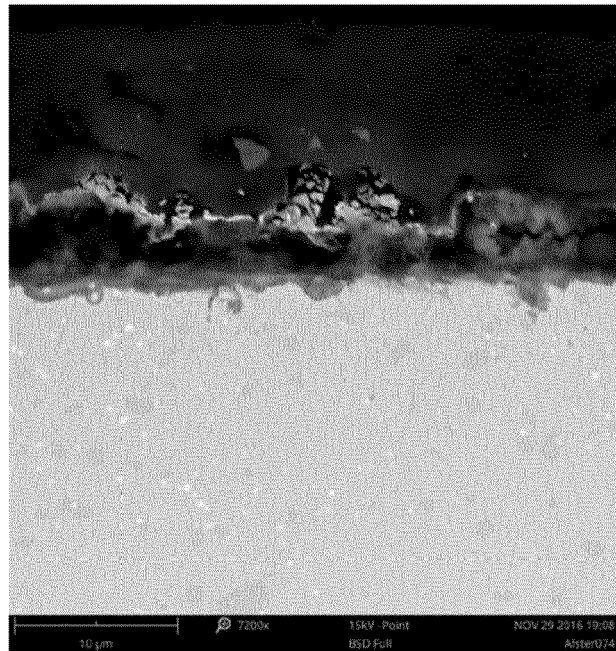


Figure 1

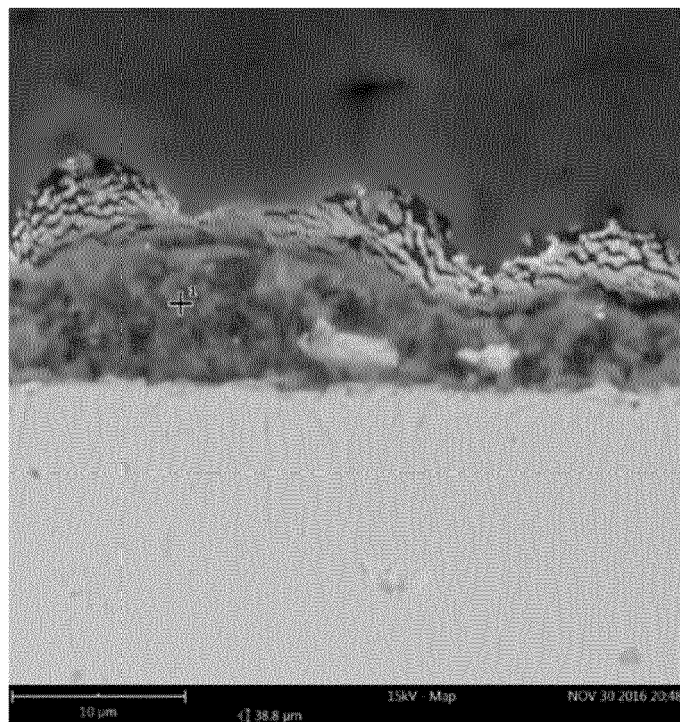


Figure 2

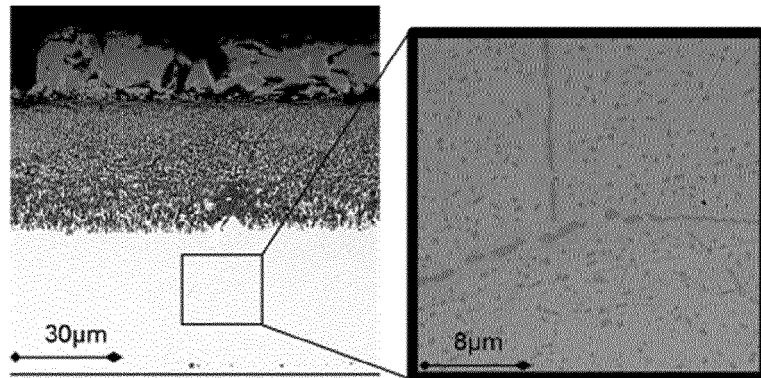


Figure 3

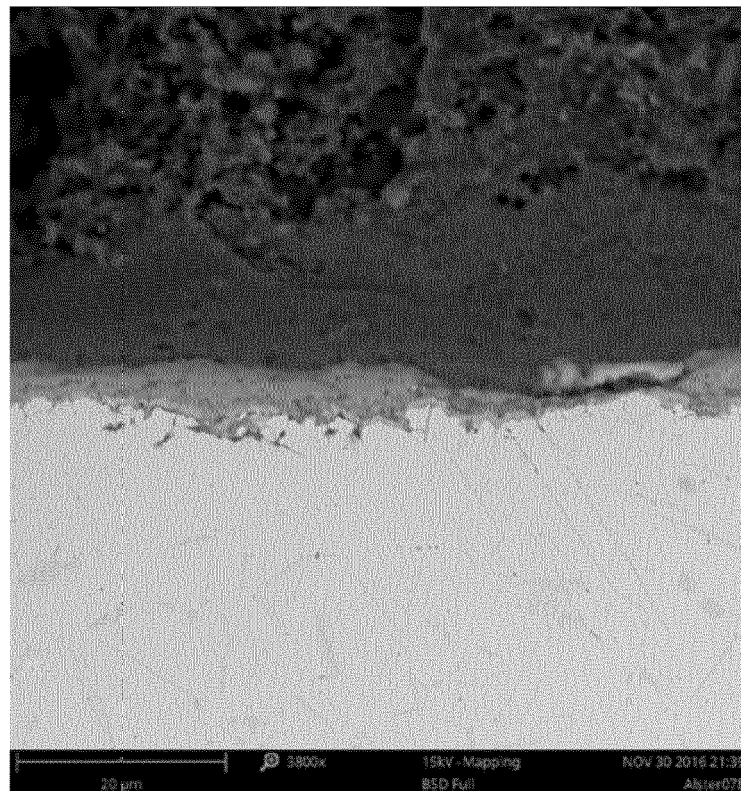


Figure 4A

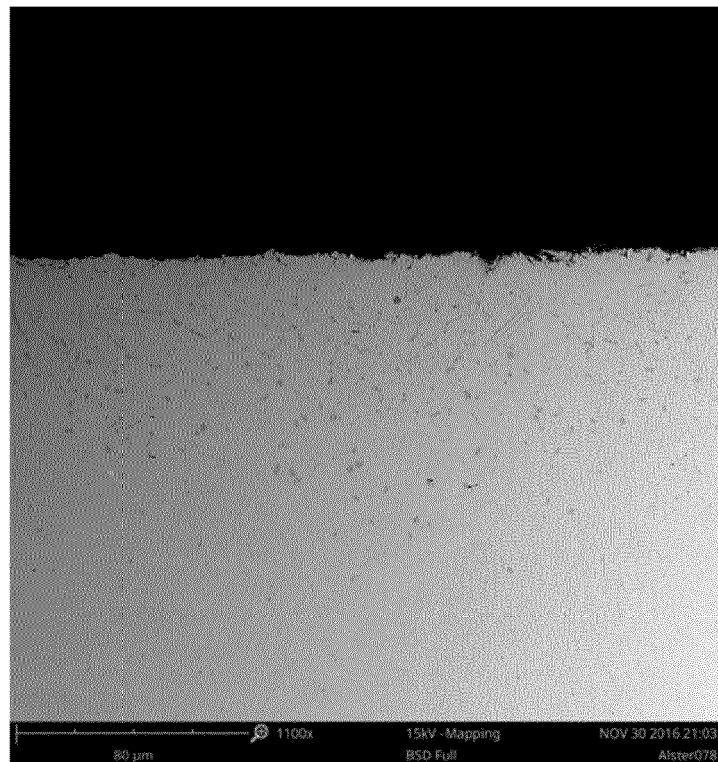


Figure 4B

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- WO 2017198831 A1 [0004]