Claims

1. A blend for brazing of joints in products of base metals and/or for coating of products of base metals, which base metal has a solidus temperature above 1040 °C, which blend comprises boron and silicon, the boron is selected from a boron source, and the silicon is selected from a silicon source, wherein the blend comprises boron and silicon in a ratio boron to silicon within a range from about 3:100 wt/wt to about 100:3 wt/wt, preferably within a range from about 5:100 wt/wt to about 1:1 wt/wt, and wherein the blend also comprises at least one binder selected from the group consisting of solvents, water, oils, gels, lacquers, varnish, binders based on monomers and/or polymers.

2. The blend according to claim 1, wherein the at least one binder is selected from polyesters, polyethylene, polypropylene, acrylic polymers, (met)acrylic polymers, polyvinyl alcohol, polyvinyl acetate, polystyrene.

3. The blend according to claim 1 or 2, wherein the blend particles having particles size less than 250 µm.

4. The blend according to any one of the preceding claims, wherein the boron source is selected from boron, B_4C, B_4Si, NiB, and FeB, and the silicon source is selected from silicon, FeSi, SiC, and B_4Si.

5. A blend according to any one of the preceding claims, wherein the blend also comprises powders of base metal having a solidus temperature above 1040 °C.

6. A blend according to any one of the preceding claims, wherein the blend is a paint.

7. An intermediate product for joining and/or coating by brazing comprising plates and/or parts of products of a base metal and a blend of boron and silicon, said base metal having a solidus temperature above 1040 °C, and the

intermediate product has at least partly a surface layer of the blend on the base metal, wherein the boron in the blend is selected from a boron source, and the silicon in the blend is selected from a silicon source, and wherein the blend comprises boron and silicon in a ratio of boron to silicon within a range from about 3:100 wt/wt to about 100:3 wt/wt.

8. An intermediate product according to claim 7, wherein the base metal has a thickness < 1 mm and the blend is applied on the base metal in an average amount less than 2.9 mg/mm^2.

9. An intermediate product according to claim 7, wherein the base metal has a thickness ≥ 1 mm.

10. An intermediate product according to claim 7, 8 or 9, wherein the blend also comprises at least one binder selected from the group consisting of solvents, water, oils, gels, lacquers, varnish, binders based on monomers and/or polymers.

11. An intermediate product according to any one of claims 7to 10, wherein the blend also comprises at least one binder selected from the group consisting of polyesters, polyethylene, polypropylene, acrylic polymers, met acrylic polymers, polyvinyl alcohol, polyvinyl acetate, polystyrene.

12. An intermediate product according to any one of claims 7 to 11, wherein the blend comprises particles having a particle size < 250 µm, preferably < 160 µm.

13. An intermediate product according to any one of claims 7 to 11, wherein the blend comprises particles having a particle size < 50 µm.

14. An intermediate product according to any one of claims 7 to 13, wherein the surface layer is applied as a powder of the blend or by means selected from spray deposit, physical vapor deposition, or chemical vapor deposition.

15. An intermediate product according to any one of claims 7 to 14, wherein the base metal is selected from the group consisting of iron based alloys, nickel based alloys, chromium based alloys, and copper based alloys.

16. An intermediate product according to any one of claims 7 to 15, wherein the base metal comprises from about 15 to about 22 wt% chromium, from about 8 to about 22 wt% nickel, from about 0 to about 3 wt% manganese, from about 0 to about 1.5 wt% silicon, optionally from about 1 to about 8 wt% molybdenum, and balanced with iron.

17. An intermediate product according to any one of claims 7 to 16, wherein the boron source is selected within the group consisting of boron, B_4C, B_4Si, NiB, and FeB, and the silicon source is selected within the group consisting of silicon, FeSi, SiC, and B_4Si.

18. An intermediate product according to any one of claims 7 to 17, wherein the surface layer of the blend is provided on at least one side of a plate or the surface layer of the blend is on both sides of a plate.

19 An intermediate product according to any one of claims 7 to 18, wherein the base metal and the surface layer have been exposed to a temperature higher than the solidus temperature of the formed brazing alloy and lower than the solidus temperature of the base metal, and a layer of the brazing alloy has been formed on the base metal surface.

20. An intermediate product according to any one of claims 7 to 19, wherein the plates are cut, formed, pressed or combinations thereof before the

application of the surface layer, after the application of the surface layer or after forming the brazing alloy on the surface of the base metal.

21. A stacked intermediate product for brazing comprising an intermediate product according to any one of claims 7 to 20, wherein the plates are stacked that the surface layers of the plates are either in contact with a base metal or with another surface layer on another plate.

22. A stacked intermediate product according to claim 21, wherein the stacked plates have no surface layers, single surface layers i.e. on one side of the plate, double surface layers, i.e. one layer on each side of the plate, and/or combinations thereof.

23. An assembled intermediate product for brazing comprising one or more intermediate products according to any one of claims 7 to 20, wherein at least one intermediate product has a thickness $\geq$ 1 mm, and wherein the assembled intermediate product has at least one surface layer in contact with a surface of at least one base metal or in contact with at least one surface layer before brazing, and after brazing brazed joint(s) is(are) obtained.

24. A stacked brazed product or an assembled brazed product obtained by brazing a stacked or an assembled intermediate product according to any one of claims 21 to 23, wherein the stacked or the assembled intermediate product is brazed at a temperature below 1250 °C, in a furnace in vacuum, in an inert gas, in a reducing atmosphere, or combinations thereof forming brazed joints of brazing alloy between the stacked plates or between contact surfaces of the assembled intermediate product, which brazing alloy is formed in a melting process of the base metal and the blend, and the brazing alloy in melted form has been transported by capillary forces to the area of the joint mainly from neighboring areas.

25. A method of brazing a product, which method comprises the following steps:
(i) applying a blend on plates or parts of products of a base metal, said base metal having a solidus temperature above 1040°C, the blend comprises boron and silicon, the boron is selected from a boron source, and the silicon is selected from a silicon source, wherein the blend comprises boron and silicon in a ratio boron to silicon within a range from about 3:100 wt/wt to about 100:3 wt/wt, preferably within a range from about 5:100 wt/wt to about 1:1 wt/wt,
(ii) obtaining an intermediate product according to any one of claims 7 to 20;
(iii) optionally exposing the obtained intermediate product in step (ii) to a temperature higher than the solidus temperature of the forming brazing alloy and lower than the solidus temperature of the base metal, and forming a layer of the brazing alloy on the base metal surface;
(iv) assembling or stacking the product from step (ii) or step (iii) with one or more products according to step (ii) or step (iii), or assembling or stacking the product with one or more parts having no blend of silicon and boron, and forming an assembled product or a stacked product;
(v) brazing the assembled or stacked product from step (iv) to a temperature below 1250 °C in a furnace in vacuum, in an inert gas, in a reducing atmosphere or combinations thereof; and
(vi) obtaining a brazed product.

26. The method according to claim 25, wherein the brazed product obtained in step (vi) is provided with a joint(s) obtained by forming a brazing alloy in a melting process of the base metal and the blend, and transporting by capillary forces the brazing alloy in melted form to the area of the joint mainly from neighboring areas.

27. The method according to anyone of claims 25 to 26, wherein step (iv) the product from step (ii) or step (iii) is brazed to a base metal having thickness $\geq$ 1 mm, or brazed to a base metal having a thickness < 1 mm, or brazed to one or more intermediate products according to any one of claims 7 to 20.

28. The method according to any one of claims 25 to 27, wherein the base metal has a thickness < 1 mm and the blend is applied on the base metal in an average amount less than 2.9 mg/mm^2 calculated on silicon and boron.

29. The method according to any one of claims 25 to 28, wherein the product from step (ii) or step (iii) is cut, formed, pressed or combinations thereof obtaining plates, preferably heat exchanger plates or reactor plates.

30. The method according to any one of claims 25 to 29, wherein the obtained brazed product is selected from the group consisting of heat exchangers, plate reactors, parts of reactors, parts of separators, parts of decanters, parts of pumps, parts of valves.

31. A brazed product obtained by the method according to any one of claims 25 to 30, wherein joint(s) of the brazed product is obtained by a brazing alloy, which brazing alloy is formed in a melting process of the base metal and the blend, and the brazing alloy in melted form has been transported by capillary forces to the area of the joint mainly from neighboring areas.

32. The brazed product obtained by the method according to any one of claims 25 to 31, wherein elements found in the brazing alloy apart from the base metal elements are Si, B and optionally C, and wherein the base metal has a solidus temperature above 1040 °C.

33. Use of an intermediate product according to any one of claims 7 to 20 for brazing of parts or products for heat exchangers, plate reactors, parts of reactors, parts of separators, parts of decanters, parts of pumps, parts of valves.

34. A pre-brazed product for brazing comprising plates and/or parts of products of a base metal having a solidus temperature above 1040°C, which

pre-brazed product is obtained by applying a surface layer of a blend on the the plates and/or the parts of products of the base metal, which blend comprises boron and silicon, the boron is selected from a boron source, and the silicon is selected from a silicon source, wherein the blend comprises boron and silicon in a ratio boron to silicon within a range from about 3:100 wt/wt to about 100:3 wt/wt, preferably within a range from about 5:100 wt/wt to about 1:1 wt/wt, wherein the base metal and the surface layer has been exposed to a temperature higher than the solidus temperature of the formed brazing alloy and lower than the solidus temperature of the base metal, and an obtained layer of the brazing alloy is on the surface of the plates and/or the parts of products of base metal.

Claims

1. A blend for brazing of joints in products of base metals and/or for coating of products of base metals, which base metal has a solidus temperature above 1040 °C, which blend comprises boron and silicon, the boron is selected from a boron source, and the silicon is selected from a silicon source, wherein the blend comprises boron and silicon in a ratio boron to silicon within a range from about 15:100 wt/wt to about 4:10 wt/wt, and wherein the blend also comprises at least one binder selected from the group consisting of solvents, water, oils, gels, lacquers, varnish, binders based on monomers and/or polymers.

2. The blend according to claim 1, wherein the at least one binder is selected from polyesters, polyethylene, polypropylene, acrylic polymers, (met)acrylic polymers, polyvinyl alcohol, polyvinyl acetate, polystyrene.

3. The blend according to claim 1 or 2, wherein the blend particles having particles size less than 250 µm.

4. The blend according to any one of the preceding claims, wherein the boron source is selected from boron, B_4C, B_4Si, NiB, and FeB, and the silicon source is selected from silicon, FeSi, SiC, and B_4Si.

5. A blend according to any one of the preceding claims, wherein the blend also comprises powders of base metal having a solidus temperature above 1040 °C.

6. A blend according to any one of the preceding claims, wherein the blend is a paint.

7. An intermediate product for joining and/or coating by brazing ,said product comprising plates and/or parts of products of a base metal and a blend of boron and silicon, said base metal having a solidus temperature above 1040 °C, and

the intermediate product has at least partly a surface layer of the blend on the base metal, wherein the blend is defined according to any one of claims 1-6.

8. An intermediate product according to claim 7, wherein the base metal has a thickness < 1 mm and the blend is applied on the base metal in an average amount less than 2.9 mg/mm^2.

9. An intermediate product according to claim 7, wherein the base metal has a thickness $\geq$ 1 mm.

10. An intermediate product according to any one of claims 7 to 9, wherein the binder is selected from the group consisting of polyesters, polyethylene, polypropylene, acrylic polymers, met acrylic polymers, polyvinyl alcohol, polyvinyl acetate, polystyrene.

11. An intermediate product according to any one of claims 7 to 10, wherein the blend comprises particles having a particle size < 250 µm, preferably < 160 µm, more preferably the blend comprises particles having a particle size < 50 µm.

12. An intermediate product according to any one of claims 7 to 11, wherein the surface layer is applied as a powder of the blend or by means selected from spray deposit, physical vapor deposition, or chemical vapor deposition.

13. An intermediate product according to any one of claims 7 to 12, wherein the base metal is selected from the group consisting of iron based alloys, nickel based alloys, chromium based alloys, and copper based alloys.

14. An intermediate product according to any one of claims 7 to 13, wherein the base metal comprises from about 15 to about 22 wt% chromium, from about 8 to about 22 wt% nickel, from about 0 to about 3 wt% manganese, from about

0 to about 1.5 wt% silicon, optionally from about 1 to about 8 wt% molybdenum, and balanced with iron.

15. An intermediate product according to any one of claims 7 to 14, wherein the boron source is selected within the group consisting of boron, B_4C, B_4Si, NiB, and FeB, and the silicon source is selected within the group consisting of silicon, FeSi, SiC, and B_4Si.

16. An intermediate product according to claim 15, wherein the base metal and the surface layer have been exposed to a temperature higher than the solidus temperature of the formed brazing alloy and lower than the solidus temperature of the base metal, and a layer of the brazing alloy has been formed on the base metal surface.

17. An intermediate product according to any one of claims 7 to 16, wherein the plates are cut, formed, pressed or combinations thereof before the application of the surface layer, after the application of the surface layer or after forming the brazing alloy on the surface of the base metal.

18. An assembled intermediate product for brazing comprising one or more intermediate products according to any one of claims 7 to 17, wherein at least one intermediate product has a thickness $\geq$ 1 mm, and wherein the assembled intermediate product has at least one surface layer in contact with a surface of at least one base metal or in contact with at least one surface layer before brazing, and after brazing brazed joint(s) is (are) obtained.

19. An assembled brazed product obtained by brazing an assembled intermediate product according to claim 18, wherein assembled intermediate product is brazed at a temperature below 1250 °C, in a furnace in vacuum, in an inert gas, in a reducing atmosphere, or combinations thereof forming brazed joints of brazing alloy between the stacked plates or between contact surfaces

of the assembled intermediate product, which brazing alloy is formed in a melting process of the base metal and the blend, and the brazing alloy in melted form has been transported by capillary forces to the area of the joint mainly from neighboring areas.

20. A method of brazing a product, which method comprises the following steps:

(i) applying a blend on plates or parts of products of a base metal, said base metal having a solidus temperature above 1040°C, the blend comprises boron and silicon, the boron is selected from a boron source, and the silicon is selected from a silicon source, wherein the blend comprises boron and silicon in a ratio boron to silicon within a range from about 15:100 wt/wt to about 4:10 wt/wt,

(ii) obtaining an intermediate product according to any one of claims 7 to 17;

(iii) optionally exposing the obtained intermediate product in step (ii) to a temperature higher than the solidus temperature of the forming brazing alloy and lower than the solidus temperature of the base metal, and forming a layer of the brazing alloy on the base metal surface;

(iv) assembling or stacking the product from step (ii) or step (iii) with one or more products according to step (ii) or step (iii), or assembling or stacking the product with one or more parts having no blend of silicon and boron, and forming an assembled product or a stacked product;

(v) brazing the assembled or stacked product from step (iv) to a temperature below 1250 °C in a furnace in vacuum, in an inert gas, in a reducing atmosphere or combinations thereof; and

(vi) obtaining a brazed product.

21. The method according to claim 20, wherein the brazed product obtained in step (vi) is provided with a joint(s) obtained by forming a brazing alloy in a melting process of the base metal and the blend, and transporting by capillary forces the brazing alloy in melted form to the area of the joint mainly from neighboring areas.

22. The method according to anyone of claims 20 or 21, wherein step (iv) the product from step (ii) or step (iii) is brazed to a base metal having thickness $\geq$ 1 mm, or brazed to a base metal having a thickness < 1 mm, or brazed to one or more intermediate products according to any one of claims 7 to 18.

23. The method according to any one of claims 20 to 22, wherein the base metal has a thickness < 1 mm and the blend is applied on the base metal in an average amount less than 2.9 mg/mm^2 calculated on silicon and boron.

24. The method according to any one of claims 20 to 23, wherein the obtained brazed product is selected from the group consisting of heat exchangers, plate reactors, parts of reactors, parts of separators, parts of decanters, parts of pumps, parts of valves.

25. A brazed product obtained by the method according to any one of claims 20 to 24, wherein joint(s) of the brazed product is obtained by a brazing alloy, which brazing alloy is formed in a melting process of the base metal and the blend, and the brazing alloy in melted form has been transported by capillary forces to the area of the joint mainly from neighboring areas.

26. A brazed product according to claim 25, wherein elements found in the brazing alloy apart from the base metal elements are Si, B and optionally C, and wherein the base metal has a solidus temperature above 1040 °C.

27. A brazed product according to any one of claims 25-26, wherein the product is selected from the group consisting of heat exchangers, plate reactors, parts of reactors, parts of separators, parts of decanters, parts of pumps and part of valves.