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Claims

1. A method of carburising, nitriding or nitrocarburising an article of stainless steel, a nickel alloy, a cobalt alloy, a titanium based material or combinations thereof, wherein the article is activated prior to carburising, nitriding or nitrocarburising by the method comprising;
   - heating the article in a heating apparatus to a first temperature which is lower than 500°C,
   - heating at least one compound containing nitrogen and carbon, said compound comprising at least four atoms, said compound hereinafter called N/C compound, to a second temperature which is lower than 500°C for providing one or more gaseous species, and
   - contacting the article with the gaseous species,

   and wherein the subsequent carburising, nitriding or nitrocarburising is carried out successively in the heating apparatus by heating the article to a third temperature which is at least as high as the first temperature and which is below 500°C.

2. A method according to claim 1, wherein the first temperature is higher than the second temperature.

3. A method according to claim 1 or 2, wherein the heating apparatus has a first heating zone and a second heating zone, wherein the article is heated to the first temperature in the first heating zone and the N/C-compound is heated to the second temperature in the second heating zone, wherein the first temperature is higher than the second temperature.

4. A method according to any of the preceding claims, wherein the heating apparatus has a gas inlet and a gas outlet for providing a passage of gas through the heating apparatus.

5. A method according to any of the preceding claims, wherein the article is heated to the first temperature before the N/C-compound is introduced into the heating apparatus.

6. A method according to any of the preceding claims, wherein the N/C-compound is an amide.

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7. A method according to any of the preceding claims, wherein the N/C-compound is selected from urea, acetamide and formamide.

8. A method according to any of the preceding claims, wherein the N/C-compound is urea.

9. A method according to any of the preceding claims, wherein the first temperature is 250 - 350 °C.

10. A method according to any of the preceding claims, wherein the second temperature is below 250 °C.

11. A method according to any of the preceding claims, wherein the second temperature is 135 - 170 °C.

12. A method according to any of the preceding claims, wherein the article is contacted with the gaseous species for at least one hour.

13. A method according to any of the preceding claims, wherein the same N/C-compound is used both for activation and for subsequent carburising, nitriding or nitrocarburising.

CLAIMS

1. A method of case hardening an article of stainless steel, a nickel alloy, a cobalt alloy, a titanium based material or combinations thereof, the method comprising:

- providing a heating apparatus having a first heating zone downstream of a second heating zone, the heating apparatus having a gas inlet and a gas outlet for providing a passage of gas through the heating apparatus,

- heating the article in the first zone of the heating apparatus to a first temperature in the range of 185 to 500°C,

- heating in the second heating zone of the heating apparatus at least one compound containing nitrogen and carbon, said compound having a single, double or triple carbon-nitrogen bond, which compound is liquid or solid at a temperature 25°C and a pressure of 1 bar, said compound hereinafter called an N/C-compound, to a second temperature, which is lower than the first temperature, and which is in the range of 135 to 450°C for providing one or more gaseous species,

- establishing a passage of gas using a carrier gas that is non-oxidative to the article for contacting the article with the gaseous species to activate the article,

- and successively heating the article in the heating apparatus in the presence of the gaseous species to a carburizing, nitriding or nitrocarburizing temperature which is at least as high as the first temperature and which is below 500°C.

2. A method of case hardening an article of stainless steel, a nickel alloy, a cobalt alloy, a titanium based material or combinations thereof, the method comprising:

- providing a heating apparatus having a doser,

- heating the article in the heating apparatus to a first temperature in the range of 185 to 500°C,

- introducing at least one compound containing nitrogen and carbon, said compound having a single, double or triple carbon-nitrogen bond, which compound is liquid or solid at a temperature 25°C and a pressure of 1 bar, said compound hereinafter called an N/C-compound, into the heating apparatus by the doser,

- allowing the N/C-compound to vaporise to form a gaseous species and allowing the gaseous species to contact the article to activate the article,

- successively heating the article in the heating apparatus in the presence of the gaseous species to a carburizing, nitriding or nitrocarburizing temperature which is at least as high as the first temperature and which is below 500°C.

3. The method according to claim 2, wherein the N/C-compound is introduced into the heating apparatus by a carrier gas that is non-oxidative to the article.

4. The method according to claim 3, wherein the N/C-compound is introduced continuously or discontinuously into the heating apparatus.

5. The method according to any one of claims 2 to 4, wherein the N/C-compound is liquid.

6. The method according to any one of claims 2 to 5, wherein the first temperature is in the range of 350 to 500°C

7. The method according to claim 1, wherein the difference between the first temperature and the second temperature is at least 50°C.

8. The method according to any of the preceding claims, wherein the N/C-compound is an amide.

9. The method according to any of claims 1 to 4 or 6 to 8, wherein the N/C-compound is selected from urea, acetamide and formamide.

10. The method according to any of claims 1 to 4 or 6 to 9, wherein the N/C-compound is urea.

11. The method according to claim 1 or claim 1 and any of claims 7 to 10, wherein the first temperature is 250 - 350 °C.

12. The method according to claim 1 or claim 1 and any of claims 7 to 10, wherein the second temperature is below 250 °C.

13. The method according to claim 1 or claim 1 and any of claims 7 to 10, wherein the second temperature is 135 - 170 °C.

14. The method according to any of the preceding claims, wherein the article is contacted with the gaseous species for at least one hour.

15. The method according to any of the preceding claims, wherein the same N/C-compound is used both for activation and for subsequent carburizing, nitriding or nitrocarburizing.