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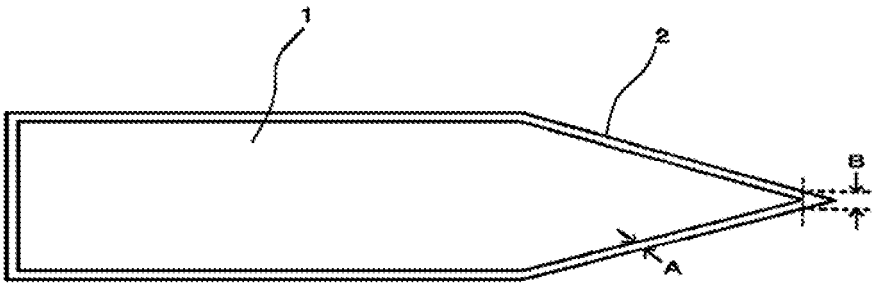
(54) Method of manufacturing a blade with high hardness nitride layer

(57) A blade made of a carbon steel or alloy steel is subjected to a surface nitriding process to form a high hardness nitride layer having a thickness in the range of 10 μm to 100 μm and a Vickers hardness Hv of 1000 or more, and a silver oxide layer, a copper oxide layer, or a silver oxide and copper oxide layer is formed on the high hardness nitride layer of the blade by firing. Through this processing, the blade that has a high cutting maintaining ability and an excellent sanitization ability such as antibiosis, sterilization ability, and antimold ability is provided.

[FIGURE 1]



EP 2 090 672 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a method of manufacturing a blade having a high hardness nitride layer, and more particularly, relates to a method of manufacturing a high hardness blade that has high hardness nitride layer formed on a blade processed by using a known method, and has also a silver oxide layer, a copper oxide layer, or a silver oxide and copper oxide layer on the nitride layer.

2. Description of the Related Art

[0002] Conventionally, a blade that has a cutting edge at least at a portion thereof is extensively used for home purposes or industrial purposes for example, a kitchen knife, a knife, scissors, a cutter, a hand ax, a sickle, a shaving knife blade, a saw, an ax, a graving knife, a plane, a chisel, a round cutter, a polygonal cutter. The various type and material of the blade are developed and used in various fields.

[0003] In the case of a general carbon steel or alloy steel blade containing carbon as the main ingredients, the hardness of the blade is obtained by heating or quenching. However, the upper limit value of the obtainable hardness is the HRC value of about 64, that is, the hardness of the Hv value of 800 or less. In result, the blade maintains the cutting ability only for short-term, and the sufficient cutting ability cannot be ensured. If the cutting ability is reduced, the grinding operation by using a whetstone is required. However, generally a home equipped with a whetstone is rare. Even though a study has been made for a long period of time in order to ensure the high cutting maintaining ability, the desirable results have not been yet obtained.

[0004] In addition, examples of forming a nitride film are as follows. There is disclosed an austenite steel bulk material that consists of austenite nanocrystalline particles containing 0.1 to 2.0% (mass) of solid solution type nitrogen, in which between the nanocrystalline particles and/or in the same particles, metal or semi-metal oxide, nitride, carbide and the like are present as a grain growth inhibition substance (see Patent Document 1), or there is disclosed a nickel free high nitrogen stainless steel having excellent corrosion resistance, strength, shapability, and wear resistance, which has a chemical component composition containing (mass %) of $0<C\leq0.08$, $0\leq Si<0.50$, $0\leq Mn\leq1.50$, $15\leq Cr\leq30$, $0\leq Ni<0.05$, $1\leq Mo\leq10$, $1.00<N\leq2.00$, and $0\leq Ca<0.005$ and Fe and impurity as the residual portion, and has the chemical component composition and the clean property of the nonmetal insertion substance so that in the contents of Cr, Mo and N, the corrosion resistance index shown in the equation (1) containing Cr, Mo and N satisfies relation with the area ratio of the nonmetal insertion substance in the steel in the equations (2) and the maximum diameter of the nonmetal insertion substance in the steel in the equations (3)(see Patent Document 2).

[Patent Document 1: Japanese Unexamined Patent Application Publication No. 2004-137600]
[Patent Document 2: Japanese Unexamined Patent Application Publication No. 2007-51368]

[0005] However, these references did not mention to the surface nitride treatment in respects to the carbon steel or alloy steel blade that is extensively used in the related art.

[0006] Meanwhile, since a blade using zirconium ceramics that is mostly used in the recent years has the hardness Hv of 1200 or more and high cutting maintaining ability, the blade is watched. However, since the toughness is reduced as compared to the metal blade, the use thereof is limited.

SUMMARY OF THE INVENTION

[0007] Accordingly, the present invention has been made keeping in mind the above problems occurring in the related art, and an object of the present invention is to provide a method of manufacturing a blade having a high hardness nitride layer wherein the high hardness nitride layer is formed by performing the surface nitriding process on a carbon steel or alloy steel blade, thereby endowing the blade with a high cutting maintaining ability.

[0008] Another object of the present invention is to provide a method of manufacturing a blade having a high hardness nitride layer wherein the method further comprises the process for forming a silver oxide layer, a copper oxide layer, or a silver oxide and copper oxide layer as a hard film on the surface of the blade having the high hardness nitride layer by firing, thereby endowing the blade with a sanitization ability such as antibiosis, sterilization ability, and antimold ability.

[0009] According to a first aspect of the present invention, a method of manufacturing a blade having a high hardness nitride layer comprises

processing a metal steel plate so as to form a blade including a part therein to be formed as a cutting edge;
processing the blade prepared by the above process by quenching and curing treatment;
grinding the surface of the blade that was subjected to the quenching and curing treatment;
forming a cutting edge in the blade that was subjected to the surface grinding process, by grinding;
grinding the cutting edge formed by the above process finally; and
performing surface nitriding processing on the surface of the blade that was subjected to the finishing process for the cutting edge thereof to form a high hardness nitride layer having a thickness of 10 μm to 100 μm and the Vickers hardness Hv of 1000 or more, wherein the sur-

face nitriding processing includes heating process at 600°C or less.

[0010] According to a second aspect of the present invention, in the first aspect, the metal steel plate comprises 10% or more chromium as a stainless steel and has a HRC hardness of 35 or more by quenching and curing treatment as heat treatment.

[0011] According to a third aspect of the present invention, in the first or second aspect, the method of manufacturing a blade having a high hardness nitride layer further comprises a finishing process by grinding for forming a final cutting edge after the process for forming the high hardness nitride layer.

[0012] According to a fourth aspect of the present invention, in the third aspect, the method of manufacturing a blade having a high hardness nitride layer further comprises a process for forming an electroless nickel plating layer on the surface of the blade after the finishing process by grinding for forming a final cutting edge.

[0013] According to a fifth aspect of the present invention, in the third or fourth aspect, the method of manufacturing a blade having a high hardness nitride layer further comprises a process for forming a silver oxide layer, a copper oxide layer, or a silver oxide and copper oxide layer, which is formed on the nitride layer or the electroless nickel plating layer of the blade, by dipping the blade in an aqueous solution of inorganic copper salt compounds, an aqueous solution of inorganic silver salt compounds, or the mixture solution of the aqueous solutions; or by applying the aqueous solution of the inorganic copper salt compounds, the aqueous solution of inorganic silver salt compounds, or the mixture solution of the aqueous solutions to the blade, and then performing heating and firing at a temperature of 450°C or more.

[0014] The method of manufacturing a blade having the high hardness nitride layer according to the present invention provides a blade that comprises a high hardness nitride layer having a thickness in the range of 10 μm to 100 μm on a surface thereof, thereby endowing the blade with a high cutting maintaining ability. The high hardness nitride layer is obtained by performing the surface nitriding process on the blade that is prepared by using carbon steel or alloy steel, wherein the carbon steel or alloy steel can be used in a manual convenience field for home or business, has been manufactured in a large amount, and can be easily obtained.

[0015] In addition, in the case of when an electroless nickel plating layer is formed on the surface of the nitride layer, the electroless nickel plating layer plays a role to prevent oxidation of the nitride layer formed on the blade, thereby endowing the blade with excellent corrosion resistance.

[0016] In addition, in the case of when a silver oxide layer, a copper oxide layer, or a silver and copper oxide layer are formed on the nitride layer or the electroless nickel plating layer of the blade by firing, since the blade further comprises one hard film, thereby endowing the blade with antibiosis, sterilization ability, and antimold ability, the blade has the high cutting maintaining ability and the excellent sanitization ability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The above and other features and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

FIG. 1 is a sectional view of a blade of an embodiment according to a method of manufacturing a blade having a high hardness nitride layer according to the present invention (1: a blade, 2: a nitride layer).

FIG. 2 is a sectional view of a blade of another embodiment according to a method of manufacturing a blade having a high hardness nitride layer according to the present invention (1: a blade, 2: a nitride layer, 3: an electroless nickel plating layer).

FIG. 3 is a sectional view of a blade of another embodiment according to a method of manufacturing a blade having a high hardness nitride layer according to the present invention(1: a blade, 2: a nitride layer, 3: an electroless nickel plating layer, 4: a silver oxide layer, a copper oxide layer, or a silver and copper oxide layer).

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Hereinafter, an embodiment of a method of manufacturing a blade having a high hardness nitride layer according to the present invention will be described in detail with reference to the accompanying drawings.

[0019] The present invention relates to a method of manufacturing a blade having a high hardness nitride layer, and more particularly, relates to a high hardness blade that has high hardness nitride layer formed on a blade processed by using a known method. Also, the blade may have an electroless nickel plating layer and/or a silver oxide layer, a copper oxide layer, or a silver and copper oxide layer on the nitride layer.

[0020] A method of manufacturing a blade having a high hardness nitride layer, which is described in claim 1, comprises

processing a metal steel plate so as to form a blade 1 including a part therein to be formed as a cutting edge;

processing the blade 1 prepared by the above process by quenching and curing treatment;

grinding the surface of the blade 1 that was subjected to the quenching and curing treatment;

forming a cutting edge in the blade 1 that was subjected to the surface grinding process, by grinding;

grinding the cutting edge formed by the above process finally; and

performing surface nitriding processing on the surface of the blade 1 that was subjected to the finishing process for the cutting edge thereof to form a high hardness nitride layer 2 having a thickness of 10 μm to 100 μm and the

Vickers hardness Hv of 1000 or more, wherein the surface nitriding processing includes heating process at 600°C or less.

[0021] In the method of manufacturing the blade having the high hardness nitride layer which is described in claim 2, the metal steel plate of claim 1 comprises 10% or more chromium as stainless steel and has a HRC hardness of 35 or more by quenching and curing treatment as heat treatment.

[0022] It is preferable that the metal steel plate comprises 10% or more chromium as stainless steel and has a HRC hardness of 35 or more. Examples of the metal steel plate may comprise a SUS-based alloy carbon steel, a carbon steel-based alloy steel, a nitride steel-based alloy steel and the like.

[0023] In the case of when the metal steel plate comprises 10% or more of Cr, it is possible to form a continuous nitride diffusion layer in the surface nitride layer by Cr at the nitriding process, and the strong fixation of the surface formation nitride layer is thereby enabled. The stripping of the cured layer is also prevented due to an anchor effect. Thus 10% or more of Cr comprised in the metal steel plate provides the significant effect. In addition, due to this effect, it is possible to increase the hardness of the nitride layer to 1000 or more.

[0024] The method of manufacturing the knife having the high hardness nitride layer, which is described in claim 3, further comprises a finishing process by grinding for forming a final cutting edge after the process for forming the high hardness nitride layer 2 in claims 1 or 2.

[0025] The method of manufacturing the blade having the high hardness nitride layer, which is described in claim 4, further comprises a process for forming an electroless nickel plating layer 3 on the surface of the blade 1 after the finishing process by grinding for forming a final cutting edge in claim 3.

[0026] The electroless nickel plating layer 3 plays a role to prevent oxidation of the nitride layer 2 formed on the blade 1, thereby endowing the blade 1 with excellent corrosion resistance.

[0027] The method of manufacturing the blade having the high hardness nitride layer, which is described in claim 5, further comprises a process for forming a silver oxide layer, a copper oxide layer, or a silver oxide and copper oxide layer 4 which is formed on the nitride layer 2 or the electroless nickel plating layer 3 of the blade 1, by dipping the blade in an aqueous solution of inorganic copper salt compounds, an aqueous solution of inorganic silver salt compounds, or the mixture solution of the aqueous solutions; or by applying the aqueous solution of the inorganic copper salt compounds, the aqueous solution of inorganic silver salt compounds, or the mixture solution of the aqueous solutions to the blade, and then performing heating and firing at a temperature of 450°C or more after the finishing process by grinding for forming a final cutting edge in claim 3, or the process for forming an electroless nickel plating layer on the surface of the blade in claims 4.

[0028] In the above, the aqueous solution of inorganic copper salt compounds may comprise, for example, copper nitrate, copper sulfate, copper chloride, and so like; and the aqueous solution of inorganic silver salt compounds may comprise, for example, silver nitrate, silver acetate, silver bromide, and so like.

[Embodiment]

[0029] In the method of manufacturing the blade having the high hardness nitride layer 2 according to the present invention, the blade 1 is processed by using the manufacturing means used to manufacture the blade all over the world. That is, in the process for forming an external shape, the metal steel plate comprises 10% or more of Cr as stainless steel and has the HRC hardness of 35 or more by quenching and curing treatment as heat treatment. For example, the metal steel plate that is made of the SUS-based alloy carbon steel, the carbon steel-based alloy steel, or the nitride steel-based alloy steel is processed by using means such as press processing and the like to form a desired blade 1 including a part therein to be formed as a cutting edge. The blade 1 may be used in a kitchen knife, a knife, scissors, a cutter, a hand ax, a sickle, a shaving knife blade, a saw, an ax, a graving knife, a plane, a chisel, a round cutter, a polygonal cutter or the like.

[0030] Next, in the quenching and curing treatment, the heating and the quenching are performed in order to cure the blade 1 processed so as to have the external shape. The blade 1 is thereby cured so that the maximum Vickers value Hv is 800 or less.

[0031] Subsequently, in the surface grinding process, the desired form of the blade 1 is formed by performing the surface grinding process for the blade 1 that was subjected to the quenching and curing treatment using a grinding device such as a grinder and the like. The surface grinding process also performs the function making the subsequent process easy.

[0032] In addition, the cutting edge forming process is that the part to be formed as a cutting edge of the blade 1 is grinded to form the sharp cutting edge using a rough grinding whetstone and the like.

[0033] In addition, the finishing process for the cutting edge is that the cutting edge is grinded to form a sharp and soft edge surface using a finish grinding whetstone and the like.

[0034] As described above, the blade 1 that is processed by using the above-mentioned process is almost the same as those that are extensively used in home and various industries, but the surface of the processed blade 1 was subjected to the surface nitriding processing to form the high hardness nitride layer 2. The surface nitriding processing is performed by using known means such as a plasma method, a salt bathing method, a sulfide gas method, an ionic method and the like.

[0035] In addition, the high hardness nitride layer 2 is a thin film that has a thickness in the range of 10 μm to

100 μm, and as shown in FIG. 1, if the thickness A of the high hardness nitride layer 2 is 10 μm, the thickness B of the high hardness nitride layer 2 at an edge of the processed blade 1 is 20 μm. In connection with this, the hardness of the high hardness nitride layer 2 is the Vickers hardness Hv of 1000 or more. That is, since the high hardness nitride layer 2 is formed on the surface of the processed blade 1, the blade has the high cutting maintaining ability.

[0036] In addition, in a method of manufacturing a blade having a high hardness nitride layer according to another embodiment of the present invention, an electroless nickel plating layer 3 is formed on the surface of the nitride layer 2 after the finishing process by grinding for forming a final cutting edge.

[0037] In addition, in a method of manufacturing a blade having a high hardness nitride layer according to another embodiment of the present invention, a silver oxide layer, a copper oxide layer, or a silver oxide and copper oxide layer 4 is formed on the surface of the nitride layer 2 or the electroless nickel plating layer 3.

[0038] That is, the blade 1 having the nitride layer 2, or the nitride layer 2 and the electroless nickel plating layer 3 is dipped in a mixture solution of an aqueous solution of an inorganic copper salt compound and an aqueous solution of an inorganic silver salt compound, and then the blade 1 is heated and fired at a temperature of 450°C or more.

Claims

1. A method of manufacturing a blade having a high hardness nitride layer, the method comprising:

   processing a metal steel plate so as to form a blade including a part therein to be formed as a cutting edge;
   processing the blade prepared by the above process by quenching and curing treatment;
   grinding the surface of the blade that was subjected to the quenching and curing treatment;
   forming a cutting edge in the blade that was subjected to the surface grinding process, by grinding;
   grinding the cutting edge formed by the above process finally; and
   performing surface nitriding processing on the surface of the blade that was subjected to the finishing process for the cutting edge thereof to form a high hardness nitride layer having a thickness of 10 μm to 100 μm and the Vickers hardness Hv of 1000 or more, wherein the surface nitriding processing includes heating process at 600°C or less.

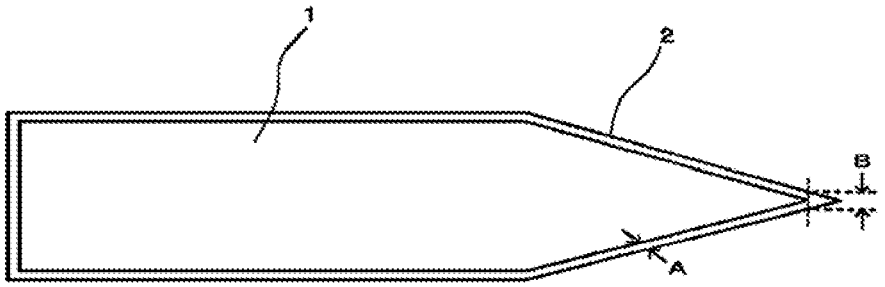
2. The method of manufacturing a knife having a high hardness nitride layer as set forth in claim 1, wherein the metal steel plate comprises 10% or more chromium as a stainless steel and has a HRC hardness of 35 or more by the quenching and curing treatment as a heat treatment.

3. The method of manufacturing a blade having a high hardness nitride layer as set forth in claims 1 or 2, wherein the method further comprises a finishing process by grinding for forming a final cutting edge after the process for forming the high hardness nitride layer.

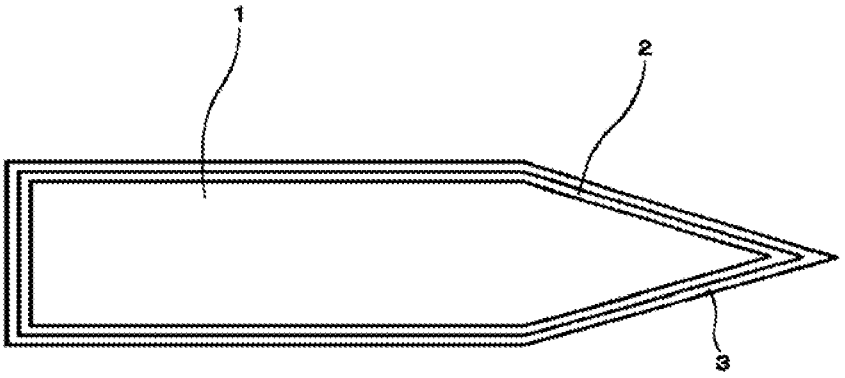
4. The method of manufacturing a blade having a high hardness nitride layer as set forth in claims 3, wherein the method further comprises a process for forming an electroless nickel plating layer on the surface of the blade after the finishing process by grinding for forming a final cutting edge.

5. The method of manufacturing a blade having a high hardness nitride layer as set forth in claims 3 or 4, wherein the method further comprises a process for forming a silver oxide layer, a copper oxide layer, or a silver oxide and copper oxide layer which is formed on the nitride layer or the electroless nickel plating layer of the blade, by dipping the blade in an aqueous solution of inorganic copper salt compounds, an aqueous solution of inorganic silver salt compounds, or the mixture solution of the aqueous solutions; or by applying the aqueous solution of the inorganic copper salt compounds, the aqueous solution of inorganic silver salt compounds, or the mixture solution of the aqueous solutions to the blade, and then performing heating and firing at a temperature of 450°C or more.

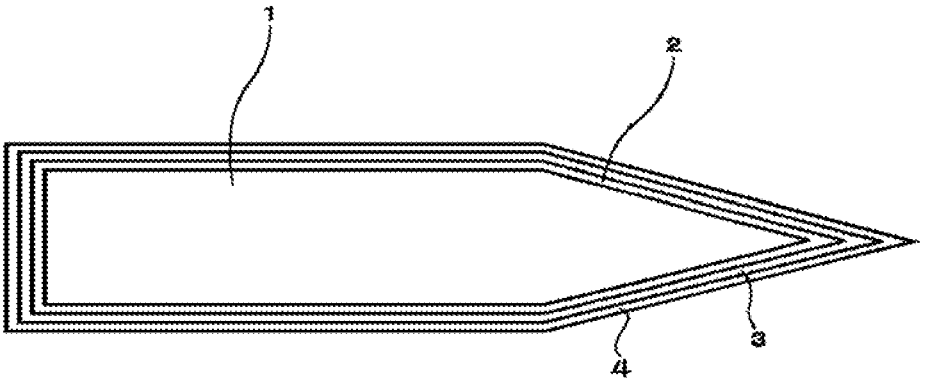
[FIGURE 1]



[FIGURE 2]



[FIGURE 3]



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EUROPEAN SEARCH REPORT

Application Number
EP 08 16 6287

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 June 2009	Juhart, Matjaz

CATEGORY OF CITED DOCUMENTS

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3

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EUROPEAN SEARCH REPORT

Application Number
EP 08 16 6287

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Munich	9 June 2009	Juhart, Matjaz

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