Conventionally, a work such as a plated steel plate is laser cut and machined after removing a plated surface of the work (for example, refer to Patent Literature 1).

[0003]

According to a configuration written in the Patent Literature 1, a plated surface of a work is removed, and thereafter, the work is cut and machined with a laser. This raises a problem in an improvement of efficiency of the work laser cutting and machining. According to the configuration mentioned in the Patent Literature 1, a cut face of the work after laser cutting is not coated with plating-layer-containing metal, and therefore, there is a problem that the cut face needs a proper surface treatment such as rustproofing.

[Prior Art Document]

[Patent Literature]

[0004]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. H7-236984

[Summary]

[0005]

Subjects to be solved by the present invention include a laser cutting and machining method that carries out laser cutting and machining on a plated steel plate such that melted and/or evaporated plating-layer-containing metal of a top surface of the plated steel plate flows toward and coat a cut face of the plated steel plate, as well as a laser cut-and-machined product.

[0005a]

According to a first aspect, the present disclosure refers to

a laser cutting and machining method for a plated steel plate, wherein when laser cutting and machining is carried out by irradiating a top surface of the plated steel plate with a laser beam, an assist gas or an auxiliary gas is impinged to a laser cutting part of the plated steel plate to guide plating-layer-containing metal of the top surface melted and/or evaporated by the laser beam toward a cut face of the plated steel plate so that the cut face is coated with the plating-layer-containing metal.

[0005b]

According to a second aspect, the present disclosure refers to a laser cut-and-machined product made from a plated steel plate, wherein a cut face of the plated steel plate is coated with plating-layer-containing metal of a top surface of the plated steel plate melted and/or evaporated at the time of laser cutting and machining.

[0005c]

According to a third aspect, the present disclosure refers to a thermal cutting and machining method for a thermal cut-and-machined product having a steel plate surface coated with plating metal and a cut face having plating-layer-containing metal, wherein the plating-layer-containing metal melts, flows to the cut face, and solidifies, thereby covering the cut face with the plating-layer-containing metal.

[0005d]

According to a fourth aspect, the present disclosure refers to a thermal cut-and-machined product employing as a raw material a surface-treated steel plate having a steel plate surface coated with plating metal, wherein plating-layer-containing

metal melts and flows to a cut face so that the melted metal solidifies to cover the cut face with the plating-layer-containing metal.

[0005e]

According to a fifth aspect, the present disclosure refers to a surface-treated steel plate having a steel plate surface coated with plating metal, wherein a cut face is covered with plating-layer-containing metal of the steel plate surface and a plating layer thin part width perpendicularly to the cut face is 0.27 mm to 0.5 mm.

[0005f]

According to a sixth aspect, the present disclosure refers to a laser cutting method for a surface-treated steel plate having a steel plate surface coated with plating metal, wherein a cutting gas such as an oxygen gas, a nitrogen gas, or a mixed gas thereof is employed to carry out laser cutting to form a cut face, and thereafter, an auxiliary gas is impinged toward a melted plating metal layer to make the melted plating metal layer flow to the cut face.

[0005g]

According to a seventh aspect, the present disclosure refers to a laser machining head used for the method according to one of the first, third and sixth aspect, wherein the laser machining head includes a nozzle for impinging an assist gas toward a laser machining part of a plated steel plate so that the assist gas jetted from the nozzle blows off melted metal to form a cut face, and an auxiliary gas nozzle for jetting an auxiliary gas to guide plating-layer-containing metal that is in a melted state on a top surface of the plated steel plate toward the cut face.

[0006]

In order to resolve the above-mentioned problems, the present invention provides a laser cutting and machining method for a plated steel plate. The method carries out laser cutting and

[CLAIMS]

[Claim 1]

A laser cutting and machining method for a plated steel plate, wherein when laser cutting and machining is carried out by irradiating a top surface of the plated steel plate with a laser beam, an assist gas or an auxiliary gas is impinged to a laser cutting part of the plated steel plate to guide plating-layer-containing metal of the top surface melted and/or evaporated by the laser beam toward a cut face of the plated steel plate so that the cut face is coated with the plating-layer-containing metal.

[Claim 2]

The laser cutting and machining method for a plated steel plate according to claim 1, wherein a focal position of the laser beam is adjusted within a range of +0.5 mm to -4.5 mm.

[Claim 3]

The laser cutting and machining method for a plated steel plate according to claim 1 or 2, wherein a nozzle gap between a nozzle of a laser machining head and the top surface of the plated steel plate is adjusted within a range of 0.3 mm to 1.0 mm and an assist gas pressure is adjusted within a range of 0.5 MPa to 1.2 MPa.

[Claim 4]

The laser cutting and machining method for a plated steel plate according to claim 1, 2 or 3, wherein a laser cutting and machining speed is adjusted within a range of 1000 mm/min to 5000 mm/min.

[Claim 5]

The laser cutting and machining method for a plated steel plate according to claim one of 1-4, wherein a diameter of an assist gas jetting nozzle is 2.0 mm to 7.0 mm.

[Claim 6]

The laser cutting and machining method for a plated steel plate according to claim one of 1-5, wherein the assist gas is a nitrogen gas or a mixture of 96% or higher nitrogen gas and 4% or lower oxygen gas.

[Claim 7]

The laser cutting and machining method for a plated steel plate according to claim 1, wherein a plate thickness is 2.3 mm, a plating quantity is K14, a nozzle diameter is 2.0 mm to 7.0 mm, an assist gas pressure is 0.5 to 0.9 (MPa), and a cutting speed is 3000 to 5000 (mm/min).

[Claim 8]

The laser cutting and machining method for a plated steel plate according to claim 1, wherein a plate thickness is 2.3 mm, a plating quantity is K27 or K35, a nozzle diameter is 2.0 mm to 7.0 mm, an assist gas pressure is 0.5 to 0.9 (MPa), and a cutting speed is 3000 to 5000 (mm/min).

[Claim 9]

The laser cutting and machining method for a plated steel plate according to claim 1, wherein a plate thickness is 3.2 mm, a plating quantity is K27 or K35, a nozzle diameter is 7.0 mm, an assist gas pressure is 0.5 to 0.9 (MPa), and a cutting speed is 2000 to 3000 (mm/min).

[Claim 10]

The laser cutting and machining method for a plated steel plate according to claim 1, wherein a plate thickness is 4.5 mm, a plating quantity is K27 or K35, a nozzle diameter is 7.0 mm, an assist gas pressure is 0.7 to 0.9 (MPa), and a cutting speed is 1500 to 2000 (mm/min).

[Claim 11]

A laser cut-and-machined product made from a plated steel plate, wherein a cut face of the plated steel plate is coated with plating-layer-containing metal of a top surface of the plated steel plate melted and/or evaporated at the time of laser cutting and machining.

[Claim 12]

The laser cut-and-machined product according to claim 11, wherein a plating thickness around an upper edge of the cut face is thinner than a plating thickness at a position away from the cut face.

[Claim 13]

The laser cut-and-machined product according to claim 11 or 12, wherein a plating melting range is within a range of 0.27 mm to 0.5 mm from the cut face.

[Claim 14]

A thermal cutting and machining method for a thermal cut-and-machined product having a steel plate surface coated with plating metal and a cut face having plating-layer-containing metal, wherein the plating-layer-containing metal melts, flows to the cut face, and solidifies, thereby covering the cut face with the plating-layer-containing metal.

[Claim 15]

The thermal cutting and machining method for a thermal cut-and-machined product having a steel plate surface coated with plating metal and a cut face having plating-layer-containing metal according to claim 1, wherein an area of the plating-layer-containing metal that is covering the cut face after flowed to the cut face is 10% or more of an area of the cut face, or a maximum inflow distance of the

plating-layer-containing metal flowed to the cut face is 30% or more of a plate thickness.

[Claim 16]

The thermal cutting and machining method for a thermal cut-and-machined product having a steel plate surface coated with plating metal and a cut face having plating-layer-containing metal according to claim one of 14-15, wherein a melted plating layer width along a vertical direction from the cut face is 0.03 mm to 0.5 mm.

[Claim 17]

The thermal cutting and machining method according to claim one of 14-16, wherein a hot-dip Zn-based plated steel plate containing 1.0 to 22.0 wt% Al is employed as a raw material to be thermally cut.

[Claim 18]

The thermal cutting and machining method according to claim 17, wherein plating composition of the zinc-based plated steel plate that is employed as a raw material to be thermally cut further contains one or more selected from a group of 0.1 to 10.0 wt% Mg, 0.10 wt% or lower Ti, 0.05 wt% or lower B, and 2 wt% or lower Si.

[Claim 19]

The thermal cutting and machining method according to claim one of 14-16, wherein a hot-dip Al-based plated steel plate containing 1.0 to 1.0 wt% Si is employed as a raw material to be thermally cut.

[Claim 20]

The thermal cutting and machining method according to claim one of 14-19, wherein the solidified plating-layer-containing metal is present like flow lines.

[Claim 21]

A thermal cut-and-machined product employing as a raw material a surface-treated steel plate having a steel plate surface coated with plating metal, wherein plating-layer-containing metal melts and flows to a cut face so that the melted metal solidifies to cover the cut face with the plating-layer-containing metal.

[Claim 22]

The thermal cut-and-machined product employing as a raw material a surface-treated steel plate having a steel plate surface coated with plating metal according to claim 21, wherein an area of the plating-layer-containing metal that is covering the cut face after flowed to the cut face is 10% or more of an area of the cut face, or a maximum inflow distance of the plating-layer-containing metal flowed to the cut face is 30% or more of a plate thickness.

[Claim 23]

The thermal cut-and-machined product employing as a raw material a surface-treated steel plate having a steel plate surface coated with plating metal according to claim one of 21-22, wherein a melted plating layer width along a vertical direction from the cut face is 0.03 mm to 0.5 mm.

[Claim 24]

The thermal cut-and-machined product according to claim one of 21-23, wherein a hot-dip Zn-based plated steel plate containing 1.0 to 22.0 wt% Al is employed as a raw material.

[Claim 25]

The thermal cut-and-machined product according to claim 24, wherein plating composition of the zinc-based plated steel plate that is employed as a raw material further contains one

or more selected from a group of 0.1 to 10.0 wt% Mg, 0.10 wt% or lower Ti, 0.05 wt% or lower B, and 2 wt% or lower Si.

[Claim 26]

The thermal cut-and-machined product according to claim one of 21-23, wherein a hot-dip Al-based plated steel plate containing 1.0 to 13.0 wt% Si is employed as a raw material.

[Claim 27]

The thermal cut-and-machined product according to claim one of 21-26, wherein the solidified plating-layer-containing metal is present like flow lines.

[Claim 28]

A surface-treated steel plate having a steel plate surface coated with plating metal, wherein a cut face is covered with plating-layer-containing metal of the steel plate surface and a plating layer thin part width perpendicularly to the cut face is 0.27 mm to 0.5 mm.

[Claim 29]

The surface-treated steel plate having a steel plate surface coated with plating metal according to claim 28, wherein an area of the plating-layer-containing metal of the steel plate surface that is covering the cut face is 10% or more of an area of the cut face, or the plating-layer-containing metal of the steel plate surface covers the cut face by an extent of 30% or more of a plate thickness from a top or bottom surface of the surface-treated steel plate and a plating layer thin part width perpendicularly to the cut face is 0.27 mm to 0.5 mm.

[Claim 30]

A laser cutting method for a surface-treated steel plate having a steel plate surface coated with plating metal, wherein a cutting gas such as an oxygen gas, a nitrogen gas, or a mixed

gas thereof is employed to carry out laser cutting to form a cut face, and thereafter, an auxiliary gas is impinged toward a melted plating metal layer to make the melted plating metal layer flow to the cut face.

[Claim 31]

The laser cutting method according to claim 30, wherein a plurality of nozzles for jetting the auxiliary gas are arranged around a nozzle of the cutting gas and the laser cutting is carried out.

[Claim 32]

The laser cutting method according to claim 30, wherein a ring-shaped nozzle for jetting the auxiliary gas is arranged around a nozzle of the cutting gas and the laser cutting is carried out.

[Claim 33]

A laser machining head used for the method according to claim one of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 14, 15, 16, 17, 18, 19, 20, 30, 31, and 32, wherein the laser machining head includes a nozzle for impinging an assist gas toward a laser machining part of a plated steel plate so that the assist gas jetted from the nozzle blows off melted metal to form a cut face, and an auxiliary gas nozzle for jetting an auxiliary gas to guide plating-layer-containing metal that is in a melted state on a top surface of the plated steel plate toward the cut face.

[Claim 34]

The laser machining head according to claim 33, wherein the auxiliary gas nozzle is configured to jet the auxiliary gas in a range larger than the width of a cut groove formed by laser cutting and machining toward the cut groove formed by the laser cutting and machining.