layer formed thereon to a heat treatment at a temperature of 480 to 900℃ to thereby form a nickel-cobalt-iron diffusion layer as an outermost surface layer. At this time, it is preferable that the total content of nickel and cobalt of the nickel plating layer and the nickel-cobalt alloy plating layer be 11.5 g/m$^2$ or lower.

[0011a] According to another aspect of the present disclosure, there is provided a method of manufacturing the surface-treated steel sheet as defined herein, comprising: a step of forming a nickel plating layer having a content of nickel of lower than 11.0 g/m$^2$ on a steel sheet; a step of forming a nickel-cobalt alloy plating layer having a total content of nickel and cobalt of 7.5 g/m$^2$ or lower on the nickel plating layer; and a step of subjecting the steel sheet having the nickel plating layer and the nickel-cobalt alloy plating layer formed thereon to a heat treatment at a temperature of 480 to 900℃ to thereby form a nickel-cobalt-iron diffusion layer as an outermost surface layer.

[0012] According to another example of the present disclosure, there is further provided a method for manufacturing a surface-treated steel sheet comprising a step of forming a nickel-cobalt alloy plating layer having a total content of nickel and cobalt of 11.5 g/m$^2$ or lower on a steel sheet, and

a step of subjecting the steel sheet having the nickel-cobalt alloy plating layer formed thereon to a heat treatment at a temperature of 480 to 900℃ to thereby form a nickel-cobalt-iron diffusion layer as an outermost surface layer.

[0012a] According to another aspect of the present disclosure, there is provided a method of manufacturing the surface-treated steel sheet as defined herein, comprising: a step of forming a nickel-cobalt alloy plating layer having a total content of nickel and cobalt of 11.5 g/m$^2$ or lower on a steel sheet, and

a step of subjecting the steel sheet having the nickel-cobalt alloy plating layer formed thereon to a heat treatment at a temperature of 480 to 900℃ to thereby form a nickel-cobalt-iron diffusion layer as an outermost surface layer.

## EFFECTS OF DISCLOSURE

[0013] According to the present disclosure, there can be provided a surface-treated steel sheet which is excellent in battery characteristics and can suppress impairing the battery characteristics also after lapse of time when used as a battery case of a battery using a strong alkaline electrolyte solution. According to the present disclosure, there can be also provided a method for manufacturing such a surface-treated steel sheet.

## BRIEF DESCRIPTION OF DRAWINGS

[0014] Figure 1 is a perspective view illustrating one embodiment of a battery to which the surface-treated steel sheet according to the present invention is applied.

Figure 2 is a cross-sectional view taken along line II-II of Figure 1.

## CLAIMS

1. A surface-treated steel sheet, comprising:

a steel sheet; and

a nickel-cobalt-iron diffusion layer formed as an outermost surface layer on the steel sheet,

wherein when a content of Ni, a content of Co and a content of Fe of the nickel-cobalt-iron diffusion layer are determined based on a Ni intensity, a Co intensity and a Fe intensity each sequentially measured in the depth direction from the surface side of the nickel-cobalt-iron diffusion layer by a radio frequency glow discharge optical emission spectrometry, a content of Co at a specific depth position D, $In_{Co_D}$, is 8.59% by mass or higher and 65% by mass or lower, a content of Fe at the specific depth position D, $In_{Fe_D}$, is 18% by mass or higher and 70% by mass or lower, a content of Ni at the specific depth position D, $In_{Ni_D}$, is 5% by mass or higher and 60% by mass or lower , the specific depth position D being a position where the Ni intensity is 0.5% of the maximum value of the Ni intensity, and the total content of nickel and cobalt in the nickel-cobalt-iron diffusion layer is 10.0 $g/m^2$ or lower.

2. The surface-treated steel sheet according to claim 1, wherein the nickel-cobalt-iron diffusion layer has a content of cobalt of 0.2 $g/m^2$ or higher.

3. The surface-treated steel sheet according to claim 1 or 2, wherein the nickel-cobalt-iron diffusion layer has $R_{Fe/Co}$ ($In_{Fe_D}/In_{Co_D}$) of 0.5 to 20, the $R_{Fe/Co}$ ($In_{Fe_D}/In_{Co_D}$) being a ratio of the content of Fe, $In_{Fe_D}$, with respect to the content of Co, $In_{Co_D}$.

4. The surface-treated steel sheet according to any one of claims 1 to 3, further comprising an iron-nickel diffusion layer between the steel sheet and the nickel-cobalt-iron diffusion layer.

5. A battery case comprising a surface-treated steel sheet according to any one of claims 1 to 4.

6. A battery comprising a battery case according to claim 5.

7. A method of manufacturing the surface-treated steel sheet according to any one of claims 1 to 4, comprising:

a step of forming a nickel plating layer having a content of nickel of lower than 11.0 g/m$^2$ on a steel sheet;

a step of forming a nickel-cobalt alloy plating layer having a total content of nickel and cobalt of 7.5 g/m$^2$ or lower on the nickel plating layer; and

a step of subjecting the steel sheet having the nickel plating layer and the nickel-cobalt alloy plating layer formed thereon to a heat treatment at a temperature of 480 to 900°C to thereby form a nickel-cobalt-iron diffusion layer as an outermost surface layer.

8. A method of manufacturing the surface-treated steel sheet according to any one of claims 1 to 4, comprising:

a step of forming a nickel-cobalt alloy plating layer having a total content of nickel and cobalt of 11.5 g/m$^2$ or lower on a steel sheet, and

a step of subjecting the steel sheet having the nickel-cobalt alloy plating layer formed thereon to a heat treatment at a temperature of 480 to 900°C to thereby form a nickel-cobalt-iron diffusion layer as an outermost surface layer.