DESCRIPTION

SURFACE-TREATED STEEL SHEET AND METHOD FOR MANUFACTURING THE SAME

TECHNICAL FIELD

[0001] The present invention relates to a surface-treated steel sheet, and a method for manufacturing the same.

BACKGROUND ART

[0002] In recent years, portable devices, such as audio devices and cell phones, have been used in many fields, and as their operating power sources, alkaline batteries, which is primary batteries, and nickel hydrogen batteries, lithium ion batteries and the like, which are secondary batteries, are widely used. For these batteries, the performance enhancement including output raising and life elongation is demanded, and also for battery cases for packing power generating elements including a positive electrode active substance, a negative electrode active substance and the like, the improvement of the performance of the case as an important constituent element of batteries is demanded.

[0003] For example, in Patent Document 1, there is disclosed a battery case having a specific nickel-cobalt alloy layer formed on the outermost surface which is to be the inner surface of the battery case in view of improving the battery characteristics when used as a battery case.

PATENT DOCUMENT

[0004] Patent Document 1: International Publication No. WO2012/147843

SUMMARY ~~OF THE INVENTION~~

PROBLEM TO BE SOLVED BY THE ~~INVENTION~~DISCLOSURE

[0005] However, in the case of using the battery case of the above Patent Document 1 as a battery case of a battery using a strong alkaline electrolyte solution, such as an alkaline battery, a nickel hydrogen battery or the like, a problem of this case is that the contact resistance value of the inner surface of the battery case contacting with the electrolyte solution rises along with lapse of time to impair the battery characteristics. With regard to this problem, further improvements of battery characteristics are demanded, including the suppression of impairing the battery characteristics after lapse of time.

[0006] An object of the present ~~invention~~ disclosure is to provide a surface-treated steel sheet excellent in battery characteristics and capable of suppressing impairing the battery characteristics also after lapse of time, in the case of its use as a battery case of a battery using a strong alkaline electrolyte solution. The present ~~invention~~ disclosure has also an object to provide a method for manufacturing such a surface-treated steel sheet.

MEANS FOR SOLVING THE PROBLEM

[0007] As a result of exhaustive studies to achieve the above objects, the present inventors have found that the above objects can be achieved by a surface-treated steel sheet including a steel sheet and a nickel-cobalt-iron diffusion layer as an outermost surface layer formed on the steel sheet when controlling the content of Co and the content of Fe in the surface of the nickel-cobalt-iron diffusion layer within respective specific ranges, as determined by a radio frequency glow discharge optical emission spectrometry on the surface-treated steel sheet, and this finding has led to the completion of the present ~~invention~~disclosure.

[0008] Specifically, according to one aspect of the present ~~invention~~disclosure, there is provided 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 5% by mass or higher and a content of Fe at the specific depth position D, In_{Fe_D}, is 11% by mass or higher, the specific depth position D being a position where the Ni intensity is 0.5% of the maximum value of the Ni intensity.

[0009] In the surface-treated steel sheet according to the present ~~invention~~disclosure, it is preferable that the nickel-cobalt-iron diffusion layer have a content of cobalt of 0.2 g/m^2 or higher.

In the surface-treated steel sheet according to the present ~~invention~~disclosure, it is preferable that 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}.

It is preferable that the surface-treated steel sheet according to the present ~~invention~~ disclosure further comprise an iron-nickel diffusion layer between the steel sheet and the nickel-cobalt-iron diffusion layer.

[0010] According to another aspect of the present ~~invention~~disclosure, there is provided a battery case comprising a ~~any of the above~~ surface-treated steel sheet~~s~~ as defined herein.

According to another aspect of the present ~~invention~~disclosure, there is further provided a battery comprising ~~the above~~a battery case as defined herein.

[0011] According to another aspect of the present disclosure~~invention~~, there is also provided a method for manufacturing a surface-treated steel sheet 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. 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.

[0012] According to another aspect of the present disclosure~~invention~~, 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°C to thereby form a nickel-cobalt-iron diffusion layer as an outermost surface layer.

EFFECTS OF ~~INVENTION~~DISCLOSURE

[0013] According to the present ~~invention~~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 ~~invention~~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.