METHOD OF MANUFACTURING CORROSION-RESISTANT WELDING ELECTRODES MADE OF TUNGSTEN OR A TUNGSTEN ALLOY

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ABSTRACT
Corrosion-resistant welding electrodes made of tungsten or a tungsten alloy are produced. Prefabricated welding electrodes are heat treated at temperatures of between 300° C. and 500° C. in an oxidizing atmosphere. This results in the formation of oxide layers on the surface of the welding electrodes; these layers have good electrical conductivity and prevent the formation of unwanted corrosion layers with poor conductivity. Welding electrodes produced in this way demonstrate outstanding spark ignition and problem-free erosion.
METHOD OF MANUFACTURING CORROSION-RESISTANT WELDING ELECTRODES MADE OF TUNGSTEN OR A TUNGSTEN ALLOY

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of copending International Application No. PCT/AT02/00182, filed Jun. 25, 2002, which designated the United States and which was not published in English.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The invention is for a method for the production of corrosion-resistant welding electrodes made of tungsten or a tungsten alloy.

[0003] In situations of high air humidity in particular, and even at room temperature, tungsten forms corrosion layers consisting of a combination of tungsten with oxygen and nitrogen. Tungsten and tungsten alloys, especially those that are alloyed with oxidic additives, such as thorium oxide, lanthanum oxide, cerium oxide or zirconium oxide, are also frequently used for the manufacture of welding electrodes for TIG welding (TIG, tungsten inert gas). Tungsten welding electrodes have to exhibit a low transfer resistance, especially to the electrode holder, in order to guarantee good spark ignition and problem-free operation.

[0004] The layers of corrosion that form on the tungsten and tungsten alloys as a result of increased air humidity greatly impair the electrical conductivity and thus increase contact resistance. Consequently, the spark ignition and erosion of such corroded welding electrodes present a considerable problem.

SUMMARY OF THE INVENTION

[0005] It is accordingly an object of the invention to provide a method of producing corrosion-protected welding electrodes of tungsten or a tungsten alloy which overcomes the above-mentioned disadvantages of the heretofore-known devices and methods of this general type and which is aimed at creating a measure that prevents, to a sufficient extent, the unwanted corrosion of tungsten or tungsten alloy welding electrodes.

[0006] With the foregoing and other objects in view there is provided, in accordance with the invention, a method of producing a corrosion-resistant welding electrode, which comprises:

[0007] providing a welding electrode of tungsten or tungsten alloy; and

[0008] heat treating the welding electrode at a temperature of between 300° C. and 500° C. in an oxidizing atmosphere, and preferably in a temperature range between 375° C. and 430° C.

[0009] That is, the above and other objects of the invention are achieved by heat-treating the prefabricated welding electrodes at temperatures of between 300° C. and 500° C. in an oxidizing atmosphere.

[0010] Such a heat treatment results in the formation of an oxide layer consisting of WO₃ or WOₓ₋ₓ on the surfaces of the welding electrodes.

[0011] The formation of this oxide layer, which exhibits good electrical conductivity, safely prevents the formation of undesirable corrosion layers with poor conductivity and the welding electrodes demonstrate outstanding spark ignition and problem-free erosion.

[0012] This process is suitable for pure tungsten, as well as for all tungsten alloys normally used as welding electrodes.

[0013] The process is cost-effective. Before the heat treatment, which can, for example, take place in a drying cabinet, the welding electrodes have to be carefully cleaned to remove traces of grease and dirt.

[0014] Ideally, heating to the oxidation temperature should occur within a period of approx. 15 to 45 minutes. Cooling to room temperature should preferably take place within a period of 30 to 60 minutes. The oxidation treatment of this invention has no negative effects whatsoever on the metallurgical properties of the welding electrodes. Oxidation treatment within a temperature range of 375° C. to 430° C. has proved to be particularly advantageous.

[0015] A period of between two and eight hours has proved to be particularly effective for the oxidation treatment. During this period, the oxide layers on the surface form with thicknesses between 10 nm and 50 nm. On the one hand, this guarantees good adhesive properties and, on the other hand, that the oxide layers thus formed are sufficiently resistant to abrasion.

[0016] It is especially easy and economical to perform the oxidation treatment using air as the oxidizing atmosphere.

[0017] Depending on the temperature attained during the oxidation treatment, it is possible to obtain different colors; at relatively low temperature deviations of 10° C. to 15° C., clear changes in color are visible. Different colors are the result of the formation of surface oxide layers of different densities. In particular, by varying the temperature, the colors gold, blue, violet and brown, with the appropriate gradations, can be obtained during the oxidation treatment.

[0018] Depending on the composition of the material used for the electrode, welding electrodes must be color-coded for identification of the electrode material.

[0019] For example, according to EN 26848 and ISO 6848, the following color markings are prescribed for the following alloys:

<table>
<thead>
<tr>
<th>Pure T</th>
<th>T with 0.35-0.55% ThO₂</th>
<th>green</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>with 0.80-1.20% ThO₂</td>
<td>blue</td>
</tr>
<tr>
<td>T</td>
<td>with 1.70-2.20% ThO₂</td>
<td>yellow</td>
</tr>
<tr>
<td>T</td>
<td>with 2.80-3.20% ThO₂</td>
<td>red</td>
</tr>
<tr>
<td>T</td>
<td>with 3.80-4.20% ThO₂</td>
<td>violet</td>
</tr>
<tr>
<td>T</td>
<td>with 0.15-0.50% ZrO₂</td>
<td>orange</td>
</tr>
<tr>
<td>T</td>
<td>with 0.70-0.90% ZrO₂</td>
<td>brown</td>
</tr>
<tr>
<td>T</td>
<td>with 1.80-2.20% CeO</td>
<td>grey</td>
</tr>
<tr>
<td>T</td>
<td>with 0.90-1.20% La₂O₃</td>
<td>black</td>
</tr>
<tr>
<td>T</td>
<td>with 1.3-1.7% La₂O₃</td>
<td>gold</td>
</tr>
</tbody>
</table>
[0020] The color-coding markings are generally applied in the form of stripes of paint that are applied to the end of the electrode that is inserted into the electrode holder. This method results in the repeated abrasion of the color-coding marking and the paint is thus distributed over the contact zone with the electrode holder. This means that the layer of paint can impair the contact between the electrode holder and the electrode.

[0021] A particularly favorable side-effect of the procedure described by this invention occurs when the oxidation conditions are such that the color of the oxide layer formed is the same as that prescribed for the identification of the electrode material used. Thus, the formation of the oxide layer serves simultaneously as oxidation protection and color-coding; this means that no additional color-coding is required.

[0022] Such a procedure is technically feasible for the following in particular:

[0023] Welding electrodes made of tungsten alloy with 1.3-1.7% La₂O₃; gold is the prescribed color-coding.
[0024] Welding electrodes made of tungsten alloy with 0.35-0.55% ThO₂; blue is the prescribed color-coding.
[0025] Welding electrodes made of tungsten alloy with 2.8-3.2% ThO₂; violet is the prescribed color-coding.
[0026] Welding electrodes made of tungsten alloy with 0.15-0.50% ZrO₂; brown is the prescribed color-coding.

[0027] If these colors can be produced clearly by the appropriate control of the oxidation treatment, additional color-coding using paint is no longer necessary. There is, consequently, no deterioration in the contact resistance between the welding electrode and electrode holder.

[0028] In the following, the invention is described using manufacturing examples with two different materials for welding electrodes.

EXAMPLE 1

[0029] Welding electrodes of length 150 mm and diameter 2.4 mm made from a tungsten alloy with 1.3 to 1.7% La₂O₃ and produced by wire-drawing were cleaned with acetone in an ultrasonic bath.

[0030] The electrodes were then heated in air in a muffle furnace for about 40 minutes to a temperature of 400° C. and oxidized over a period of 75 minutes.

[0031] After the completion of the heat treatment, the welding electrodes were removed from the furnace and cooled to room temperature.

[0032] After the oxidation treatment, the welding electrodes were gold-colored.

EXAMPLE 2

[0033] Apart from the treatment time, welding electrodes as per example 1 were treated under the same conditions as described in example 1.

[0034] In this case, the treatment time was 120 minutes.

[0035] After the oxidation treatment, the welding electrodes were violet-colored.

EXAMPLE 3

[0036] Apart from the treatment temperature and the treatment time, welding electrodes as per example 1 were treated under the same conditions as described in example 1.

[0037] In this case, the treatment temperature was 450° C. and the treatment time was 10 hours.

[0038] After the oxidation treatment, the welding electrodes were blue-colored.

EXAMPLE 4

[0039] Welding electrodes of length 150 mm and diameter 2.4 mm made from pure tungsten were produced and cleaned as described in example 1.

[0040] Apart from the treatment time, the further oxidation treatment was in accordance with example 1. In this case, the treatment time was 45 minutes.

[0041] After the oxidation treatment, the welding electrodes were gold-colored.

[0042] In order to investigate the corrosion resistance, the welding electrodes produced as per the examples were stored together with welding electrodes produced with no oxidation treatment in a climatic chamber for 90 hours at 70° C. and 98% air humidity.

[0043] After storage, the welding electrodes produced in accordance with the invention exhibit no visibly discernible surface changes, which would indicate the formation of a corrosion layer. In a subsequent welding test, the welding electrodes demonstrate a good spark ignition and outstanding erosion.

[0044] In contrast, the welding electrodes that were produced without any oxidation treatment show clearly visible black patches that indicate the formation of a corrosion layer. In the subsequent welding test, the spark ignition and the erosion were much worse than the welding electrodes produced in accordance with the invention.

We claim:

1. A method of producing a corrosion-resistant welding electrode, which comprises:

   providing a welding electrode of tungsten or tungsten alloy; and

   heat treating the welding electrode at a temperature of between 300° C. and 500° C. in an oxidizing atmosphere.

2. The method according to claim 1, which comprises heat treating at a temperature between 375° C. and 430° C.

3. The method according to claim 1, which comprises heat treating over a period of between 2 and 8 hours.

4. The method according to claim 1, wherein the oxidizing atmosphere is air.

5. The method according to claim 1, which comprises adjusting oxidation conditions to form an oxide layer with a color corresponding to a color prescribed to identify the electrode material.

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