METHOD FOR THE DEPOSITION OF AN ALLOY ON A SUBSTRATE

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Abstract:
In previously known electrodeposition methods, alloys can be deposited only badly on a substrate from the components thereof. The inventive method allows an alloy layer to be deposited on a substrate by pulsing the current/voltage used for electrode position.
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CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is the US National Stage of International Application No. PCT/DE2003/004155, filed Dec. 16, 2003 and claims the benefit thereof. The International Application claims the benefits of German Patent application No. 10259362.0 DE filed Dec. 18, 2002, both of the applications are incorporated by reference herein in their entirety.

FIELD OF THE INVENTION

[0002] The invention relates to a method for the deposition of an alloy on a substrate.

BACKGROUND OF THE INVENTION

[0003] There are various known methods for applying layers to a substrate. These include, for example, plasma spraying, electrodeposition or vapor deposition processes, inter alia.


[0006] DE 39 43 669 C2 discloses a method and an apparatus for electrolytic surface treatment, in which the parts of the compound used for coating are intimately mixed by vibratory movement and/or rotary movement, so that a uniform electrolytic layer is deposited.

[0007] Other electrolytic coating methods are known from GB 2 167 446 A, EP 443 377 A1 and from the article by J. Zehavi et al. in Plating and Surface Finishing, January 1982, pp. 76 ff “Properties of electrodeposited composite coatings”, in which undissolved particles are used in the electrolyte in order for these particles also to be deposited in the layer.


[0009] U.S. Pat. No. 6,375,823 B1 describes an electrolytic coating method in which an ultrasound probe is used.

[0010] DE 195 45 231 A1 describes a method for the electrolytic deposition of metal layers which uses a pulsed current or pulsed voltage method. However, this is only employed to reduce ageing phenomena in deposition baths.


[0012] DE 196 53 681 C2 discloses a method for the electrolytic deposition of a pure copper layer which uses a pulsed current or pulsed voltage method.

[0013] DE 100 61 186 C1 describes a method for electrolytic deposition which uses periodic current pulses.

[0014] In the article entitled “Electrodeposited composite coatings for protection from high temperature corrosion” in Trans IMF 1987, 65, 21 ff. V. Sova describes an electrolytic deposition method, in which particles which are not dissolved in the electrolyte are used for the layer which is to be applied. The article also describes the use of pulsed currents.

[0015] Layers applied using the known methods have poor adhesion to the substrate under the conditions of some intended uses. Moreover, it is only possible to deposit materials with a constant composition.

SUMMARY OF THE INVENTION

[0016] Therefore, it is an object of the invention to overcome the above problems.

[0017] The object is achieved by a method for the deposition of an alloy on a substrate in accordance with the claims.

[0018] The use of pulsed currents or the generation of graduated layers improves the bonding of layers to the substrate and/or the deposition rate.

[0019] Further advantageous configurations of the method are listed in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] An exemplary embodiment of the invention is explained in more detail in the figures, in which:

[0021] FIG. 1 shows an apparatus for carrying out the method according to the invention, and

[0022] FIG. 2 shows a sequence of a current/voltage pulse which is used for a method according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0023] FIG. 1 shows an apparatus 1 for carrying out the method according to the invention.

[0024] An electrolyte 7, an electrode 10 and a substrate 13 that is to be coated are arranged in a vessel 4. The substrate 13 which is to be coated is, for example, a combustion chamber lining, a housing part or a turbine blade or vane, made from a nickel-, cobalt- or iron-base superalloy, of a gas or steam turbine, which, however, may also already have a layer on the substrate (MCrAlY).

[0025] The substrate 13 and the electrode 10 are electrically conductively connected to a current/voltage source 16 via electrical supply conductors 19. The current/voltage source 16 generates pulsed electric currents/voltages (FIG. 2).

[0026] The electrolyte 7 contains the individual constituents of an alloy which are to be deposited on the substrate 13. For example, the electrolyte 7 contains a first constituent 28 and a second constituent 31 of an alloy.

[0027] The constituents 28, 31 are deposited on the substrate 13 by suitable selection of the process parameters
(FIG. 2). Gradients can also be produced in the chemical composition of the layer to be produced by suitable selection of the process parameters.

[0028] By way of example, an alloy NiCrAlY, in which M stands for at least one element selected from the group consisting of iron, cobalt or nickel, is deposited on the substrate 13. The alloying elements Cr, Al, Y and any further elements are introduced either by the addition of suitable soluble salts to the electrolyte or by suspending fine-grain, insoluble powders in the electroplating bath, with these powders being deposited as solid particles. By way of example, at least two constituents are dissolved, for example in the form of salts, in the electrolyte 7.

[0029] The layer can be homogenized or densified by a subsequent thermal process, or defined phases can be established in the layer.

[0030] An ultrasound probe 22, which may be arranged in the electrolyte 7 and is controlled by an ultrasound transmitter 25, improves the hydrodynamics and the mixing of the constituents 28, 31 in the region of the substrate 13, so as to accelerate the deposition process.

[0031] The oscillation frequency is, for example, above 1 kHz.

[0032] The current/voltage level, the pulse duration and the interpulse period are defined for at least one and in particular for every constituent 28, 31 of the alloy.

[0033] FIG. 2 shows an example of a series of repeating current pulses (40).

[0034] A sequence 34 comprises at least two blocks 37. In FIG. 2, there are four blocks 37. However, there may also be three, five or more blocks 37.

[0035] Each block 37 comprises at least one current pulse 40. In FIG. 2, each block comprises three, four or six current pulses 40. However, it is also possible to use two, five or more than six current pulses 40 per block 37. A current pulse 40 is characterized by its duration $t_{\text{on}}$, the intensity $I_{\text{max}}$, and its shape (square-wave, delta-wave, etc.). The pauses between the individual current pulses $t_{\text{on}}$ and the pauses between the blocks 37 are also important process parameters.

[0036] The sequences may likewise change over the course of time.

[0037] The sequence 34 consists, for example, of a first block 37 with three current pulses 40, between each of which there is a pause. This is followed by a second block 37, which has a higher or lower current intensity, since it is adapted to a different constituent 28, 31, and comprises six current pulses 40. After a further pause, there then follow four current pulses 40 in the opposite direction, i.e. with an altered polarity, in order to correct the alloy composition, the hydrogen desorption or to effect activation.

[0038] Each block 37 may therefore include a different number of current pulses 40, pulse durations $t_{\text{on}}$ or interpulse periods $t_{\text{off}}$.

[0039] The sequence 34 is concluded by a further block 37 of four current pulses.

[0040] The sequence can be repeated a number of times.

[0041] The individual pulse times $t_{\text{on}}$ are preferably of the order of magnitude of approximately 1 to 100 milliseconds. The duration of the block 37 is of the order of magnitude of up to 10 seconds, which means that up to 5000 pulses are emitted in a block 37.

[0042] It is optionally possible for a low potential (base current) to be applied both during the pulse sequences and during the interpulse period. This avoids interruption to the electrodeposition, which can cause inhomogeneities.

[0043] The parameters of a block 37 are adapted to a constituent 28, 31 of the alloy, in order to achieve the optimum deposition of this constituent 28, 31. These parameters can be determined in individual tests. An optimized block 37 leads to an optimized deposition of the constituent optimized for this block 37, i.e. the duration and nature of the deposition are improved. The other constituents are likewise also deposited.

[0044] This optimization can be carried out for at least one further constituent, for example all the constituents 31 of the alloy. The result is that the composition of the constituents 28, 31 is optimized.

[0045] The level of the constituents 28, 31 in the layer to be applied can be defined, for example, by the duration of the individual blocks 37.

[0046] Gradients can likewise be produced in the layer. This is done by correspondingly lengthening or shortening the duration of the block 37, the current/voltage intensity or the number of pulses 40 per block which is optimally adapted to a constituent 28, 31 (i.e. the sequence 34 is altered).

[0047] A sequence 34 can also be altered if, for example, the deposition rate of a constituent 28, 31 alters over the course of time on account of the layer which has already been deposited.

[0048] It is also possible for further non-alloying constituents, such as for example secondary phases, to be contained in the electrolyte 7 and deposited.

1-9. (canceled)
10. A method for the electrolytic deposition of an alloy at least two constituents as a layer on a substrate, comprising:

- arranging the alloy in an electrolyte and the at least two constituents of the alloy are suspended and/or dissolved;
- using a plurality of repeated voltage pulses for the electrolytic deposition and combined in a sequence that comprises at least two different blocks;
- adapting one block in each case to a constituent of the alloy to achieve optimum deposition of the constituent and a block comprising two or more voltage pulses, and following a first block of a sequence by a second block in the same sequence of the same polarity and the second block has a higher or lower voltage level on account of being adapted to one constituent of the alloy.

11. The method as claimed in claim 10, wherein mechanical vibrations are imparted to the electrolyte.
12. The method as claimed in claim 11, wherein an ultrasound probe is operated in the electrolyte.
13. The method as claimed in claim 10, wherein a current/voltage pulse is used for the electrolytic deposition and is defined by the current/voltage pulse time profile.

14. The method as claimed in claim 13, wherein a current/voltage pulse time profile is a square-wave or a delta-wave form.

15. The method as claimed in claim 10, wherein both a positive and a negative current/voltage pulses are used for the electrolytic deposition.

16. The method as claimed in claim 10, wherein a block is defined by a number of current pulses, pulse duration, interpulse period, current intensity, and time profile.

17. The method as claimed in claim 10, wherein an MCrAlY layer is deposited as an alloy on a substrate, with M being an element selected from the group consisting of iron, cobalt and nickel.

18. The method as claimed in claim 10, wherein a gradient in the composition of the material is produced in an alloy layer.

19. The method as claimed in claim 10, wherein a base current is superimposed on the current pulses and the interpulse periods.

20. The method as claimed in claim 10, wherein a base current is superimposed on the current pulses or the interpulse periods.

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