(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 277 855 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.01.2003 Bulletin 2003/04

(51) Int Cl.^7: **C25D 13/22**

(21) Application number: **02012987.0**

(22) Date of filing: **12.06.2002**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **16.07.2001 US 906166**

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(54) Electrodeposition coating process in continuous electrodeposition coating plants

(57) A process for electrodeposition coating electrically conductive substrates in continuous electrodeposition coating plants, wherein, in the event of a shutdown of the conveying means, conventionally a belt, all the substrates not in motion and immersed in the electrodeposition coating tank are, at the latest after a brief de-energized interruption, completely coated while ensuring at least the nominal deposition period at the nominal deposition voltage, and then the completely coated, still immersed substrates not in motion remain de-energized in the electrodeposition coating tank and, when the conveying means has restarted, the substrates remain de-energized until reaching the end of the electrodeposition coating tank and are removed therefrom.

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Description

Field of the Invention

[0001] The present invention relates to a process for electrodeposition coating (EDC) electrically conductive substrates in continuous EDC plants.

Background of the Invention

[0002] The known electrodeposition coating process for coating electrically conductive substrates may be performed in batch or continuous plants. Industrially manufactured substrates that are to be electrodeposition coated, such as, automotive bodies, are virtually exclusively electrodeposition coated in continuous plants (c.f. Ullmann's Encyclopedia of Industrial Chemistry, volume A 18, pages 495 to 497).

[0003] Continuous EDC plants allow the EDC process to proceed continuously at high levels of productivity. Such continuous plants are distinguished from batch plants in that the EDC tank has a large volume, for example, of the order of 100 to 500 cubic meters, and a large tank length, for example of the order of 10 to 30 meters and in that several substrates connected as deposition electrode are conveyed in a longitudinal direction at a constant belt speed simultaneously in a successive arrangement through the EDC tank and are electrocoated. While a substrate is being immersed at the beginning of the EDC tank, one or more substrates are passing in the immersed state through the central part of the EDC tank and a substrate is being removed from the bath at the end of the EDC tank. In this manner, each substrate passes through the EDC tank in a period, depending upon belt speed, of the order of a few, for example, 2 to 6 minutes.

[0004] It is not unusual for the EDC process to be interrupted in such continuous plants. Such interruptions are scheduled, for example due to preassembly work or staff rest breaks, or unscheduled, for example, due to breakdowns in the conveying system or in the various supply systems for the EDC plant.

[0005] During such interruptions, the mechanism conveying the substrates comes to a standstill (belt shutdown) and the electrical power is switched off or a holding voltage of for example 100 to 300 V below the nominal deposition voltage is applied. The holding voltage is intended to prevent the EDC layer that has already been deposited onto the immersed substrates from redissolving back into the EDC bath. The holding voltage is here selected such that it gives rise to an equilibrium between redissolution and deposition of the EDC. Once the interruption is over, the coating process is continued as normal. In this manner, it is ensured that all the substrates to be electrodeposition (ED) coated receive the nominal quantity of electricity required for the coating thereof, irrespective of whether they have passed through the coating process with or without interruption. The ED coated substrates are then rinsed with EDC ultrafiltrate and/or deionized water and introduced into the curing process, in particular a baking process.

[0006] Especially if such interruptions of the EDC process are of relatively long duration, for example, longer than 5 minutes, coating defects within the cured EDC layer, in particular on horizontal surfaces, are often subsequently observed. Such coating defects must be removed laboriously by reworking operations, such as, sanding. The coating defects are often so severe that reworking is not economically viable or, in other words, the ED coated substrate has become scrap.

[0007] It has been observed that coating defects arising as a result of a belt shutdown in continuous EDC plants may be avoided if all substrates that are in an immersed state during a belt shutdown are, at the latest after a brief interruption of the continuous EDC process, completely coated at the nominal deposition voltage and then, once the belt has been restarted, the continuous EDC plant remains de-energized until the substrates completely coated in this manner are removed from the bath.

Summary of the Invention

[0008] The present invention provides a process for electrodeposition coating electrically conductive substrates in continuous electrodeposition coating plants by conveying conductive substrates connected as deposition electrodes through an electrodeposition coating tank containing an electrocoating bath composition via a conveying means, wherein, in the event of a shutdown of the conveying means, all the substrates not in motion and immersed in the electrodeposition coating tank are, at the latest after a brief de-energized interruption, completely coated while ensuring at least the nominal deposition period at the nominal deposition voltage, and then the completely coated, still immersed substrates not in motion remain de-energized in the electrodeposition coating tank and when the conveying means has restarted, the substrates remain de-energized until reaching the end of the electrodeposition coating tank and are removed therefrom.

Detailed Description of the Embodiments

[0009] The phrase "at least the nominal deposition period" is used in the description and the claims. The nominal deposition period is the period of time that is specified for a given substrate with a given EDC agent and given EDC parameters in order to achieve a desired nominal layer thickness of the EDC layer. Obviously, the nominal deposition period has a certain tolerance range with a minimum deposition period, below which the period must not fall, and a maximum deposition period. While the minimum deposition period is an absolute minimum, it is less problematic from a technical standpoint if the maximum deposition period is exceeded.

[0010] The "conveying means" used to transport substrates to be electrocoated through an EDC process may be a belt and hereinafter, for brevity, will be referred to as a "belt".

[0011] The process according to the invention may be used with success both in anodic electrodeposition (AED) coating and in the more widespread, preferred cathodic electrodeposition (CED) coating process.

[0012] In contrast with the prior art, in the process according to the invention, when the EDC process is interrupted, the immersed substrates, which, due to the associated belt shutdown, are not in motion and in the incompletely coated state are not left for an extended period in a de-energized state or only provided with a holding voltage. Instead, at the latest after a brief de-energized interruption, the coating process for the substrates not in motion is taken to completion. For example, at the latest after a 5 minute de-energized interruption, but preferably sooner, the nominal deposition voltage is reapplied. Reapplication of the nominal deposition voltage may proceed manually or automatically at the desired time, for example, by automatically recording the time that has elapsed since the beginning of a belt shutdown. It is convenient to ramp up the nominal deposition voltage with current limitation in order to avoid current peaks.

[0013] Particularly preferably, the nominal deposition voltage is simply applied without interruption until at least the nominal deposition period has been achieved. Once at least the nominal deposition period has been achieved, the electrical power may be shut off manually or automatically, for example, by automatically recording the time that has elapsed since the beginning of a belt shutdown.

[0014] The nominal deposition voltage is or remains applied until at least the nominal deposition period at the nominal deposition voltage is achieved for each of the immersed substrates not in motion. To this end, the nominal deposition voltage for that substrate immersed in the immersion zone of the continuous EDC plant is applied at least until the intended nominal deposition period is achieved. The nominal deposition period may, however, be exceeded by, for example, up to 100%, for example to offset any redissolution of previously deposited EDC. If the nominal deposition period is, for example, 3 minutes and if the first substrate located in the immersion zone has been connected as deposition electrode at the nominal deposition voltage for, for example, 1 minute prior to the belt shutdown, the nominal deposition voltage is or remains applied to the immersed substrates not in motion for approximately 2 minutes, so achieving the nominal deposition period in this manner. As a result of this procedure, the nominal deposition period for the other substrates also not in motion and in the immersed state that are located in the middle of the tank or in the removal zone is exceeded. However, exceeding the nominal deposition period has no disadvantageous consequences upon the surface of the EDC layer; the EDC process is ultimately self-limiting due to the electrically insulating properties of the deposited EDC layer. It may merely be the case that the EDC layer of the substrates for which the nominal deposition period has been exceeded has a somewhat greater layer thickness than intended. This is, however, not disadvantageous. Once at least the nominal deposition period for all the immersed substrates not in motion has been achieved in this manner, the electrical power is turned off.

[0015] During undisturbed operation of a continuous EDC plant, the nominal deposition period is inevitably obtained as a result of the length of the EDC tank, the arrangement of the counter-electrodes and the belt speed at which the substrates to be coated pass through the EDC tank. The nominal deposition period is, for example, 2 to 5 minutes, while the nominal deposition voltage is, for example, 200 to 500 V.

[0016] Once the interruption is over or the belt is restarted, the substrates which have been completely ED coated while not in motion are conveyed in a de-energized state through the EDC tank, removed from the bath, rinsed in the conventional manner with EDC ultrafiltrate and/or deionized water and introduced into the curing process, in particular a baking process. Only once the last substrate, i.e. the substrate immersed at the immersion zone of the EDC tank during the belt shutdown, has been removed from the electrocoating bath the electrical power is turned back on for the purpose of ED coating of the following substrates. In this case too, it is convenient to ramp up the nominal deposition voltage with current limitation.

[0017] The nominal deposition period is not achieved for all the substrates following the substrates that have been conveyed through and removed from the EDC tank in the de-energized state. This is because the immediately following substrates were immersed into the EDC tank in the de-energized state and have passed through the EDC tank for a greater or lesser distance in the de-energized state before the electrical power was turned back on. In other words, in particular the EDC layer of the immediately following substrates may exhibit a lower thickness. It may accordingly be convenient, when the electrical power is turned back on, to halt the belt again for an appropriate period in order to achieve in this manner at least the nominal deposition period for the following substrates. Thereafter, the continuous

EDC plant may be further operated under normal conditions without either turning off the electrical power or shutting down the belt.

[0018] The process according to the invention may be operated as above if the EDC material used is not excessively susceptible to redissolution. It is preferred to use EDC agents that have a low susceptibility to redissolution. For example, an EDC layer deposited to the nominal layer thickness should not be more than 25% redissolved by spending 20 minutes in the de-energized state in the EDC bath. Such a low level of redissolution is prior art for today's EDC agents, in particular for preferred CED coating agents.

[0019] Excessive redissolution of the deposited EDC layer from the substrate immersed in the EDC bath in the de-energized state may occur if the belt shutdown after completion of ED coating of the immersed substrates not in motion is of very long duration, for example longer than 60 minutes, and/or if an EDC agent which is highly susceptible to redissolution has been used. If, after completion of ED coating of the immersed substrates not in motion, excessive redissolution of the EDC layer has occurred, the substrates, after removal from the bath in the de-energized state, are treated exactly as described above, but are not baked. They are not scrap because, either after being stripped or still provided with the excessively thin, uncured EDC layer, they can be reintroduced into the EDC process together with uncoated new substrates.

[0020] The process according to the invention is particularly useful for ED coating of substrates having large proportions of horizontal surfaces or substrates to which stringent coating quality requirements are applied. Examples of such substrates are automotive bodies and parts thereof, metal furniture and agricultural machinery. In comparison with prior art processes, both the reworking and the scrap rates may be distinctly reduced by the process according to the invention. In the Examples, the conditions prevailing in a continuous CED plant are replicated in a batch operated CED bath.

EXAMPLES

[0021] Metal test sheets bent into an L shape were coated in a CED coating bath with a solids content of 16 wt-% (Herberts Aqua-EC 3000, R 39855.1 from DuPont Performance Coatings GmbH & Co. KG) in accordance with the coating conditions stated in Table 1 at a bath temperature of 30°C and a deposition voltage of 240 V, were then removed from the bath, rinsed with deionized water and baked for 25 minutes at 175°C.

Table 1

Example	Coating conditions	Coating result on horizontal surfaces
1	1 min electrodeposition/30 min de-energized/2 min electrodeposition	Not OK
2	1 min electrodeposition/30 min at 30 V holding voltage/2 min electrodeposition	Not OK
3	30 min de-energized/3 min electrodeposition	Not OK
4	3 min electrodeposition/30 min de-energized	OK
5	1 min electrodeposition/2 min de-energized/2 min electrodeposition	OK

[0022] Examples 1 to 3 are Comparative Examples. Examples 4 and 5 correspond to the process according to the invention.

Claims

1. A process for electrodeposition coating electrically conductive substrates in continuous electrodeposition coating plants by conveying conductive substrates connected as deposition electrodes through an electrodeposition tank containing an electrocoating bath via a conveying means, wherein, in the event of a shutdown of the conveying means, all the substrates not in motion and immersed in the electrodeposition coating tank are, at the latest after a brief de-energized interruption, completely coated while ensuring at least the nominal deposition period at the nominal deposition voltage, and then the completely coated, still immersed substrates not in motion remain de-energized in the electrodeposition coating tank and, when the conveying means has restarted, the substrates remain de-energized until reaching the end of the electrodeposition coating tank and are removed therefrom.

2. The process according to claim 1, wherein the brief de-energized interruption is no longer than 5 minutes.

3. The process according to claim 1, wherein electrodeposition coating of the substrates not in motion and immersed in the electrocoating bath is taken to completion without interruption.

4. The process according to any one of the preceding claims, wherein the electrically conductive substrates comprise substrates selected from the group consisting of automotive bodies, automotive body parts, metal furniture and agricultural machinery.

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EUROPEAN SEARCH REPORT

Application Number
EP 02 01 2987

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	PATENT ABSTRACTS OF JAPAN vol. 004, no. 077 (C-013), 4 June 1980 (1980-06-04) & JP 55 041953 A (MAZDA MOTOR CORP;OTHERS: 01), 25 March 1980 (1980-03-25) * abstract *	1-4	C25D13/22
X	PATENT ABSTRACTS OF JAPAN vol. 006, no. 057 (C-098), 14 April 1982 (1982-04-14) & JP 56 169797 A (MAZDA MOTOR CORP), 26 December 1981 (1981-12-26) * abstract *	1-4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			C25D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 November 2002	Zech, N

CATEGORY OF CITED DOCUMENTS

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21-11-2002

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