



US 20080289968A1

(19) **United States**(12) **Patent Application Publication**  
**MENOVCIK et al.**(10) **Pub. No.: US 2008/0289968 A1**(43) **Pub. Date: Nov. 27, 2008**(54) **METHOD OF COATING A SUBSTRATE  
INCLUDING A SIMULTANEOUS CURE****Publication Classification**(75) Inventors: **GREGORY G. MENOVCIK**,  
Northville, MI (US); **Cynthia A.  
Stants**, Pinckney, MI (US);  
**Timothy S. December**, Rochester  
Hills, MI (US)(51) **Int. Cl.**  
**C23C 28/00** (2006.01)  
**C25D 5/00** (2006.01)(52) **U.S. Cl. .... 205/194**

Correspondence Address:

**HOWARD & HOWARD ATTORNEYS, P.C.**  
**BASF CORPORATION**  
**THE PINEHURST OFFICE CENTER, SUITE**  
**#101, 39400 WOODWARD AVENUE**  
**BLOOMFIELD HILLS, MI 48304-5151 (US)**(73) Assignee: **BASF CORPORATION**,  
SOUTHFIELD, MI (US)(21) Appl. No.: **11/753,587**(22) Filed: **May 25, 2007**(57) **ABSTRACT**

A method of coating a substrate includes the steps of applying an electrocoat to the substrate, applying a powder primer onto the electrocoat, and then applying a topcoat onto the powder primer. The topcoat typically includes a powder basecoat and a clearcoat. The powder primer is applied to the electrocoat without first curing the electrocoat before application of the powder primer. The powder basecoat is applied to the powder primer without first curing the powder primer before application of the powder basecoat. The clearcoat is applied over the powder basecoat after which the electrocoat, the powder primer, the powder basecoat, and the clearcoat are simultaneously cured in an oven.

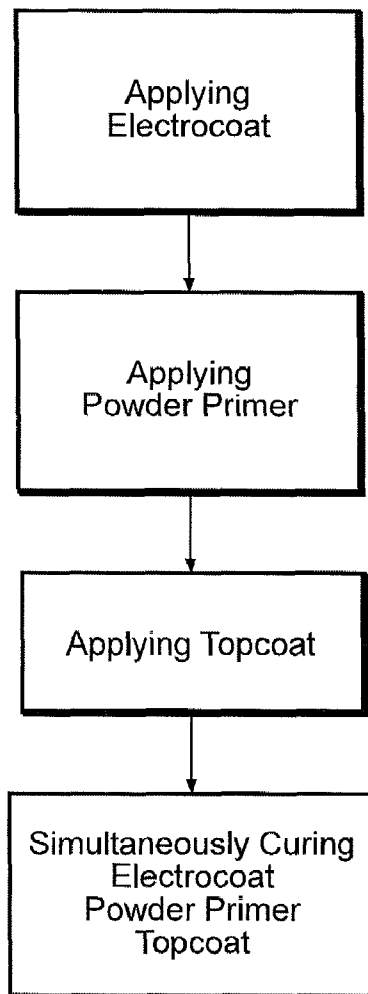


FIG - 1A

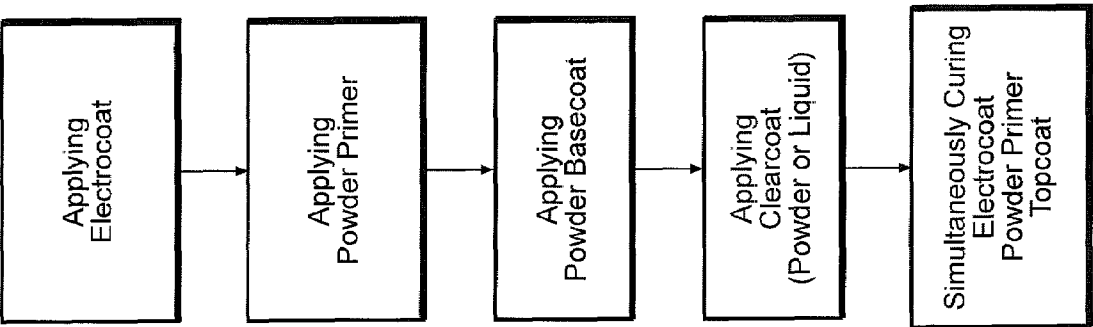
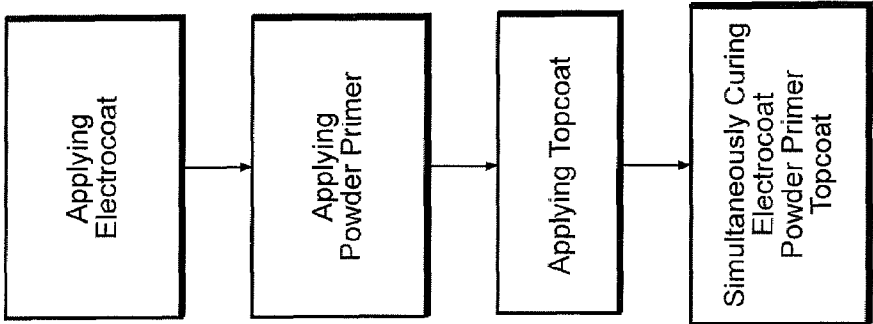
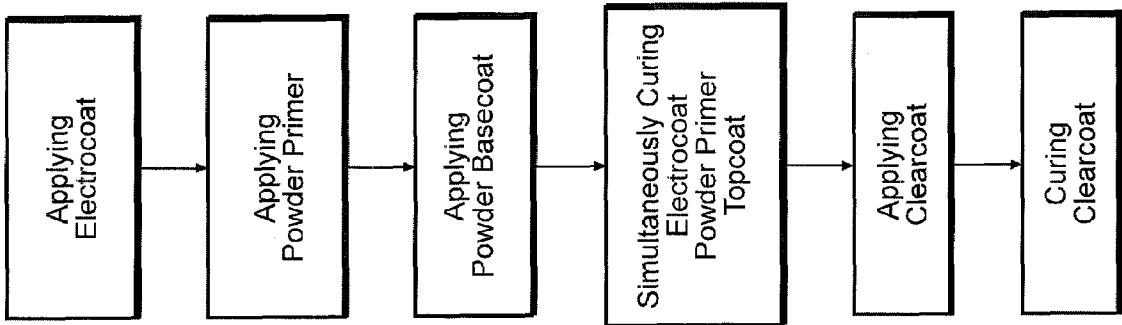


FIG - 1B

FIG - 1C



## METHOD OF COATING A SUBSTRATE INCLUDING A SIMULTANEOUS CURE

### BACKGROUND OF THE INVENTION

**[0001]** 1. Field of the Invention

**[0002]** The subject invention generally relates to a method of coating a substrate, and more specifically relates to a method including a step of simultaneously curing an electrocoat, a powder primer, and a topcoat.

**[0003]** 2. Description of the Related Art

**[0004]** Mass production painting processes typically include either a liquid paint spraying process or a powder paint coating process. The liquid paint spraying process includes a method comprising preparing a substrate, which typically includes a phosphate pre-treatment followed by application of an electrocoat. The electrocoat is preferably applied by a process known as electrodeposition, in which the substrate is electrically charged and immersed in a bath of an electrocoat composition. The electrocoat composition in the bath includes an opposite electrical charge relative to the substrate. The particles of the electrocoat composition are attracted to the substrate, neutralized, and then cured. The preferred method includes making the substrate the cathode, in which the process is called cathodic electrocoating as is well known in the art. The electrocoat, which is deposited onto the substrate, is then cured in a first oven. After the electrocoat is cured, final preparation of the substrate includes sanding the electrocoat to reduce the average surface roughness ( $R_a$ ) of the electrocoat.

**[0005]** The substrate is then moved to a first paint booth, where a liquid primer is applied over the cured electrocoat by a standard industrial spray painting technique. The substrate is then moved to a second oven, where the liquid primer is then cured. The substrate is then moved to a second paint booth, where a liquid basecoat (color coat) is then applied over the primer by the standard industrial spray painting technique. The liquid basecoat is allowed to form a film layer, i.e., flash-off, after which a liquid clearcoat is applied by the standard spray painting technique. The substrate is then moved to a third oven, where the basecoat and the clearcoat are then both cured in an oven simultaneously to provide the finished product.

**[0006]** The traditional powder paint coating process includes a method comprising the same substrate preparation process as described above in the liquid paint spraying process. After the electrocoat is cured in the first oven, the substrate is moved to a first paint booth, where a powder primer is applied over the cured electrocoat by a standard electrostatic spray technique, such as with an electrostatic spray gun. The substrate is then moved to a second oven, where the powder primer is then cured. The substrate is then moved to a second paint booth, where a powder basecoat is applied to the cured powder primer by the electrostatic spray technique. A clearcoat is then applied onto the powder basecoat. The substrate is then moved to a third oven, where the powder basecoat and the clearcoat are cured in an oven to provide a finished product. It should be noted that the use of a powder primer in the powder coating process is optional, and usually only utilized when required to improve durability of the coating on the substrate, and to improve resistance of the coating on the substrate to chipping.

**[0007]** The different application and curing steps described above for the liquid spray painting process and the powder coating process each require significant space along a pro-

duction line, and travel time between the various ovens and paint booths. Additionally, the curing process requires a large amount of energy to heat the ovens, thereby adding to the cost of producing the product.

### SUMMARY OF THE INVENTION AND ADVANTAGES

**[0008]** The subject invention provides a method of coating a substrate with an electrocoat, a powder primer, and a topcoat. The method comprises the steps of applying the electrocoat onto the substrate, applying the powder primer onto the electrocoat, and then applying the topcoat onto the powder primer. The method further comprises simultaneously curing the electrocoat, the powder primer, and the topcoat, in an oven by application of heat.

**[0009]** Accordingly, the subject invention provides a method of coating a substrate that requires only a single oven and eliminates the step of curing the electrocoat prior to application of the powder primer, and also eliminates the step of curing the powder primer prior to application of the topcoat. Therefore, the subject invention reduces the space requirements within a production facility by eliminating the oven to cure the electrocoat and the oven to cure the powder primer, reduces production time by eliminating the movement of the substrate between the electrocoat oven and the powder primer paint booth as well as between the powder primer paint booth and the powder primer oven, and reduces the energy required to coat the substrate by eliminating the separate steps of independently curing the electrocoat and the powder primer, thereby reducing production costs.

### BRIEF DESCRIPTION OF THE DRAWINGS

**[0010]** Other advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

**[0011]** FIG. 1A is a flowchart generally illustrating a method of the present invention;

**[0012]** FIG. 1B is a flowchart illustrating a specific application of the method of the subject invention; and

**[0013]** FIG. 1C is a flowchart illustrating another specific application of the method of the subject invention.

### DETAILED DESCRIPTION OF THE INVENTION

**[0014]** Referring to FIG. 1, a method of coating a substrate is shown. The method includes the application of an electrocoat, a powder primer, and a clearcoat onto the substrate.

**[0015]** The method includes applying the electrocoat to the substrate. The step of applying the electrocoat is further defined as applying the electrocoat having a film build between the range of 20 microns and 30 microns. The electrocoat is preferably applied by a process known as electrodeposition, in which the substrate is electrically charged and immersed in a bath of the electrocoat. Examples of the electrocoat are given in U.S. Pat. No. 6,951,602, Ser. No. 10/009,161, the disclosure of which is herein incorporated by reference. It should be understood that the electrocoat may include other electrocoats not specifically described in U.S. Pat. No. 6,951,602. The electrocoat in the bath includes an opposite electrical charge relative to the substrate. The particles of the electrocoat are attracted to the substrate and neutralized. The preferred method includes making the sub-

strate the cathode, in which the process is called cathodic electrocoating as is well known in the art. The electrocoat is allowed to dry, or dehydrate, and form a film on the substrate, i.e., flash-off. The electrocoat is dehydrated in a suitable manner, such as by exposing the substrate to ambient air without any added heat. However, the electrocoat may also be dehydrated by application of heat so long as the heat applied is not sufficient to cure the electrocoat. For example, a suitable method of dehydrating the electrocoat includes heating the substrate in an oven at a temperature of 100° C. for 10 minutes. It should be understood that other methods of dehydrating the electrocoat may be utilized so long as the electrocoat is not cured, i.e., no cross linking occurs.

**[0016]** After the electrocoat has been dehydrated, i.e., flashed-off, the substrate is moved to a first paint booth, where the powder primer is applied onto the electrocoat. Notably, the powder primer is applied onto the electrocoat without curing the electrocoat, thereby eliminating the need for an oven and a step of curing the electrocoat prior to application of the powder primer. The step of applying the powder primer is further defined as applying the powder primer having a film build between the range of 30 microns and 50 microns. The powder primer is preferably applied utilizing an electrostatic spray system as is well known in the art, where the powder primer is electrically charged as it passes through the electrostatic spray system and applied to the substrate while the substrate is grounded. It should be understood that the powder primer may be applied onto the electrocoat in some other manner and still fall within the scope of the claims. Preferably, the powder primer comprises a polyurethane, i.e., the powder primer is a polyurethane powder primer. Examples of the powder primer are given in U.S. Pat. No. 6,248,743, Ser. No. 09/156,050, the disclosure of which is herein incorporated by reference. It should be understood that the powder primer is not limited to polyurethane powder primers, and that the powder primer may include some other powder primer not specifically described in U.S. Pat. No. 6,248,873.

**[0017]** The method further comprises applying the topcoat onto the powder primer. Preferably, the topcoat includes a basecoat and a clearcoat. However, it should be understood that the topcoat may include only the basecoat and not the clearcoat, or may include only the clearcoat and not the basecoat. If utilized, the clearcoat may include either a powder clearcoat or a liquid clearcoat. Also if utilized, the basecoat may include either a powder basecoat or a liquid basecoat. Whether the basecoat is a powder basecoat or a liquid basecoat, it preferably comprises a polyurethane, i.e., the basecoat is typically a polyurethane powder basecoat or a polyurethane liquid basecoat. However, neither the powder basecoat or liquid basecoat are limited to polyurethane-based chemistries.

**[0018]** If the basecoat is utilized, then the step of applying the topcoat is further defined as applying the basecoat onto the powder primer prior to curing the powder primer. If the basecoat includes the powder basecoat, then the step of applying the powder basecoat is further defined as applying the powder basecoat having a film build between the range of 40 microns and 50 microns. When utilizing the powder basecoat, the thickness of the film build of the powder primer may be reduced. Accordingly, the step of applying the powder primer when the powder basecoat is utilized is further defined as applying the powder primer having a film build between the range of 30 microns and 40 microns. If the basecoat includes the liquid basecoat, then the step of applying the liquid

basecoat is further defined as applying the liquid basecoat having a film build between the range of 20 microns and 25 microns.

**[0019]** The powder basecoat is preferably applied with an electrostatic spray system as described above for applying the powder primer. However, it should be understood that the powder basecoat may be applied by some other system and still fall within the scope of the claims. As indicated above, the powder basecoat is preferably a polyurethane powder basecoat. Examples of the powder basecoat are given in U.S. Pat. No. 6,992,149, Ser. No. 10/777,301, the disclosure of which is hereby incorporated by reference. It should be understood that the powder basecoat is not limited to polyurethane powder basecoats and that the powder basecoat may include other powder basecoats not specifically described in U.S. Pat. No. 6,992,149. If the basecoat includes the liquid basecoat, then the liquid basecoat is applied by a liquid paint spray system or the like as is well known in the art. While the powder primer and the powder basecoat are similar in composition, there are several differences distinguishing between the powder primer and the powder basecoat. Some of the differences between the powder primer and the powder basecoat are listed in Table 1 below. It should be understood that the list in Table 1 is not exhaustive, and that other differences may exist.

TABLE 1

	Primer	Basecoat
Color	Normally no flake additive	Typically includes flake additive
Pigment Selection	Lower cost pigments - not typically selected for outdoor durability	Pigments selected for outdoor durability
Filler Pigments	Generally higher levels, P/B of 0.2 of filler or extender pigments such as barium sulfate are typical	Normally no filler or extender pigments
Performance	Designed for corrosion properties and chip	Often not optimized for corrosion properties
Film Hardness	Designed for film hardness and the ability to sand	Not typically designed for sanding
Filling Power	Designed to fill roughness from electrocoat	Not typically designed for filling - designed for high flow and leveling
Bake	Typically baked as a separate layer, typically 125° C.-160° C.	Normally used wet on wet with clearcoat and then baked together with clearcoat

**[0020]** As noted in Table 1, the powder basecoat may comprise a flake additive. Preferably, the flake additive comprises at least one of a mica flake and a metal flake. It should be appreciated that the additive may also include some other flake additive not specifically described herein. If the powder basecoat comprises the flake additive, then the step of applying the powder basecoat is further defined as applying the powder basecoat comprising the flake additive onto the powder primer.

**[0021]** The powder basecoat may be applied in the same paint booth as the powder primer, thereby eliminating the time to transport the substrate between paint booths to apply the powder primer and the powder basecoat, as well as the space required for the separate paint booths. It should be understood that separate paint booths may also still be utilized if desired.

**[0022]** If no clearcoat is applied over the powder basecoat, then the substrate is moved to a first oven, where the electrocoat, the powder primer, and the powder basecoat are simultaneously cured together in an oven. Preferably the electrocoat, the powder primer, and the powder basecoat are cured at a temperature of between 150° C. and 180° C. for a time between 15 minutes and 30 minutes. More specifically, the electrocoat, the powder primer, and the powder basecoat are cured at a temperature of 170° C. for 20 minutes. It should be understood that the electrocoat, the powder primer, and the powder basecoat are cured simultaneously, but that the temperature and time used in the step of curing the electrocoat, the powder primer, and the powder basecoat may differ from those described above.

**[0023]** If the topcoat includes only the basecoat, in which case the electrocoat, the powder primer, and the basecoat are cured simultaneously, then the method may further comprise the step of applying a clearcoat onto the topcoat after simultaneously curing the electrocoat, the powder primer, and the topcoat. After the clearcoat is applied to the topcoat, then the method further comprises curing the clearcoat. The clearcoat is preferably cured at a temperature between the range of 150° C. and 180° C. for a time between 15 minutes and 30 minutes. More preferably, the clearcoat is cured at a temperature of 170° C. for 20 minutes. It should be understood that the temperature and the times utilized in the step of curing the clearcoat may differ from those described herein.

**[0024]** If a clearcoat is to be utilized, then the method further comprises the step of applying the clearcoat onto the powder basecoat. The step of applying the clearcoat is further defined as applying the clearcoat having a film build between the range of 40 microns and 50 microns. As described above, the clearcoat may include either a liquid clearcoat or a powder clearcoat. If the clearcoat is a powder clearcoat, then the powder clearcoat is applied with the electrostatic spray system as described above for applying the powder primer and the powder basecoat. The powder clearcoat may also be applied in the same paint booth utilized for applying the powder primer and the powder basecoat, if desired. It should be understood that a method other than the electrostatic spray system may also be utilized to apply the powder clearcoat and still fall within the scope of the claims. If the clearcoat is a liquid clearcoat, then the liquid clearcoat is applied by a liquid paint spray system or the like as is well known in the art.

**[0025]** The clearcoat, whether the liquid clearcoat or the powder clearcoat, comprises a resin preferably selected from the group of acrylic polymers, polyester polymers, polyurethane polymers, and combination thereof. In terms of a cross linking agent, the clearcoat is preferably based on a blocked isocyanate or triazole blocked urethane. Examples of the powder clearcoat are given in U.S. Pat. No. 6,992,149, Ser. No. 10/777,301, the disclosure of which is herein incorporated by reference. It should be understood that the powder clearcoat may include other powder clearcoats not described in U.S. Pat. No. 6,992,149.

**[0026]** If the clearcoat is utilized in the coating process and applied over the powder basecoat, then the substrate is moved to a first oven, and the method further comprises simultaneously curing the electrocoat, the powder primer, the powder basecoat, and the clearcoat in an oven by application of heat. Preferably the electrocoat, the powder primer, the powder basecoat, and the clearcoat are cured at a temperature between the range of 150° C. and 180° C. for a time of between 15 minutes and 30 minutes. More preferably, the

electrocoat, the powder primer, the powder basecoat and the clearcoat are cured at a temperature of 170° C. for 20 minutes. It should be understood that the electrocoat, the powder primer, the powder basecoat, and the clearcoat are cured simultaneously, but that the temperatures and timing utilized in the step of curing the electrocoat, the powder primer, the powder basecoat, and the clearcoat may differ from those described above.

**[0027]** If no basecoat is utilized, then the topcoat comprises the clearcoat only, and the clearcoat is applied over the powder primer. The substrate is moved to a first oven, and the method further comprises simultaneously curing the electrocoat, the powder primer, and the clearcoat in an oven by application of heat. Preferably, the electrocoat, the powder primer, and the clearcoat are cured at a temperature between the range of 150° C. and 180° C. for a time between the range of 15 minutes and 30 minutes. More preferably, the electrocoat, the powder primer, and the clearcoat are cured at a temperature of 170° C. for 20 minutes. It should be understood that the electrocoat, the powder primer, and the clearcoat are cured simultaneously, but that the temperature and timing utilized in the step of curing the electrocoat, the powder primer, and the clearcoat may differ from those described above.

**[0028]** The method further comprises collecting any excess of the powder primer for later use. Likewise, the method includes the steps of collecting any excess of the powder basecoat for later use and collecting any excess of the powder clearcoat for later use. The method further includes re-circulating the collected powder primer, the collected powder basecoat, and the collected powder clearcoat for use in the steps of applying the powder primer onto the electrocoat, applying the powder basecoat onto the powder primer, and applying the powder clearcoat over the powder basecoat respectively. The method of collecting and re-circulating the powder primer, the powder basecoat, and the powder clearcoat are well known in the art and are not described in detail herein.

**[0029]** The foregoing invention has been described in accordance with the relevant legal standards; thus, the description is exemplary rather than limiting in nature. Variations and modifications to the disclosed embodiments may become apparent to those skilled in the art and do come within the scope of the invention. Accordingly, the scope of legal protection afforded this invention can only be determined by studying the following claims.

What is claimed is:

1. A method of coating a substrate with an electrocoat, a powder primer, and a topcoat, said method comprising the steps of:

applying the electrocoat onto the substrate;  
applying the powder primer onto the electrocoat;  
applying the topcoat onto the powder primer; and  
simultaneously curing the electrocoat, the powder primer, and the topcoat in an oven by application of heat.

2. A method as set forth in claim 1 wherein the step of simultaneously curing the electrocoat, the powder primer, and the topcoat is further defined as simultaneously curing the electrocoat, the powder primer, and the topcoat at a temperature between the range of 150° C. and 180° C. for a time between the range of 15 minutes and 30 minutes.

3. A method as set forth in claim 1 further comprising the step of dehydrating the electrocoat.

4. A method as set forth in claim 3 wherein the step of dehydrating the electrocoat is further defined as dehydrating the electrocoat at a temperature of 100° C. for a time of 10 minutes.

5. A method as set forth in claim 1 wherein the topcoat includes a basecoat and the step of applying the topcoat is further defined as applying the basecoat onto the powder primer.

6. A method as set forth in claim 5 wherein the basecoat includes a powder basecoat and the step of applying the basecoat is further defined as applying the powder basecoat onto the powder primer.

7. A method as set forth in claim 6 wherein the powder basecoat comprises a flake additive and the step of applying the powder basecoat is further defined as applying the powder basecoat comprising the flake additive onto the powder primer.

8. A method as set forth in claim 7 wherein the flake additive comprises at least one of a mica flake and a metal flake.

9. A method as set forth in claim 6 wherein the step of simultaneously curing the electrocoat, the powder primer and the topcoat is further defined as simultaneously curing the electrocoat, the powder primer, and the powder basecoat in an oven by application of heat.

10. A method as set forth in claim 6 wherein the step of applying the powder basecoat comprises a polyurethane.

11. A method as set forth in claim 6 wherein the step of applying the powder basecoat is further defined as applying the powder basecoat having a film build between the range of 40 microns and 50 microns.

12. A method as set forth in claim 11 wherein the step of applying the powder primer is further defined as applying the powder primer having a film build between the range of 30 microns and 40 microns.

13. A method as set forth in claim 5 wherein the basecoat includes a liquid basecoat and the step of applying the basecoat is further defined as applying the liquid basecoat onto the powder primer.

14. A method as set forth in claim 13 wherein the step of simultaneously curing the electrocoat, the powder primer and the topcoat is further defined as simultaneously curing the electrocoat, the powder primer, and the liquid basecoat in an oven by application of heat.

15. A method as set forth in claim 13 wherein the liquid basecoat comprises a polyurethane.

16. A method as set forth in claim 13 wherein the step of applying the liquid basecoat is further defined as applying the liquid basecoat having a film build between the range of 20 microns and 25 microns.

17. A method as set forth in claim 1 wherein the topcoat includes a clearcoat and the step of applying the topcoat is further defined as applying the clearcoat onto the powder primer.

18. A method as set forth in claim 17 wherein the step of applying the clearcoat is further defined as applying a powder clearcoat.

19. A method as set forth in claim 17 wherein the step of applying the clearcoat is further defined as applying a liquid clearcoat.

20. A method as set forth in claim 17 wherein the step of applying the clearcoat is further defined as applying the clearcoat having a film build between the range of 40 microns and 50 microns.

21. A method as set forth in claim 17 wherein the step of simultaneously curing the electrocoat, the powder primer and the topcoat is further defined as simultaneously curing the electrocoat, the powder primer, and the clearcoat in an oven by application of heat.

22. A method as set forth in claim 17 wherein the clearcoat comprises a resin selected from the group of acrylic polymers, polyester polymers, polyurethane polymers, and combinations thereof.

23. A method as set forth in claim 1 wherein the powder primer comprises a polyurethane.

24. A method as set forth in claim 1 wherein the topcoat includes a basecoat and a clearcoat and the step of simultaneously curing the electrocoat, the powder primer, and the topcoat is further defined as simultaneously curing the electrocoat, the powder primer, the basecoat, and the clearcoat in an oven by application of heat.

25. A method as set forth in claim 1 further comprising the step of applying a clearcoat onto the topcoat after simultaneously curing the electrocoat, the powder primer, and the topcoat.

26. A method as set forth in claim 25 further comprising the step of curing the clearcoat in an oven by application of heat.

\* \* \* \* \*