



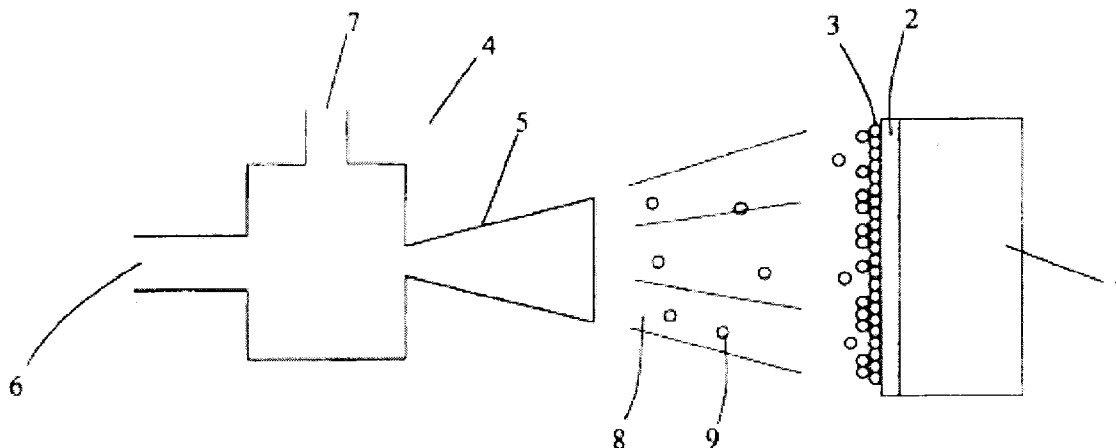
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Hertter et al.(10) **Pub. No.: US 2013/0129976 A1**(43) **Pub. Date: May 23, 2013**(54) **COATING PLASTIC COMPONENTS BY
MEANS OF KINETIC COLD GAS SPRAYING**(30) **Foreign Application Priority Data**

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USPC **428/141; 427/446**(73) Assignee: **MTU AERO ENGINES GMBH**,
Munich (DE)(57) **ABSTRACT**

A method for coating a plastic surface and a plastic component is disclosed. The method includes applying a base layer to a plastic surface. A layer of a coating is applied by kinetic cold gas spraying on the base layer. The base layer is applied by a method that is different from the kinetic cold gas spraying. The base layer adheres to the plastic surface and the layer of the coating applied by kinetic cold gas spraying is deposited on the base layer by the kinetic cold gas spraying.

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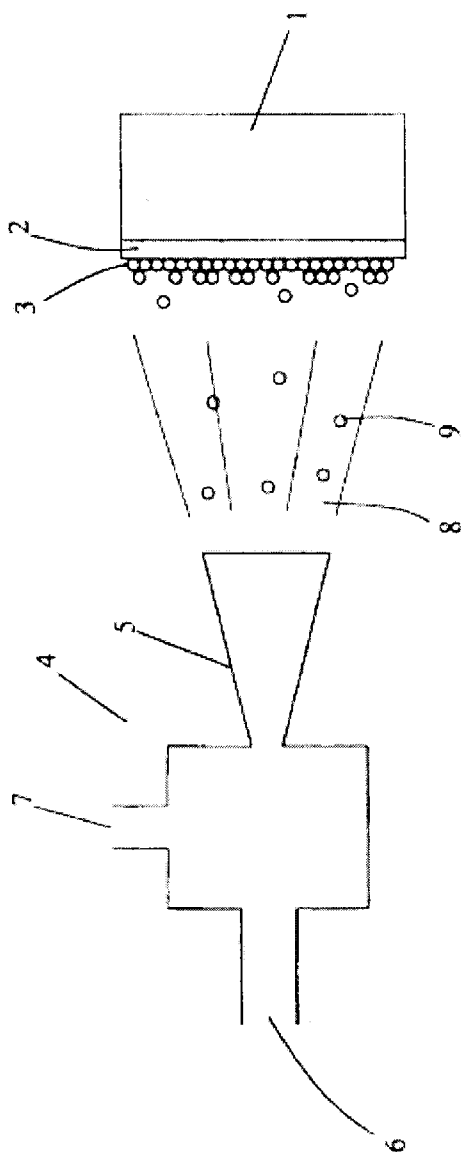


Fig. 1

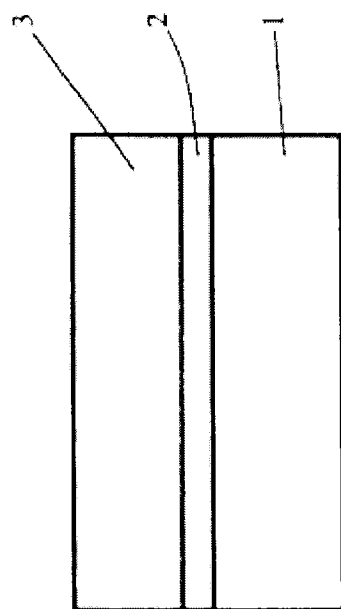


Fig. 2

COATING PLASTIC COMPONENTS BY MEANS OF KINETIC COLD GAS SPRAYING

[0001] This application claims the priority of International Application No. PCT/DE2010/001321, filed Nov. 11, 2010, and German Patent Document No. 10 2009 052 983.7, filed Nov. 12, 2009, the disclosures of which are expressly incorporated by reference herein.

BACKGROUND AND SUMMARY OF THE INVENTION

[0002] The present invention relates to a method for coating a plastic surface, wherein at least one partial layer of the coating is applied by means of kinetic cold gas spraying as well as a correspondingly coated plastic component.

[0003] Kinetic cold gas spraying has been used for some time in a wide variety of fields to deposit layers on components. In the case of kinetic cold gas spraying, solid particles are accelerated at a high speed on the component being coated or the surface thereof, where the particles remain adherent while forming a layer. Kinetic cold gas spraying is characterized by the process temperatures being selected in such a way that the particles from the coating material neither melt nor begin to melt. In contrast to thermal spray methods such as electric arc spraying or flame spraying—in which the powder being sprayed is melted by an electric arc or by the burned combustible gas—in the case of kinetic cold gas spraying, unmelted solid particles impact the surface being coated. The formation of the layer and the adhesion of the layer to the base material are produced in this case by a corresponding plastic deformation of the coating particles both in the region of the boundary layer between the layer being generated and the base material as well as in the region of the base material. This causes the materials to flow into one another, which produces a positive bond. In addition, the transformation of the high kinetic energy into deformation energy also generates corresponding thermal energy, which can produce a fusing of the particles.

[0004] While this functions well for diverse material pairings, i.e., a corresponding pair made up of the base material and the coating material, components made of certain materials cannot be provided with corresponding layers using cold gas spraying if the adhesion mechanisms described above are not present or are present only insufficiently. Thus far, this has led to a limited use of cold gas spraying, even though cold gas spraying is advantageous with respect to certain aspects such as low temperature load, targeted coating, very little overspray, etc.

[0005] In particular, providing plastics, and especially fiber-reinforced plastics, with corresponding layers using cold gas spraying is problematic.

[0006] German Patent Document No. DE 10 2005 047 688 B3 describes that in manufacturing a lamp socket for motor vehicle headlights, micro-encapsulated agglomerates of nanoparticles can be applied to a plastic body using kinetic cold gas spraying to form a coating to protect against UV radiation. However, this does not hold for wear-resistant layers that are formed of high-strength materials with, in particular, hard material particles which are supposed to be deposited, for example, on fiber-reinforced plastics, because in this case, it is possible for the fiber-reinforced plastic to get damaged when cold gas spraying the layer.

[0007] German Patent Document No. DE 100 37 212 A1 describes that fiber-reinforced plastics may be formed with a

wear-resistant coating made of exothermically reacting materials and in particular zinc, zinc alloys, aluminum alloys, nickel aluminum or molybdenum, but apparently the process temperature is selected so high here, also in the case cold gas spraying, that, predominantly, adhesion processes corresponding to thermal spraying methods come into play.

[0008] In contrast, however, in the present invention, a method for coating a plastic surface is made available in which a layer made of a high-strength, hard, wear-resistant material may be applied by means of kinetic cold gas spraying. In particular, the layer is deposited at a temperature at which the particles applied by means of kinetic cold gas spraying at least partially do not melt or begin to melt. Nevertheless, a good adhesion of the layer on the plastic surface is achieved, and damage to the plastic material is prevented. The method is simple and efficient to carry out. In addition, the object of the present invention is making a corresponding component available.

[0009] Contrary to the approach in the prior art, as described in DE 100 37 213 A1, where the corresponding layer is applied directly to the plastic surface by kinetic cold gas spraying and contrary to the approach in DE 10 2005 047 688 B3, in which the composition of the layer applied by means of kinetic cold gas spraying is correspondingly modified in the boundary region between the plastic surface and layer, the present invention provides another solution to the effect that an intermediate layer between the plastic base material and the cold gas sprayed functional layer is provided as a base layer, which is deposited using a different coating method than the kinetic cold gas spraying. The base layer, in this case, produces both a good adhesion to the plastic base material and also makes a corresponding deposition of a subsequent layer using kinetic cold gas spraying possible. Correspondingly, the composition of the base layer is selected in such a way that when the particles impact during kinetic cold gas spraying, a corresponding flowing into one another and/or fusing of the materials with one another is possible. In addition, the base layer guarantees that the plastic surface beneath it is not damaged by the mechanical stress from the kinetic cold gas spraying.

[0010] This may be used in particular for material pairs that otherwise could not be used together in a corresponding manner. In this case, for example, plastics that are sensitive to shock or impact stress such as that which occurs from impacting particles during kinetic cold gas spraying may be cited as a material pair. In particular, the plastic surface may be formed by a fiber-reinforced plastic, while the functional layer may be a high-strength, wear-resistant layer, which may include, in particular, corresponding hard material particles having a high level of hardness and strength, such as diamond-like materials, nitrides, carbides or oxides.

[0011] The base layer may be in particular a metallic layer made of an essentially pure metal or metal mixture or a metal alloy, which provides the appropriate ductility.

[0012] The base layer may be applied to the plastic using a wide variety of coating methods, such as galvanic deposition, physical vapor deposition, cathode sputtering (sputtering) or chemical vapor deposition. In particular, methods may be selected which, like kinetic cold gas spraying, only require a low temperature load of the substrate.

[0013] The base layer may be applied in a thickness that securely prevents damage to the plastic surface during the subsequent deposition of the cold gas sprayed functional layer.

BRIEF DESCRIPTION OF THE FIGURES

[0014] Additional advantages, characteristics and features of the present invention will become clear from the following detailed description of an exemplary embodiment based on the enclosed drawings. In this case, the drawings show the following in a purely schematic manner.

[0015] FIG. 1 is a schematic representation of an arrangement for carrying out the method according to the invention; and

[0016] FIG. 2 is a sectional view of a plastic component, which was produced with the arrangement in FIG. 1.

DETAILED DESCRIPTION OF THE FIGURES

[0017] FIG. 1 shows a schematic representation of an arrangement for coating a plastic component 1 according to the present invention. The arrangement includes a plastic component 1, which has a base layer 2, on which a functional layer 3 is applied by means of kinetic cold gas spraying. To do so, a cold gas spraying device 4 is provided with a nozzle arrangement, for example a Laval nozzle 5, in which process gas at a high pressure is fed via a process gas feed 6 so that powder particles that are fed via the powder particle feed 7 exit the nozzle 5 at a high speed and impact the surface of the base layer 2 of the plastic component 1. The speed of the particles 9 in the spray beam 8 in this connection may go up to and over the range of sonic speed. Characteristic of the kinetic cold gas spraying is that the powder particles 9 do not melt or begin to melt and therefore the process temperature may be selected to be below the melting temperature of the sprayed material.

[0018] When the particles 9 impact the surface of the base layer 2 of the plastic component 1, the particles as well as the base layer 2 or already deposited particles are deformed and the materials of the base layer 2 and the particles 9 form a compact and well-adhering functional layer 3 on the plastic component 1 due to the strong, in particular mutual, deformation with possibly mutual fusing. In the case of the further layer structure of the functional layer 3, there is a mutual deformation of the deposited particles and possibly mutual fusing so that a dense and well-adhering functional layer 3 is formed on the plastic component 1.

[0019] FIG. 2 depicts a completed component 1 having the coating with the partial layers 2, 3, wherein the partial layer 2 constitutes the base layer 2 and the partial layer 3 constitutes the actual functional layer.

[0020] The base layer 2 is a partial layer which has been deposited on the plastic component 1 in order to make a subsequent coating by means of kinetic cold gas spraying possible. In the depicted exemplary embodiment, the base layer 2 is a metallic base layer, which is formed of a single metal or a metal alloy. The base layer 2 may be applied using a wide variety of coating methods. The coating method and/or the material of the base layer 2 are selected in this case such that when applying the base layer 2 to the surface of the plastic component 1 no damage occurs to the plastic surface or the plastic base material. Therefore, coating methods other than kinetic cold gas spraying, such as galvanic deposition, physical vapor deposition, cathode sputtering (sputtering) or chemical vapor deposition or the like, may be used, which makes a gentle coating of the plastic surface of the plastic component 1 possible.

[0021] In the case of the depicted exemplary embodiment, the plastic component, for example, may be formed by a

fiber-reinforced plastic that is sensitive to impact stress from the particles impacting during kinetic cold gas spraying. Correspondingly, sputtering may be used to deposit, for example, a metallic base layer in a sufficient thickness, which, as a ductile intermediate layer, assumes, during a subsequent coating process with kinetic cold gas spraying, the protection of the plastic surface, for one, and secondly, facilitates a secure adhesion of the cold gas sprayed functional layer 3 through a corresponding deformation and flowing of the materials into one another. In particular, the functional layer may be formed in this manner as an anti-wear layer or anti-erosion layer or the like, in which the hard particles impact the surface of the base layer 2 of the plastic component 1 at a high speed. Correspondingly, a high-strength or hard functional layer 3, in particular with embedded hard material particles, such as diamond or diamond-like materials, cubic crystalline boron nitride, silicon carbide, aluminum oxide, boron carbide, tungsten carbide, titanium carbide, titanium nitride or zirconium dioxide or generally with corresponding carbides, nitrides and oxides, may be deposited by means of kinetic cold gas spraying, whereby a low thermal load on the plastic component is made possible by the kinetic cold gas spraying and a targeted coating may be carried with a focused spray beam and a low level of overspray, i.e., correspondingly lower amount of masking off.

[0022] Although the present invention has been described in detail based on the exemplary embodiment, it is self-evident to a person skilled in the art that the invention is not limited to this exemplary embodiment, but that, in fact, modifications are possible within the framework of the protective scope that is defined by the enclosed claims. In particular, individual features of those presented may be omitted, or different combinations of the features presented may be realized. The invention includes, in particular, all combinations of all features presented.

1.-11. (canceled)

12. A method for coating a plastic surface, comprising the steps of:

applying a base layer to the plastic surface;
applying a layer of a coating by kinetic cold gas spraying on the base layer;
wherein the base layer is applied by a method that is different from the kinetic cold gas spraying;
and wherein the base layer adheres to the plastic surface and the layer of the coating applied by kinetic cold gas spraying is deposited on the base layer by the kinetic cold gas spraying.

13. The method according to claim 12, wherein a material of the plastic surface and a composition of the coating applied by the kinetic cold gas spraying are such that a direct deposition of the coating applied by the kinetic cold gas spraying directly on the plastic surface is not possible.

14. The method according to claim 12, wherein the base layer is a metallic layer.

15. The method according to claim 12, wherein the method of applying the base layer is galvanic deposition or physical vapor deposition or cathode sputtering or chemical vapor deposition.

16. The method according to claim 12, wherein the plastic surface is a fiber-reinforced plastic.

17. The method according to claim 12, wherein the base layer is applied with a thickness with which damage to the plastic surface is prevented during the applying of the layer of the coating by kinetic cold gas spraying on the base layer.

18. The method according to claim **12**, wherein the base layer is applied with a thickness of 20 μm to 200 μm .

19. The method according to claim **12**, wherein during the step of applying the layer of the coating by kinetic cold gas spraying on the base layer, particles of the layer are deformed.

20. The method according to claim **19**, wherein the particles are fused with the base layer.

21. A plastic component, comprising:

a plastic surface; and

a coating, wherein the coating includes:

a base layer on the plastic surface; and

a layer applied by kinetic cold gas spraying on the base layer;

wherein the base layer is applied to the plastic surface by a method that is different from the kinetic cold gas spraying;

wherein the base layer is adhered on the plastic surface; and wherein particles of the layer applied by kinetic cold gas spraying are deformed on the base layer.

22. The plastic component according to claim **21**, wherein the plastic surface is a fiber-reinforced plastic.

23. The plastic component according to claim **21**, wherein the layer applied by kinetic cold gas spraying on the base layer is a high-strength, wear-resistant layer.

24. The plastic component according to claim **21**, wherein the particles are fused with the base layer.

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