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(54) **METHOD OF COLD SPRAYING COMPONENTS OF A GAS TURBINE ENGINE MASK THEREFOR**

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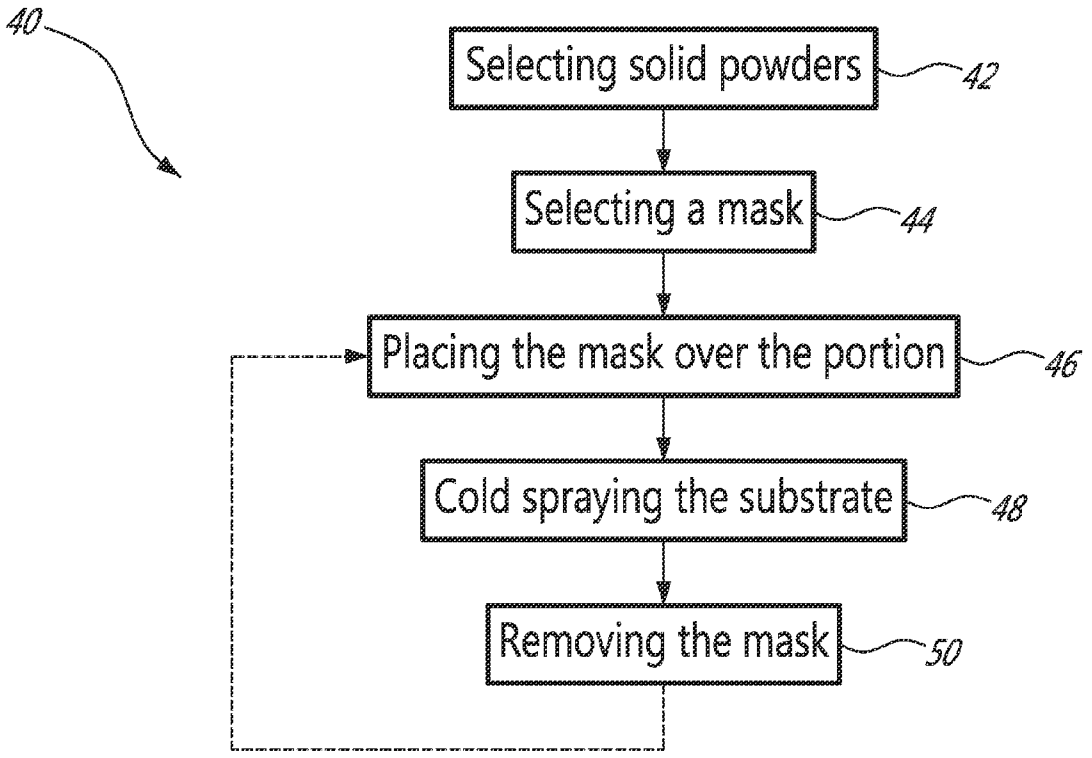
(57) **ABSTRACT**

A method of cold spray coating a target surface of a component, the coating provided using selected solid powders, the method comprising: placing a mask onto the component to cover an area of the component adjacent the target surface which is not to be coated, the mask having a masking top surface provided of a material selected to be non-adhesive with the selected solid powders when cold-sprayed onto the masking top surface, the mask having a melting point above a temperature at which cold spray is performed; cold spraying the target surface with the selected solid powders, including at least some overspraying onto the mask; removing the overspray from the mask; and removing the mask from the component. A mask for a cold sprayed component of a gas turbine engine is also presented.



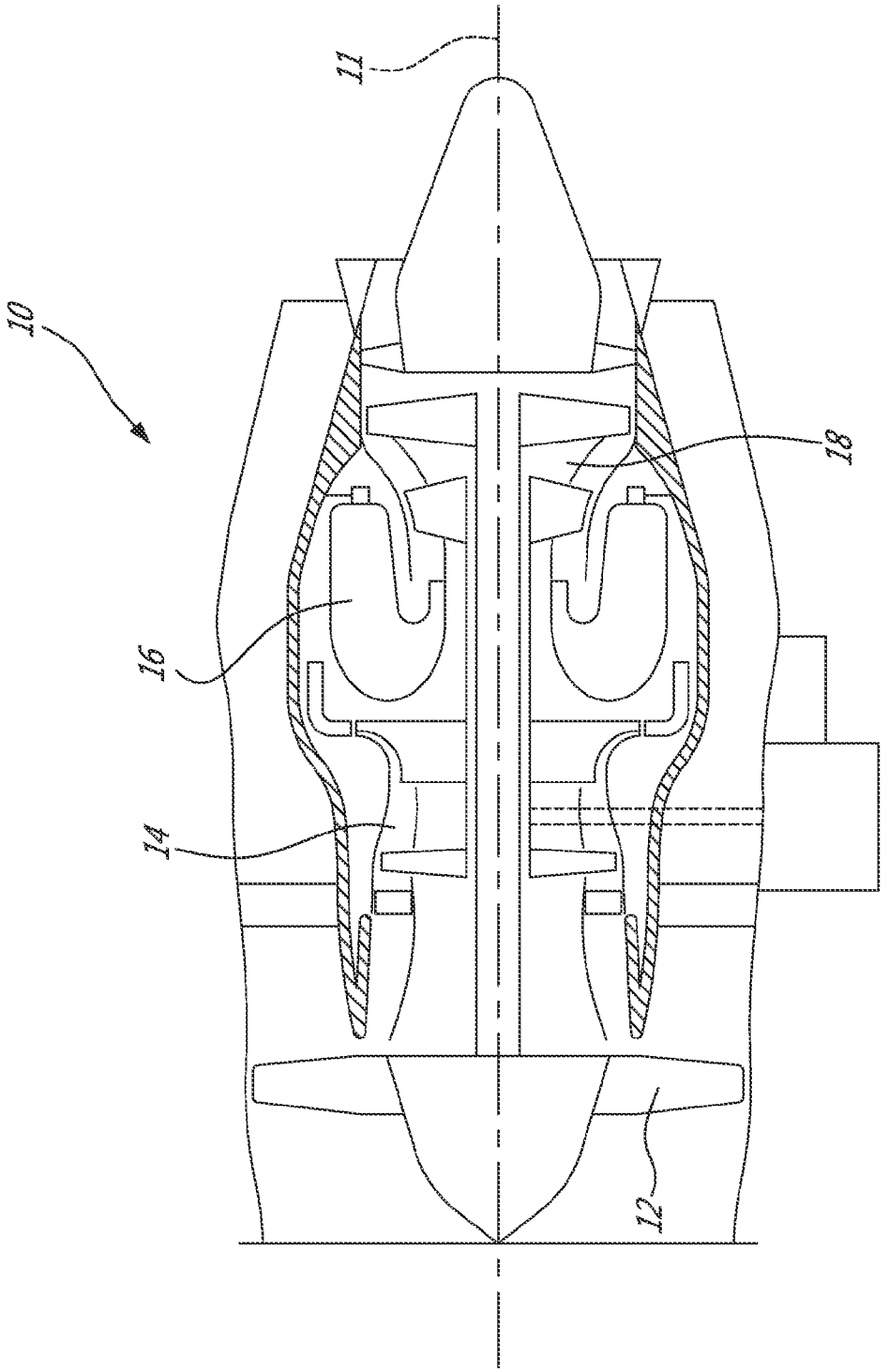


Fig. 1

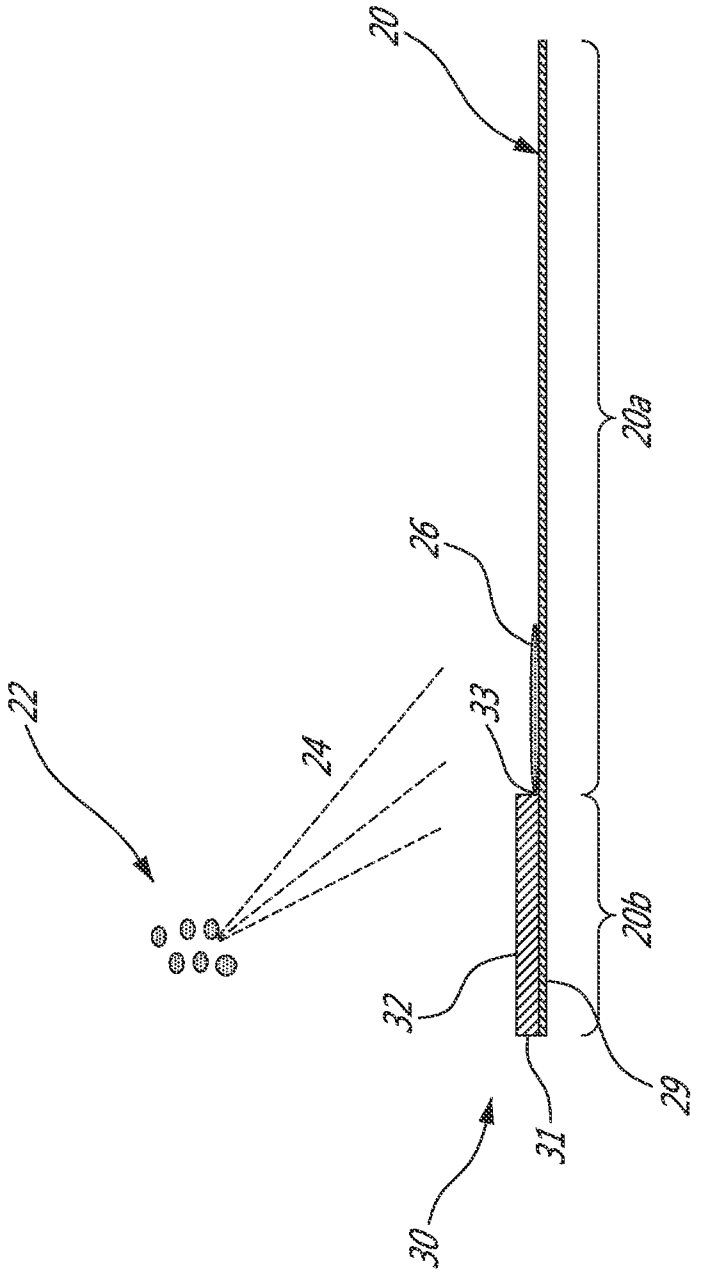


Fig. 2

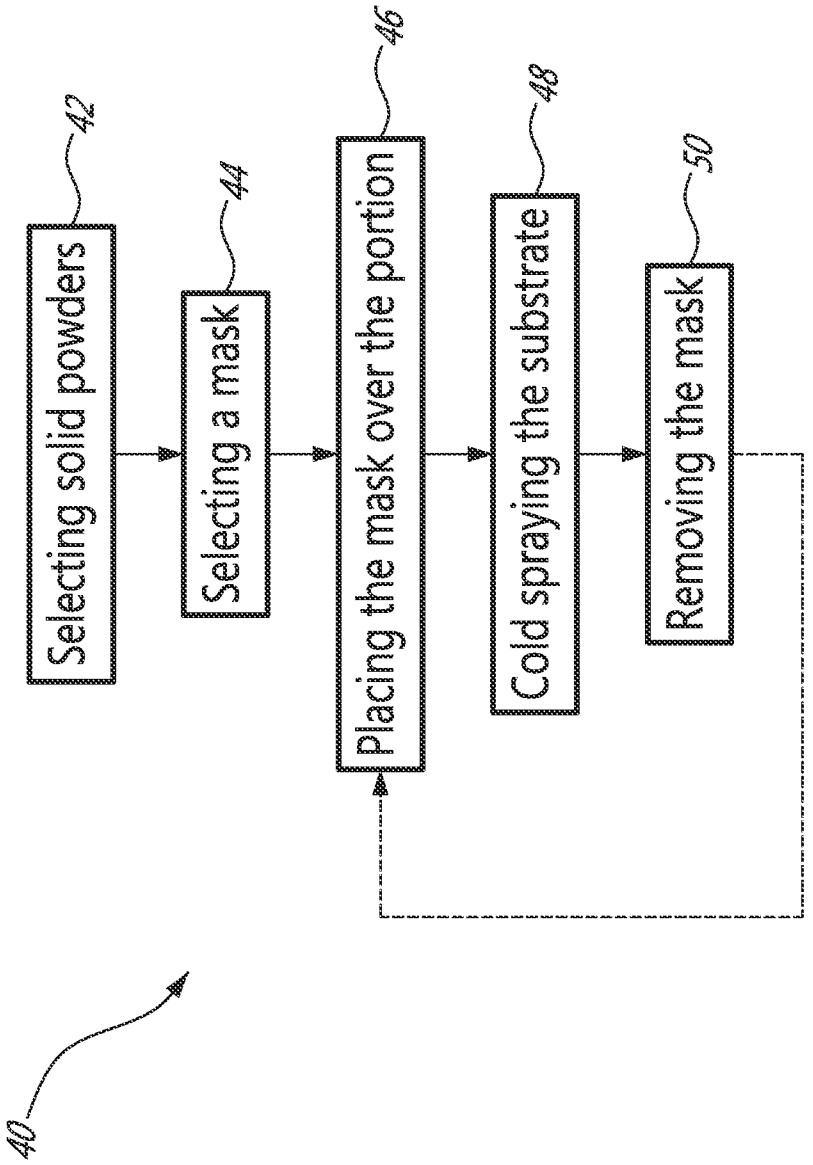

40
Selecting solid powders
42
Selecting a mask
44
Placing the mask over the portion
46
Cold spraying the substrate
48
Removing the mask
50

Fig. 4

METHOD OF COLD SPRAYING COMPONENTS OF A GAS TURBINE ENGINE MASK THEREFOR

TECHNICAL FIELD

[0001] The application relates generally to methods of cold spray, and more particularly to methods of cold spraying components of a gas turbine engine.

BACKGROUND OF THE ART

[0002] When spray coating a surface, coating is sometimes desired only on specific portions of that surface. In such cases, the operator can direct the spray so as to avoid accidentally spraying adjacent portions. However, this may result in imprecise coating and most likely in coating of those portions of the surface that should have been devoid of coating. The operator can use a masking tape, but the tape may detach from the surface due to the pressure exerted by the spray. In some cases, the temperatures involved may cause tape to even melt and bond to the surface it was masking. To remove the excess coating, the operator may have to machine the portions of the surface that have been involuntarily coated, which is time consuming and may deteriorate the masking pattern.

SUMMARY

[0003] In one aspect is provided a method of cold spray coating a target surface of a component, the coating provided using selected solid powders, the method comprising: placing a mask onto the component to cover an area of the component adjacent the target surface which is not to be coated, the mask having a masking top surface provided of a material selected to be non-adhesive with the selected solid powders when cold-sprayed onto the masking top surface, the mask having a melting point above a temperature at which cold spray is performed; cold spraying the target surface with the selected solid powders, including at least some overspraying onto the mask; removing the overspray from the mask; and removing the mask from the component.

[0004] In another aspect, there is provided a mask for a cold sprayed component of a gas turbine engine, the mask comprising: a body delimited by a top surface, a bottom surface, and a periphery, the bottom surface adapted to contact and mask a portion of the component to be devoid of coating, the bottom surface having a characteristic of being non-adhesive with the surface of the component, the top surface adapted to be exposed to solid powders of the cold spray when the body masks the component, the top surface having a characteristic of being non-adhesive with the solid powders when cold sprayed at applicable temperatures and pressures, and the periphery shaped to define a masking pattern on the component, the body having a melting point above a temperature at which cold spray is performed, whereby the mask ensures a reproduction of said masking pattern throughout uses of the mask in cold spraying similar one of said component.

DESCRIPTION OF THE DRAWINGS

[0005] Reference is now made to the accompanying figures in which:

[0006] FIG. **1** is a schematic cross-sectional view of a gas turbine engine;

[0007] FIG. **2** is a schematic of a substrate, for use in a gas turbine engine such as the gas turbine engine of FIG. **1**, being cold sprayed and having a mask thereon; and

[0008] FIG. **3** is a flow chart of a method of cold spraying a substrate such as the one of FIG. **2**.

DETAILED DESCRIPTION

[0009] FIG. **1** illustrates a gas turbine engine **10** of a type preferably provided for use in subsonic flight, generally comprising in serial flow communication a fan **12** through which ambient air is propelled, a compressor section **14** for pressurizing the air, a combustor **16** in which the compressed air is mixed with fuel and ignited for generating an annular stream of hot combustion gases, and a turbine section **18** for extracting energy from the combustion gases. Some parts of the engine **10** have spray-coated surfaces. As such, a gas turbine engine component provides an example application of the methods described below.

[0010] Referring to FIG. **2**, a component or substrate **20**, for example as may be for use in an engine such as the gas turbine engine **10**, is to be cold sprayed with a desired coating. Cold spray is a coating deposition method where solid powders **22** are projected in gas jets **24**. In opposition to thermal spray, the solid powders **22** in the cold spray process are not melted. A suitable cold spray gun (not shown) may be used to propel the solid powders **22** into jets **24**. Upon impacting with the substrate **20**, the solid powders **22** undergo plastic deformation which allows them to adhere to the substrate **20** and as a result create a coating **26**. Metals, polymers, and composites are examples of materials which can be deposited using cold spray. In one embodiment, the cold spray uses nitrogen at 350° C., 35 bars and a standoff between 20 mm and 40 mm from the substrate **20**. In one embodiment, the standoff is at a distance is at 30 mm.

[0011] The substrate **20** has a portion **20***a* onto which coating is desired to be applied and a portion **20***b*, adjacent to the portion **20***a*, onto which coating is undesired. In order to prevent the portion **20***b* from being accidently coated by the solid powders **22**, a mask **30** covers the portion **20***b*. The mask **30** has a body **31** which periphery determines a masking pattern **33**, i.e. a delimitation of a coating between a zone covered by coating and a zone free of coating.

[0012] The mask **30** may have a bottom surface **29** congruent with the portion **20***b* so as to fit snuggly over the portion **20***b*, at least at the periphery so as to prevent bleed of the coating. The mask **30** may be placed onto the portion **20***b* and retained there, in one example, by its tight fit with the portion **20***b*. In another example, the mask **30** may be temporarily retained on the portion **20***b* by a suitable securing means, such as clips. The amount and type of securing will be a matter of choice depending on the selected cold spray process; indeed, the cold spraying is often automated and may involve quick movements of the substrate **20** relative to a cold spray source, in which case are more robust securing approach will be needed. The mask **30** may be provided as a rigid or flexible body **31**. The mask **30** is typically made of a material substantially resistant to the temperatures and pressures generated during the cold spray process, so that the mask **30** does not appreciably deform and/or bond to or alter the underlying portion **20***b* of the substrate **20**.

[0013] The mask **30** has a top surface **32** made of a material that is preferably non-adhesive with the solid powders **22** which may be over-sprayed onto the mask **30**. The mask **30** is also non-adhesive with top portion **20***a* of the substrate **20**. The top surface **32** is the surface that will be in contact with the solid powders **22** projected by the cold spray. By non-adhesive, one should understand a surface which does not

form a metallurgical or a mechanical bond with the solid powders projected thereon, or with the top portion **20***a* of the substrate **20** is spite of the pressure of the solid powders projected thereon. Any bond that is, for one example, easily breakable by wiping or dusting the surface for example would not be considered as an adhesive bond. Another example of a non-adhesive bond is a static bond. Because the material of the top surface **32** is non-adhesive, the sprayed metal powders **22** can be removed from the top surface **32** of the mask **30** without significant effort. This may allow the mask **30** to be reused single or multiple times in some situations. In addition. the material of the mask **30** is chosen to have a melting point above a temperature at which cold spray is performed. By choosing a mask **30** which does not plastically deform, the masking pattern **33** is kept intact over the one or more uses of the mask **30**. It one example, the body **31**, top and/or bottom surfaces **32**, **29** may be made of a same non-adhesive, non-deforming/melting material. The bottom and top surfaces **29**, **32** may have the same non-adhesive material, or may be different. Some materials may be adhesive for some selected solid powders, but may be non-adhesive for other selected solid powders. In one example, the solid powders **22** are Al-12%Si, the selected material/coating for the mask **30** (including top surface **32** and bottom surface **29**) is one of Nylatron® NSM and Nylatron® MC901 (i.e. solid lubricant filled type 6), the substrate is one of magnesium and aluminum, and the cold spray process is as described above. In this example, the material/coating for the mask **30** (or at least for top surface **32**) is chosen so that the desired coating of Al-12%Si does not adhere with the mask **30**. Other materials for the mask **30** are contemplated. In a non-limiting example, the mask **30** may be made of a nylon or a cast nylon. Other factors for the selection of the top surface **32** material include resistance properties in regards to gas high temperatures and high pressure combinations used in the cold spray process. In the example above, the mask **30** made of one of Nylatron® NSM and Nylatron® MC901 is resistant to the pressures and temperatures of the cold spray process associated with Al-12%Si metal powders **22**. It is pointed out that the expressions "bottom surface **29**" and "top surface **32**" are used not in relation the gravity, but rather as indicating that the top is exposed to cold spray and typically faces away from the substrate **20**, while the bottom surface **29** of the mask **30** is that facing toward the substrate **20** and in contact with the portion **20***b* of the substrate **20**.

[0014] Turning now to FIG. **3**, a method **40** of cold spraying the substrate **20** will now be described.

[0015] The method **40** starts at step **42** by selecting the solid powders **22** corresponding to the desired coating **26** on the substrate **20**. In one example, the desired coating **26** is Al-12%Si and solid powders **22** of Al-12%Si are selected and the substrate **20** is made of one of magnesium and aluminium.

[0016] From step **42**, the method **40** goes to step **44** where the mask **30** and the portion **20***b* of the substrate **20** to be devoid of the coating **26** are selected. The mask **30** may be selected before or after selecting the portion **20***b*. The mask **30** is selected to have a shape allowing the cover of the portion **20***b*. The mask **30** is also selected to have its top surface **32** non-adhesive with the selected solid powders **22**, and to have a melting point above a temperature at which cold spray is performed. As such, the mask **30** is selected to not deform and alter the masking pattern **33**, and to not bond with the portion **20***b* during the cold spray, both which could negatively alter the quality of the masking operation. In one embodiment where the solid powders **22** are Al-12%Si and the cold spray temperatures for cold spraying Al-12%Si are below 660° C. (temperature at which the mask **30** may be altered), the mask **30** may have its top surface **32** made of one of Nyaltron® NSM and Nylatron® MC901. In one embodiment, the cold spray process involves pressures between 20 and 50 bars and temperatures around 350° C. The above ranges of temperatures and pressures correspond to standard cold spray processes for the particular selected solid powders **22**, though other selected process may require a mask which performs to different criteria.

[0017] From step **44**, the method **40** goes to step **46** where the mask **30** is placed onto the portion **20***b*. As mentioned above, the mask **30** may or may not be secured by additional securing means to the portion **20***b*, according to the process requirements.

[0018] From step **46**, the method **40** goes to step **48** where the substrate **20** is cold sprayed with the solid powders **22**. In one embodiment, the cold spray uses nitrogen at 350° C. and 35 bars as a gas, and a standoff between 20 mm and 40 mm.

[0019] From step **48**, the method **40** goes to step **50** where the mask **30** is removed (as is described further below) from the portion **20***b* which leads to obtaining the coating **26** and the masking pattern **33** onto the substrate **20**. The mask **30** indestructively removed from the substrate **20** as a unitary piece after cold-spraying is complete. The masking pattern **33** delimits the desired coating **26** disposed on the portion **20***a* of the substrate **20** adjacent to the portion **20***b* and the absence of coating **26** on the portion **20***a*. Overspray may be removed from the mask before or after removing mask from the portion **20***b*.

[0020] Because the mask **30** is non-adhesively mounted onto the portion **20***b* and has a material selected to not melt and bond with the portion **20***b*, removing the mask **30** may, in one example, involves picking up (e.g. lifting, peeling back, or other suitable approach) the mask **30** from the substrate **20**. If the mask **30** was temporarily secured to the portion **20***b*, the step **50** includes removing the securing from the mask **30** and/or from the portion **20***b* before picking up or otherwise removing the mask **30** from the substrate **20**. Because the mask **30** is non-adhesive with the solid powders **22**, the mask **30** may be optionally wiped or dusted to remove any excess coating that may have been applied to the mask there. The mask **30** would preferably not altered by the wiping, leaving the mask to be removed by other suitable means, potentially for reuse if appropriate.

[0021] The mask **30** may, in one example, be provided such that it may be non-destructively removed from the component and reused for masking another component in a subsequent cold spray process. The subsequent component preferably is similar (if not identical) to the substrate **20** and having the same configuration, i.e. portion **20***b* to be covered with the mask **30** directly to reproduce the masking pattern **33**. In another example, a mask **30** which not have the non-adhesive surface **32**, the mask **30** would need to be machined or abraded from the component, which would alter the mask **30**, may modify its shape and in turn change the masking pattern, but otherwise leave the masking material in a condition suitable for reuse. Thus, the removed mask material **30** may be suitable for collection, processing and reapplication as a masking material and thus subsequent use despite the mask **30** form being destroyed during removal. In another example, a non-adhesive coating may nevertheless be destructive removed because a complex component shape requires such

removal, or process efficiency is not gained by non-destructive removal, or other process detail gravitating towards destructive removal of the mask **30**. The present approach thus provides the skilled person with options is designing an optimal process. In any event, a dotted arrow illustrates in FIG. **3** the possible reusability of the mask **30**. After removing the mask **30** and obtaining the masking pattern **33**, the reusable mask **30** is placed, using a suitable process, onto another substrate at a portion of to be devoid of coating identical to the portion **20***b*. This substrate is then cold sprayed with the solid powders **22**. The mask **30** is then removed thereby obtaining the desired coating and a masking pattern identical to that of the substrate **20** on the other substrate. The process steps are thus repeated as necessary for subsequent components **20** to be masked and cold-spray coated.

[0022] Using a mask allows covering portions of a substrate and avoiding overspray on areas where coating is not desired. A mask having a bottom surface congruent with the substrate allows for precision masking. In addition, the use of a non-adhesive material for the top surface may allow the mask to be substantially free of coating, while using a non-adhesive material for the mask bottom surface may impede adherence of the mask to the component, which may facilitate removal of the mask from the component. As a consequence, the mask may possible be used multiple times to reproduce similar masking patterns within desired tolerances Traditional masks may tend to have their shape altered by the elimination of the previous coating or the accumulation of coating and as a consequence won't allow a reproducible masking pattern. If the coating is not eliminated from one cold spray process to another, bridging from such traditional masks onto the substrate may occur. This could shadow the area to be sprayed or cause bonding problems when the mask is removed. Providing a non-adhesive surface on the mask may help address these or other problems. Providing a mask which is non-deformable and non-destructibly removable from the component surface may allow the mask to be reused multiple times without any alteration. These and other features of the present approach may help ensure masking pattern reproducibility which may improve coating preciseness and/or may save costs and time in the masking-coating-demasking process.

[0023] The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without departing from the scope of the invention disclosed. For example, any suitable mask material having the properties described with respect to the substrate material and/or cold-spray material may be used. Any suitable method of applying and/or removing the mask may be used. Any suitable cold-spray process, materials and parameters may be used. Still other modifications which fall within the scope of the present invention will be apparent to those skilled in the art, in light of a review of this disclosure, and such modifications are intended to fall within the appended claims.

1. A method of cold spray coating a target surface of a component, the coating provided using selected solid powders, the method comprising:

placing a mask onto the component to cover an area of the component adjacent the target surface which is not to be coated, the mask having a masking top surface provided of a material selected to be non-adhesive with the selected solid powders when cold-sprayed onto the masking top surface, the mask having a melting point above a temperature at which cold spray is performed;

cold spraying the target surface with the selected solid powders, including at least some overspraying onto the mask;

removing the overspray from the mask; and

removing the mask from the component.

2. The method as defined in claim **1**, further comprising the steps of removing the mask after cold-spraying is complete and then reusing the mask to cold spray a second component identical to said component.

3. The method as defined in claim **1**, wherein the mask has a component-facing surface which is non-adhesive to the component and wherein the mask is non-destructively removed from the component as a unitary piece after cold-spraying is complete.

4. The method as defined in claim **1**, wherein the top surface is made of a nylon, and wherein the selected solid powders contain aluminum.

5. The method as defined in claim **1**, wherein the entire mask is made of a nylon, and wherein the selected solid powders contain aluminum.

6. The method as defined in claim **1**, wherein the top surface is made of a cast nylon.

7. The method as defined in claim **1**, wherein the selected solid powders are Al-12%Si.

8. The method as defined in claim **1**, wherein cold spraying comprises cold spraying a gas at a pressure comprises between 20 and 50 bars and at a temperature below 660° C.

9. The method as defined in claim **1**, wherein cold spraying comprises cold spraying nitrogen at 350° C. and 35 bars at a standoff between 20 mm and 40 mm.

10. The method as defined in claim **1**, wherein:

the step of placing the mask includes providing additional securing to secure the placed mask to the component after being applied to the component; and

the step of removing the mask includes removing said additional securing from one of the mask and the component.

11. The method as defined in claim **1**, where the step of removing the overspray includes dusting the mask to remove oversprayed coating.

12. A mask for a cold sprayed component of a gas turbine engine, the mask comprising:

a body delimited by a top surface, a bottom surface, and a periphery, the bottom surface adapted to contact and mask a portion of the component to be devoid of coating, the bottom surface having a characteristic of being non-adhesive with the surface of the component, the top surface adapted to be exposed to solid powders of the cold spray when the body masks the component, the top surface having a characteristic of being non-adhesive with the solid powders when cold sprayed at applicable temperatures and pressures, and the periphery shaped to define a masking pattern on the component, the body having a melting point above a temperature at which cold spray is performed, whereby the mask ensures a reproduction of said masking pattern throughout uses of the mask in cold spraying similar one of said component.

13. The mask as defined in claim **11**, wherein the bottom surface of the mask has a shape adapted to be congruent with the portion of the component of the gas turbine engine to be devoid of cold spray coating.

14. The mask as defined in claim **11**, wherein the top surface is made of a nylon.

15. The mask as defined in claim **11**, wherein the top surface is made of a cast nylon.

* * * * *