Summary

According to a first aspect, there is provided a system, comprising: a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to direct the laser at a focal area on a component; an imaging device structured to view the focal area of the component; and an additive material delivery means that delivers additive material to the component at the focal area on the component; and a shield coupled to the deposition device, the shield *structured to prevent a reflected portion of the laser from melting an opposing surface* to the focal area.

According to a second aspect, there is provided a method, comprising: interpreting a target geometry for a component; positioning a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to focus the laser at a focal area on the component, wherein the positioning places the directing optics at a position to focus the laser at the focal area; positioning an imaging device structured to view the focal area of the component; positioning an additive material delivery means that delivers an additive material to the component at the focal area of the component; generating a deposition tool path according to the target geometry of the component; and controlling movement of the deposition device according to the deposition tool path, and depositing the additive material on a surface of the component in response to the controlling movement of the deposition device, and shielding an opposing surface to the focal area from a reflected portion of the laser during the controlling.

According to a third aspect, there is provided a system, comprising: a deposition device operatively coupled to a fiber optic Nd:YAG laser, the deposition device comprising a directing prism structured to direct the Nd:YAG laser at a focal area on a bladed disk, wherein the focal area on the bladed disk is disposed between two blades of the disk; an imaging means that views the focal area of the bladed disk, wherein the imaging means and the fiber optic Nd:YAG laser each comprise a substantially similar optical relationship to the focal area on the bladed disk; an additive material delivery means that delivers additive material to the bladed disk at the focal area on the bladed disk; and a shield coupled to the deposition device, the shield structured to prevent a reflected portion of the Nd:YAG laser from melting an opposing surface to the focal area.

According to a fourth aspect, there is provided a system, comprising: a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to direct the laser to a focal area on a component; an imaging device structured to view the focal area of the component; an additive material delivery means that delivers additive material to the component at the focal area of the component; a cooling passage disposed in the deposition device, the cooling passage structured to allow coolant to pass through the deposition device and dissipate heat from a reflected portion of the laser.

According to a fifth aspect, there is provided a method, comprising: interpreting a target geometry for a component; positioning a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to focus the laser at a focal area on the component and the deposition device comprising a cooling passage disposed therein; positioning an imaging device structured to view the focal area of the component; positioning an additive material delivery means that delivers additive material to the component at the focal area of the component; generating a deposition tool path according to the target geometry of the component; and controlling movement of the deposition device according to the deposition tool path, and depositing the additive material on a surface of the component in response to the controlling movement of the deposition device, and passing coolant through the coolant passage during the controlling.

According to a sixth aspect, there is provided a system, comprising: a deposition device operatively coupled to a fiber optic Nd:YAG laser, the deposition device comprising a directing prism structured to direct the Nd:YAG laser at a focal area on a bladed disk, wherein the focal area on the bladed disk is disposed between two blades of the disk; an imaging means that views the focal area of the bladed disk, wherein the imaging means and the fiber optic Nd:YAG laser each comprise a substantially similar optical relationship to the focal area on the bladed disk; and an additive material delivery means that delivers additive material to the bladed disk at the focal area on the bladed disk; and a cooling passage disposed in the deposition device, the cooling passage structured to a allow coolant to pass through the deposition device and dissipate heat generated from a reflected portion of the Nd:YAG laser.

According to a seventh aspect, there is provided a system, comprising: a deposition device operatively coupled to a laser, the deposition device comprising directing optics for directing the laser at a focal area on a component; an imaging device structured to view the focal area of the component; and an additive material delivery means that delivers additive material to the component at the focal area on the component; characterized in that directing optics comprise a prism structured to direct the laser at the focal area on the component.

According to an eighth aspect, there is provided a method, comprising: interpreting a target geometry for a component; positioning a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to focus the laser at a focal area on a component, the directing optics including a prism; positioning an imaging device structured to view the focal area of the component; positioning an additive material delivery means that delivers additive material to the component at the focal area of the component; generating a deposition tool path according to the target geometry of the component; and controlling movement of the deposition device according to the deposition tool path, and depositing additive material on a surface of the component in response to the controlling movement of the deposition device.

One embodiment is unique component material addition system. Other embodiments include unique systems and methods to add material to components by powder metal deposition. Further embodiments, forms, objects, features, advantages, aspects, and benefits shall become apparent from the following description and drawings.

Claims

1. A system, comprising:

a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to direct the laser at a focal area on a component, wherein the directing optics includes a prism;

an imaging device structured to view the focal area of the component; and

an additive material delivery means that delivers additive material to the component at the focal area on the component.

2. The system of claim 1, wherein the focal area of the component is between blades on a bladed wheel.

3. The system of claim 2, wherein the deposition device has a width of less than one inch.

4. The system of claim 1, wherein imaging device views the focal area of the component down the axis of the deposition device from a close proximity to the component.

5. The system of claim 4, wherein the imaging device views the focal area of the component from within 2 inches of the component.

6. The system of claim 1, wherein the imaging device views the focal area of the component through the directing optics.

7. The system of claim 6, wherein the imaging device includes a coaxial viewing element in the deposition device.

8. The system of claim 1, further comprising a lighting device structured to deliver light to the component at the focal area on the component.

9. The system of claim 8, wherein the lighting device comprises one of a light operatively coupled to the deposition device that shines down a body tube of the deposition device, and a laser diode on the deposition device.

10. The system of claim 1, wherein the laser comprises an Nd:YAG fiber-optic laser.

11. The system of claim 1, further comprising final focusing optics wherein the final focusing optics are more than one centimeter distant from the focal area of the component.

12. The system of claim 1, further comprising final focusing optics wherein the final focusing optics include a focal length greater than 40 cm.

13. A method, comprising:

interpreting a target geometry for a component;

positioning a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to focus the laser at a focal area on a component, wherein the directing optics includes a prism;

positioning an imaging device structured to view the focal area of the component;

positioning an additive material delivery means that delivers additive material to the component at the focal area of the component;

generating a deposition tool path according to the target geometry of the component; and

controlling movement of the deposition device according to the deposition tool path, and depositing additive material on a surface of the component in response to the controlling movement of the deposition device.

14. The method of claim 13, wherein the laser comprises a fiber optic laser.

15. The method of claim 13, wherein the imaging device views the focal area of the component through the directing optics.

16. The method of claim 13, wherein generating a deposition tool path according to the target geometry of the component comprises performing a teach-and-learn operation.

17. The method of claim 13, wherein the additive material comprises one of titanium and a titanium alloy.

18. The method of claim 13, wherein the focal area on the component comprises an area on a bladed disk between two blades.

19. The method of claim 13, further comprising operating the laser and flowing a shield gas over the focusing optics in response to the operation of the laser.

20. A system, comprising:

a deposition device operatively coupled to a fiber optic Nd:YAG laser, the deposition device comprising a directing prism structured to direct the Nd:YAG laser at a focal area on a bladed disk, wherein the focal area on the bladed disk is disposed between two blades of the disk;

an imaging means that views the focal area of the component, wherein the imaging means and the fiber optic Nd:YAG laser each comprise a substantially similar optical relationship to the focal area on the bladed disk; and

an additive material delivery means that delivers additive material to the component at the focal area on the component.

21. The system of claim 20, wherein the imaging means views the focal area of the component through the directing prism.

22. The system of claim 20, further comprising means for generating a deposition device tool path, and a means for operating the deposition device in response to the deposition device tool path.

23. The system of claim 20, further comprising final focusing optics wherein the final focusing optics are more than one centimeter distant from the focal area of the component.

24. The system of claim 20, wherein the deposition device includes a deposition head having a width less than one inch.

25. The system of claim 20, wherein the additive delivery means includes a metal powder delivery device disposed in the deposition head.

26. The system of claim 20, further comprising a shield coupled to the deposition device, the shield structured to prevent a reflected portion of the Nd:YAG laser from melting an opposing surface to the focal area.

27. The system of claim 20, further comprising a cooling passage disposed in the deposition device, the cooling passage structured to allow coolant to pass through the deposition device and dissipate heat generated from a reflected portion of the Nd:YAG laser.

28. The system of claim 27, wherein the Nd:YAG laser further includes an irradiance value at the focal area of the component, wherein the irradiance value is at least 2 mega Watts/cm^2.

29. The system of claim 20, further comprising a purge gas delivery device structured to flow a purge gas across the final optics.

30. The system of claim 1, further comprising a purge gas delivery device structured to flow a purge gas across the final optics.

Claims

What is claimed is:

1. A system, comprising:

a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to direct the laser at a focal area on a component;

an imaging device structured to view the focal area of the component; and

an additive material delivery means that delivers additive material to the component at the focal area on the component; and

a shield coupled to the deposition device, the shield structured to prevent a reflected portion of the laser from melting an opposing surface to the focal area.

2. The system of claim 1, wherein the focal area of the component is between blades on a bladed wheel.

3. The system of claim 2, wherein the deposition device has a width of less than one inch.

4. The system of claim 1, wherein the imaging device views the focal area of the component down the axis of the deposition device from a close proximity to the component.

5. The system of claim 4, wherein the imaging device views the focal area of the component from within 2 inches of the component.

6. The system of claim 1, wherein the imaging device views the focal area of the component through the directing optics.

7. The system of claim 6, wherein the imaging device includes a coaxial viewing element in the deposition device.

8. The system of claim 1, further comprising a lighting device structured to deliver light to the component at the focal area on the component.

9. The system of claim 8, wherein the lighting device comprises one of a light operatively coupled to the deposition device that shines down a body tube of the deposition device, and a laser diode on the deposition device.

10. The system of claim 1, wherein the laser comprises a Nd:YAG fiber-optic laser.

11. The system of claim 1, further comprising final focusing optics wherein the final focusing optics are more than one centimeter distant from the focal area of the component.

12. The system of claim 1, further comprising final focusing optics wherein the final focusing optics include a focal length greater than 40 cm.

13. A method, comprising:

interpreting a target geometry for a component;

positioning a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to focus the laser at a focal area on the component, wherein the positioning places the directing optics at a position to focus the laser at the focal area;

positioning an imaging device structured to view the focal area of the component;

positioning an additive material delivery means that delivers an additive material to the component at the focal area of the component;

generating a deposition tool path according to the target geometry of the component; and

controlling movement of the deposition device according to the deposition tool path, and depositing the additive material on a surface of the component in response to the controlling movement of the deposition device, and shielding an opposing surface to the focal area from a reflected portion of the laser during the controlling.

14. The method of claim 13, wherein the laser comprises a fiber optic laser.

15. The method of claim 13, wherein the directing optics includes a prism.

16. The method of claim 15, wherein the imaging device views the focal area of the component through the directing optics.

17. The method of claim 13, wherein generating the deposition tool path according to the target geometry of the component comprises performing a teach-and-learn operation.

18. The method of claim 13, wherein the additive material comprises one of titanium and a titanium alloy.

19. The method of claim 13, wherein the focal area on the component comprises an area on a bladed disk between two blades.

20. The method of claim 13, further comprising operating the laser and flowing a shield gas over the directing optics in response to the operation of the laser.

21. A system, comprising:

a deposition device operatively coupled to a fiber optic Nd:YAG laser, the deposition device comprising a directing prism structured to direct the Nd:YAG laser at a focal area on a bladed disk, wherein the focal area on the bladed disk is disposed between two blades of the disk;

an imaging means that views the focal area of the bladed disk, wherein the imaging means and the fiber optic Nd:YAG laser each comprise a substantially similar optical relationship to the focal area on the bladed disk;

an additive material delivery means that delivers additive material to the bladed disk at the focal area on the bladed disk; and

a shield coupled to the deposition device, the shield structured to prevent a reflected portion of the Nd:YAG laser from melting an opposing surface to the focal area.

22. The system of claim 21, wherein the imaging means views the focal area of the bladed disk through the directing prism.

23. The system of claim 21, further comprising means for generating a deposition device tool path, and a means for operating the deposition device in response to the deposition device tool path.

24. The system of claim 21, further comprising final focusing optics wherein the final focusing optics are more than one centimeter distant from the focal area of the bladed disk.

25. The system of claim 21, wherein the deposition device includes a deposition head having a width less than one inch.

26. The system of claim 21, wherein the additive delivery means includes a metal powder delivery device disposed in the deposition head.

27. The system of claim 21, wherein the Nd:YAG laser further includes an irradiance value at the focal area of the bladed disk, wherein the irradiance value is at least 2 megaWatts/cm^2.

28. The system of claim 21, further comprising a purge gas delivery device structured to flow a purge gas across the final optics.

29. A system, comprising:

a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to direct the laser to a focal area on a component;

an imaging device structured to view the focal area of the component;

an additive material delivery means that delivers additive material to the component at the focal area of the component;

a cooling passage disposed in the deposition device, the cooling passage structured to allow coolant to pass through the deposition device and dissipate heat from a reflected portion of the laser.

30. A method, comprising:

interpreting a target geometry for a component;

positioning a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to focus the laser at a focal area on the component, and the deposition device comprising a cooling passage disposed therein;

positioning an imaging device structured to view the focal area of the component;

positioning an additive material delivery means that delivers additive material to the component at the focal area of the component;

generating a deposition tool path according to the target geometry of the component; and

controlling movement of the deposition device according to the deposition tool path, and depositing the additive material on a surface of the component in response to the controlling movement of the deposition device, and passing coolant through the coolant passage during the controlling.

31. A system, comprising:

a deposition device operatively coupled to a fiber optic Nd:YAG laser, the deposition device comprising a directing prism structured to direct the Nd:YAG laser at a focal area on a bladed disk, wherein the focal area on the bladed disk is disposed between two blades of the disk;

an imaging means that views the focal area of the bladed disk, wherein the imaging means and the fiber optic Nd:YAG laser each comprise a substantially similar optical relationship to the focal area on the bladed disk; and

an additive material delivery means that delivers additive material to the bladed disk at the focal area on the bladed disk; and

a cooling passage disposed in the deposition device, the cooling passage structured to a allow coolant to pass through the deposition device and dissipate heat generated from a reflected portion of the Nd:YAG laser.

32. A system, comprising:

a deposition device operatively coupled to a laser, the deposition device comprising directing optics for directing the laser at a focal area on a component;

an imaging device structured to view the focal area of the component; and

an additive material delivery means that delivers additive material to the component at the focal area on the component;

characterized in that directing optics comprise a prism structured to direct the laser at the focal area on the component.

33. The system of claim 32, wherein the component is a bladed wheel and the focal area on the component is between blades on the bladed wheel.

34. The system of claim 32 or 33, wherein the deposition device has a width of less than one inch.

35. The system of any one of claims 32 to 34, wherein the imaging device views the focal area of the component through the directing optics.

36. The system of any one of claims 32 to 35, wherein the imaging device includes a coaxial viewing element in the deposition device.

37. The system of any one of claims 32 to 36, further comprising a lighting device, wherein the lighting device is structured to deliver light to the component at the focal area on the component, and wherein the lighting device comprises one of a light operatively coupled to the deposition device that shines down a body tube of the deposition device, and a laser diode on the deposition device.

38. The system of any one of claims 32 to 37, wherein the laser comprises a Nd:YAG fiber-optic laser.

39. The system of any one of claims 32 to 38, further comprising final focusing optics wherein the final focusing optics includes a focal length greater than 40 cm.

40. The system of any one of claims 32 to 39, further comprising means for generating a deposition device tool path, and a means for operating the deposition device in response to the deposition device tool path.

41. The system of any one of claims 32 to 39, wherein the additive material delivery means includes a metal powder delivery device disposed in the deposition device.

42. The system of claim 38, further comprising a shield coupled to the deposition device, the shield structured to prevent a reflected portion of the Nd:YAG laser from melting an opposing surface to the focal area.

43. The system of claim 38, further comprising a cooling passage disposed in the deposition device, the cooling passage structured to allow coolant to pass through the deposition device and dissipate heat generated from a reflected portion of the Nd:YAG laser.

44. The system of claim 43, wherein the Nd:YAG laser further includes an irradiance value at the focal area of the component, wherein the irradiance value is at least 2 megaWatts/cm2.

45. The system of any one of claims 32 to 38, 40, 41, 42, 43 or 44, further comprising a purge delivery device structured to flow a purge gas across a final focusing optics.

46. A method, comprising:

interpreting a target geometry for a component;

positioning a deposition device operatively coupled to a laser, the deposition device comprising directing optics structured to focus the laser at a focal area on a component, the directing optics including a prism;

positioning an imaging device structured to view the focal area of the component;

positioning an additive material delivery means that delivers additive material to the component at the focal area of the component;

generating a deposition tool path according to the target geometry of the component; and

controlling movement of the deposition device according to the deposition tool path, and

depositing additive material on a surface of the component in response to the controlling movement of the deposition device.

47. The method of claim 46, wherein the imaging device views the focal area of the component through the directing optics.

48. The method of claim 46 or 47, wherein the additive material comprises one of titanium and a titanium alloy.

49. The method of any one of claims 46 to 48, wherein the focal area on the component comprises an area on a bladed disk between two blades.

50. The method of claim 47, further comprising flowing shield gas over the directing optics.