Claims

What is claimed is:

1. A thermal spray system for producing coatings on a substrate from a liquid suspension comprising:

a thermal spray torch for generating a plasma;

a liquid suspension delivery subsystem for delivering a flow of the liquid suspension with sub-micron particles; and

a nozzle assembly for delivering the plasma from the thermal spray torch to the liquid suspension to produce a plasma effluent, the nozzle assembly adapted for producing a reactive gas shroud substantially surrounding said plasma effluent;

the reactive gas shroud configured to substantially retain entrainment of the sub-micron particles in the plasma effluent and substantially inhibit gases from entering and reacting with the plasma effluent;

wherein the reactive gas shroud reacts with the plasma effluent to enhance fragmentation of the suspension droplets and create evaporative species of the sub-micron particles within the plasma effluent.

2. The thermal spray system of claim 1, wherein the shroud extends from the substrate surface to the nozzle assembly.

3. The thermal spray system of claim 1, wherein the shroud is a laminar flowing shield.

4. The thermal spray system of claim 1, wherein the shroud has an axial distance less than a distance from the nozzle to the substrate surface.

5. The thermal spray system of claim 1, further comprising an inert gas shroud disposed about the reactive gas shroud.

6. The thermal spray system of claim 1, further comprising a first reactive gas shroud and a second reactive gas shroud.

7. The thermal spray system of claim 1, further comprising an injector adapted to produce a flame envelope surrounding the flow of the liquid suspension.

8. The thermal spray system of claim 1, wherein the liquid suspension system is configured internal to the nozzle.

10. The thermal spray system of claim 1, wherein the liquid suspension system is configured internal to the nozzle so as to deliver an axial flow of the liquid suspension.

11. The thermal spray system of claim 1, wherein the liquid suspension system is configured external to the nozzle.

12. A method of producing coatings on a substrate using a liquid suspension with sub-micron particles dispersed therein, the method comprising the steps of:

generating a plasma from a thermal spray torch;

delivering a flow of liquid suspension with sub-micron particles dispersed therein to the plasma or in close proximity thereto to produce a plasma effluent stream;

surrounding the plasma effluent with a reactive gas shroud to keep the sub-micron particles entrained within the plasma effluent and substantially prevent entrainment of ambient gases into the plasma effluent;

reacting the shroud gas with the plasma effluent to enhance fragmentation of the suspension droplets and create evaporative species of the sub-micron particles within the plasma effluent; and

directing the shrouded plasma effluent with the sub-micron particles contained therein towards the substrate to coat the substrate.

13. The method of claim 12, further comprising the step of substantially preventing entrainment of gases into the shrouded effluent.

14. The method of claim 12, further comprising the step of fragmenting droplets of the liquid suspension across the reactive shroud.

15. The method of claim 12, further comprising the step of introducing an inert gas shroud substantially surrounding the effluent.

16. The method of claim 12, further comprising the step of introducing a second reactive shroud gas substantially surrounding the effluent.

17. The method of claim 12, further comprising the step of introducing a flame envelope surrounding the liquid suspension.

18. The method of claim 12, further comprising injecting the liquid suspension external to the nozzle.

19. The method of claim 12, further comprising injecting the liquid suspension internal to the nozzle.

20. A coating deposited on the substrate prepared according to the process of claim 12.

Claims

What is claimed is:

1. A thermal spray system for producing coatings on a substrate from a liquid suspension comprising:

a thermal spray torch for generating a plasma;

a liquid suspension delivery subsystem for delivering a flow of the liquid suspension with sub-micron particles; and

a nozzle assembly for delivering the plasma from the thermal spray torch to the liquid suspension to produce a plasma effluent, the nozzle assembly adapted for producing a reactive gas shroud substantially surrounding said plasma effluent;

the reactive gas shroud configured to substantially retain entrainment of the sub-micron particles in the plasma effluent and substantially inhibit gases from entering and reacting with the plasma effluent;

wherein the reactive gas shroud reacts with the plasma effluent to enhance fragmentation of the suspension droplets and create evaporative species of the sub-micron particles within the plasma effluent.

2. The thermal spray system of claim 1, wherein the shroud extends from the substrate surface to the nozzle assembly.

3. The thermal spray system of claim 1, wherein the shroud is a laminar flowing shield.

4. The thermal spray system of claim 1, wherein the shroud has an axial distance less than a distance from the nozzle to the substrate surface.

5. The thermal spray system of claim 1, further comprising an inert gas shroud disposed about the reactive gas shroud.

6. The thermal spray system of claim 1, further comprising a first reactive gas shroud and a second reactive gas shroud.

7. The thermal spray system of claim 1, further comprising an injector adapted to produce a flame envelope surrounding the flow of the liquid suspension.

8. The thermal spray system of claim 1, wherein the liquid suspension system is configured internal to the nozzle.

9. The thermal spray system of claim 1, wherein the liquid suspension system is configured internal to the nozzle so as to deliver an axial flow of the liquid suspension.

10. The thermal spray system of claim 1, wherein the liquid suspension system is configured external to the nozzle.

11. A method of producing coatings on a substrate using a liquid suspension with sub-micron particles dispersed therein, the method comprising the steps of:

generating a plasma from a thermal spray torch;

delivering a flow of liquid suspension with sub-micron particles dispersed therein to the plasma or in close proximity thereto to produce a plasma effluent stream;

surrounding the plasma effluent with a reactive gas shroud to keep the sub-micron particles entrained within the plasma effluent and substantially prevent entrainment of ambient gases into the plasma effluent;

reacting the shroud gas with the plasma effluent to enhance fragmentation of the suspension droplets and create evaporative species of the sub-micron particles within the plasma effluent; and

directing the shrouded plasma effluent with the sub-micron particles contained therein towards the substrate to coat the substrate.

12. The method of claim 11, further comprising the step of substantially preventing entrainment of gases into the shrouded effluent.

13. The method of claim 11, further comprising the step of fragmenting droplets of the liquid suspension across the reactive shroud.

14. The method of claim 11, further comprising the step of introducing an inert gas shroud substantially surrounding the effluent.

15. The method of claim 11, further comprising the step of introducing a second reactive shroud gas substantially surrounding the effluent.

16. The method of claim 11, further comprising the step of introducing a flame envelope surrounding the liquid suspension.

17. The method of claim 11, further comprising injecting the liquid suspension external to the nozzle.

18. The method of claim 11, further comprising injecting the liquid suspension internal to the nozzle.

19. A coating deposited on the substrate prepared according to the process of claim 11.