CLAIMS

1. A system comprising:

a vacuum pump;

a vacuum chamber;

a plasma spray device that generates a plasma into which a silicon metal-based coating material is introduced internal of or external to the plasma spray device, wherein the silicon metal-based coating material consists essentially of silicon metal or silicon metal and an additional constituent, and wherein the additional constituent comprises at least one of a transition metal carbide, a transition metal boride, a transition metal nitride, mullite, silica, a silicide, a rare earth oxide, an alkali metal oxide, or a silicate;

a source of a reactive gaseous species; and

a computing device configured to:

control the vacuum pump to evacuate the vacuum chamber to a vacuum of less than 1.33 kPa;

control the plasma spray device to deposit the silicon metal-based coating material in a silicon metal-based coating on a substrate in the vacuum chamber using plasma spray physical vapor deposition, wherein the silicon metal-based coating consists essentially of silicon metal or silicon metal and the additional constituent; and

control the source of the reactive gaseous species to introduce a controlled amount of the reactive gaseous species into the vacuum chamber at a location outside of a vapor plume generated by the plasma spray device during the plasma spray physical vapor deposition process, wherein the reactive gaseous species reacts with the silicon metal of the silicon metal-based coating material to form a dispersed silica phase in at least part of the silicon metal-based coating.

2. The system of claim 1, wherein the source of the reactive gaseous species comprises a source of a gaseous oxidizing agent, and wherein the reactive gaseous species comprises the gaseous oxidizing agent.

3. The system of claim 2, wherein the source of the gaseous oxidizing agent comprises an oxygen source, and wherein the gaseous oxidizing agent comprises oxygen.

4. The system of claim 1, wherein the computing device is further configured to control the plasma spray device to scan the vapor plume comprising constituents of the silicon metal-based coating material over the substrate.

5. The system of claim 4, wherein scanning the vapor plume forms the silicon metal-based coating in layers, and wherein the dispersed silica phase forms proximate to interfaces between the layers.

6. The system of claim 1, wherein the additional constituent forms a second phase distinct from the silica phase within the silicon metal-based coating.

7. A method comprising:

controlling a vacuum pump to evacuate a vacuum chamber to a vacuum of less than 1.33 kPa;

controlling a plasma spray device to generate a plasma into which a silicon metal-based coating material is introduced internal of or external to the plasma spray device, wherein the silicon metal-based coating material consists essentially of silicon metal or silicon metal and an additional constituent, and wherein the additional constituent comprises at least one of a transition metal carbide, a transition metal boride, a transition metal nitride, mullite, silica, a silicide, a rare earth oxide, an alkali metal oxide, or a silicate;

controlling the plasma spray device to deposit the silicon metal-based coating material in a silicon metal-based coating on a substrate in the vacuum chamber using plasma spray physical vapor deposition, wherein the silicon metal-based coating consists essentially of silicon metal or silicon metal and the additional constituent; and

controlling a source of a reactive gaseous species to introduce a controlled amount of the reactive gaseous species into the vacuum chamber at a location outside of a vapor plume generated by the plasma spray device during the plasma spray physical vapor deposition process, wherein the reactive gaseous species reacts with the silicon metal of the silicon metal-based coating material to form a dispersed silica phase in at least part of the silicon metal-based coating.

8. The method of claim 7, wherein the source of the reactive gaseous species comprises a source of a gaseous oxidizing agent, and wherein the reactive gaseous species comprises the gaseous oxidizing agent.

9. The method of claim 8, wherein the source of the gaseous oxidizing agent comprises an oxygen source, and wherein the gaseous oxidizing agent comprises oxygen.

10. The method of claim 7, further comprising controlling the plasma spray device to scan the vapor plume comprising constituents of the silicon metal-based coating material over the substrate.

11. The method of claim 10, wherein scanning the vapor plume forms the silicon metal-based coating in layers, and wherein the dispersed silica phase forms proximate to interfaces between the layers.

12. A computer readable storage device comprising instructions that, when executed, cause a computing device to:

control a vacuum pump to evacuate a vacuum chamber to high vacuum;

control a plasma spray device to generate a plasma into which a silicon metal-based coating material is introduced internal of or external to the plasma spray device, wherein the silicon metal-based coating material consists essentially of silicon metal or silicon metal and an additional constituent, and wherein the additional constituent comprises at least one of a transition metal carbide, a transition metal boride, a transition metal nitride, mullite, silica, a silicide, a rare earth oxide, an alkali metal oxide, or a silicate;

control the plasma spray device to deposit the silicon metal-based coating material in a silicon metal-based coating on a substrate in the vacuum chamber using plasma spray physical vapor deposition, wherein the silicon metal-based coating consists essentially of silicon metal or silicon metal and the additional constituent; and

control a source of a reactive gaseous species to introduce a controlled amount of the reactive gaseous species into the vacuum chamber at a location outside of a vapor plume generated by the plasma spray device during the plasma spray physical vapor deposition process, wherein the reactive gaseous species reacts with the silicon metal of the silicon metal-based coating material to form a dispersed silica phase in at least part of the silicon metal-based coating.

13. The computer readable storage device of claim 12, wherein the source of the reactive gaseous species comprises a source of a gaseous oxidizing agent, and wherein the reactive gaseous species comprises the gaseous oxidizing agent.

14. The computer readable storage device of claim 13, wherein the source of the gaseous oxidizing agent comprises an oxygen source, and wherein the gaseous oxidizing agent comprises oxygen.

15. The computer readable storage device of claim 12, further comprising instructions that, when executed, cause the computing device to control the plasma spray device to scan the vapor plume comprising constituents of the silicon metal-based coating material over the substrate, wherein scanning the vapor plume forms the silicon

metal-based coating in layers, and wherein the dispersed silica phase forms proximate to interfaces between the layers.