

【DESCRIPTION】

【Invention Title】

PLASMA SPRAYED COATING COMPRISING Y₂O₃-BASED COMPOSITE AND MANUFACTURING METHOD THEREOF

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【Technical Field】

[1] The present disclosure relates to a Y₂O₃ plasma sprayed coating and, more specifically, to a plasma sprayed coating containing a Y₂O₃-based composite and a manufacturing method thereof.

10

【Background Art】

[2] In recent years, high-integration and ultra-fine line width techniques in semiconductor processes require plasma etching under extreme environments, such as high-density plasma, high cleanliness, and excessive electrical overstress. In particular, a plasma etching process using reactant gases including a halogen element, such as F, Cl, or Br, with strong chemical reactivity does not only involve etching various deposition materials on a wafer surface, but also causes damage to the surface of components and generation of non-volatile contaminant particles through chemical and physical reactions with metal or ceramic components inside a chamber.

[3] Therefore, an interest in coating of ceramic materials exhibiting excellent plasma resistance on the surface of metal or ceramic components has been greatly increasing, and as representative examples, yttrium oxide (Y₂O₃) coatings are widely applied.

[4] Yttrium oxide (Y₂O₃) shows a high melting point (2,450°C), chemical stability, and crystallographic stability at up to 2,300°C, and particularly, Y₂O₃ shows excellent chemical stability against F radicals, high ion bombardment resistance due to high atomic mass of yttrium, and excellent plasma resistance due to superior mechanical properties of the reaction product YF₃.

[5] However, when the upper surface of the Y₂O₃ coating layer reacts with plasma gas, such as SF₆, CF₄, CHF₃, or HF, at the beginning of an etching process, the concentration of fluorine-based gas in the chamber changes, resulting in an increase in the seasoning time of the etching process, and the surface of Y₂O₃ reacts with the plasma gas to form fluorine-containing contaminant particles. When the Y₂O₃ undergoes thermal cycling, stress occurs due to the difference in thermal expansion coefficient between the contaminant particles and Y₂O₃, resulting in detachment of the contaminant particles. YF₃ having excellent corrosion resistance was introduced to address the above issues, but this causes a problem in that YF₃ is melted by ultra-high-temperature plasma during atmospheric plasma spraying (APS), a portion of the fluoride is oxidized to form a coating

layer in which a fluoride and an oxide are partially mixed. Moreover, when compared to Y_2O_3 sprayed coating layers, YF_3 may cause problems of cracks within the coating layer and the generation of particles in the etching chamber. To solve these problems of Y_2O_3 and YF_3 , a Y-O-F coating layer having intermediate properties between Y_2O_3 and YF_3 has been introduced.

[6] Meanwhile, the plasma resistance of plasma-resistant members depends on the size of grains. As the size of grains is larger, the roughness change is greater after plasma etching, causing reduced plasma resistance. Moreover, the larger the size of grains, the larger the particles generated by plasma etching, and thus, the particles are not carried out of the chamber by the fluid flow and are adsorbed onto the wafer, thereby hindering the operation of semiconductor devices and reducing the yield. Therefore, there is a demand for spray coating of a Y_2O_3 -based compound with a small grain size.

[7] On the other hand, the hardness of plasma sprayed coatings affects the semiconductor process yield. Lower coating hardness may generate particles due to plasma impact or high temperatures. Therefore, there is a demand for a high-hardness sprayed coating of a Y_2O_3 -based compound.

【Disclosure】

【Technical Problem】

[8] Therefore, the present disclosure has been made in view of the above-mentioned problems, and an aspect of the present disclosure is to provide a plasma sprayed coating containing a Y_2O_3 -based composite with a low average grain size.

[9] Furthermore, another aspect of the present disclosure is to provide a high-hardness plasma sprayed coating containing a Y_2O_3 -based composite.

[10] Furthermore, still another aspect of the present disclosure is to provide a method for manufacturing the above-described plasma sprayed coating.

【Technical Solution】

[11] In accordance with an aspect of the present disclosure, a plasma sprayed coating may include a composite of a magnesium compound and an yttrium compound, wherein the composite contains a monoclinic yttrium oxide.

[12] The monoclinic yttrium oxide may constitute the main phase of crystalline yttrium oxide.

[13] The yttrium compound may further contain a cubic yttrium oxide.

[14] The composite may include grains with an EBSD grain size of 250 nm or less. Additionally, the composite may include grains with an EBSD grain size of 100 nm or less.

- [15] The weight ratio of the yttrium compound to the magnesium compound in the composite may be 1:9 to 9:1.
- [16] The composite may show a maximum frequency peak at 200 nm or less in the EBSD grain size distribution.
- 5 [17] The composite may show a maximum frequency peak at 100 nm or less in the EBSD grain size distribution.
- [18] The composite may further contain Al_2O_3 .
- [19] The yttrium compound may include YF_3 or Y-O-F.
- [20] In accordance with another aspect of the present disclosure, a method for
10 manufacturing a plasma sprayed coating may include: (a) introducing a feedstock powder containing yttrium and magnesium sources into a plasma stream to melt at least a portion of the feedstock powder; and (b) exposing a substrate to an atmospheric plasma stream containing the yttrium and magnesium sources to form a plasma sprayed coating containing a composite of a magnesium compound and an yttrium compound.
- 15 [21] In step (a), the yttrium and magnesium sources may be composed of a mixture of yttrium oxide and magnesium oxide.
- [22] In the magnesium and yttrium sources, the weight ratio of magnesium and yttrium, converted to MgO and Y_2O_3 , may be 1:9 to 9:1.
- [23] The yttrium and magnesium sources may contain cubic yttria.
- 20 [24] The composite may contain a monoclinic yttrium oxide.
- [25] The monoclinic yttrium oxide may constitute the main phase of crystalline yttrium oxide.
- [26] The yttrium compound may further contain a cubic yttrium oxide.
- 25 **【Advantageous Effects】**
- [27] According to the present disclosure, a plasma sprayed coating containing a Y_2O_3 -based composite with a low average grain size can be provided. Furthermore, a high-hardness plasma sprayed coating containing a Y_2O_3 -based composite can be provided.
- 30 **【Description of Drawings】**
- [28] FIG. 1 schematically shows a plasma spray apparatus according to an exemplary embodiment of the present disclosure.
- [29] FIG. 2 shows graphs of X-ray diffraction analysis results of sprayed coating specimens manufactured according to an exemplary embodiment of the present disclosure.
- 35 [30] FIGS. 3A and 3B show JCPDS XRD patterns of cubic Y_2O_3 and monoclinic Y_2O_3 .
- [31] FIGS. 4A and 4B show images of EBSD maps for a specimen manufactured

according to an exemplary embodiment of the present disclosure, where FIG. 4A shows an image illustrating the crystal structure, and FIG. 4B shows an image illustrating the crystallographic orientation.

[32] FIGS. 5 and 6 show images of EBSD maps for a specimen manufactured according to an exemplary embodiment of the present disclosure, where FIG. 5 shows an image illustrating the crystal structure, and FIG. 6 shows an image illustrating the crystallographic orientation.

[33] FIGS. 7A and 7B show grain size distributions obtained by calculation from EBSD computational analysis for specimens manufactured according to an exemplary embodiment of the present disclosure.

【Best Mode for Invention】

[34] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by a person skilled in the art to which this disclosure pertains. In general, the nomenclature used herein are well known and commonly employed in the art.

[35] Throughout the specification, when a component "includes", "comprises", or "contains" an element, unless there is a description contrary thereto, the component can further include other elements, not excluding the other elements.

[36] In the present disclosure, an yttrium compound includes a Y_2O_3 -based composite. In the present disclosure, the Y_2O_3 -based composite refers to a composition that contains other components in addition to Y_2O_3 , which is an yttrium oxide. Y_2O_3 -MgO to be later described is one type of Y_2O_3 -based composite, and the composite may further contain two or more additional components. In the present disclosure, the types of phases constituting the composite is not particularly limited. For example, each compound constituting the composite may be separately present as a distinct phase or may form a solid solution.

[37] In the present disclosure, the weight ratio of Y_2O_3 : MgO in the Y_2O_3 -MgO composite may be 9:1 to 1:9, 8:2 to 2:8, 7:3 to 3:7, or 6:4 to 4:6. Preferably, the content of MgO may be 30 wt% relative to the total weight of the Y_2O_3 -MgO composite of the present disclosure.

[38] Herein, the yttrium compound may include YF_3 or yttrium oxyfluoride (Y-O-F) in addition to Y_2O_3 . Herein, the Y-O-F compound refers to a ternary compound of Y, O, and F, expressed by the chemical formula $Y_xO_yF_z$, but is not necessarily limited thereto, and may contain trace amounts of additional elements that is solid-soluble while maintaining its crystal structure. In the present disclosure, the Y-O-F compound may include, for example, at least one compound selected from the group consisting of YOF,

$\text{Y}_7\text{O}_6\text{F}_9$, $\text{Y}_6\text{O}_5\text{F}_8$, $\text{Y}_5\text{O}_4\text{F}_7$, and $\text{Y}_4\text{O}_3\text{F}_6$. In the present disclosure, the yttrium compound may contain two or more cations. For example, the yttrium compound may contain at least one element selected from the group consisting of Al, Zr, Y, Sm, Dy, Er, and Hf.

[39]

5 [40] Therefore, the yttrium compound in the present disclosure may include yttrium aluminate, such as $\text{Y}_4\text{Al}_2\text{O}_9$, $\text{Y}_3\text{Al}_5\text{O}_{12}$, or YAlO_3 , or yttria-stabilized zirconia. Meanwhile, the magnesium compound in the present disclosure is interpreted in the same manner. For example, the magnesium compound may include a fluoride, such as Mg-O-F or MgF_2 , in addition to MgO . Additionally, the magnesium compound may include
10 a ternary compound such as MgAl_2O_4 , or multi-component compounds having more cations and anions.

[41]

[42] Hereinafter, a manufacturing method of a plasma sprayed coating containing a composite of magnesium and yttrium compounds will be described.

15 [43] In the present disclosure, the thermal sprayed coating may preferably be implemented by plasma spraying. Hereinafter, atmospheric plasma spraying is described for a method for forming the thermal sprayed coating of the present disclosure, but the present disclosure is not limited thereto. For example, other thermal spraying methods, such as low-pressure plasma spraying or suspension plasma spraying, may be
20 used.

[44] The atmospheric plasma spray (APS) is a thermal spray technique in which a powder or linear material is changed into molten droplets by a high-temperature thermal source, allowing the droplets to be impacted onto a substrate at a high speed, followed by rapid cooling, thereby forming a layered coating. More specifically, APS is a technique
25 in which a gas, such as Ar, He, or N_2 , is converted into plasma by an atmospheric arc, and ejected through a nozzle to form a coating by using ultra-high-temperature, high-rate plasma jet as a heat source, wherein a thermal spray material is impacted onto a substrate, which is a material to be treated, at high speed, thereby enabling the formation of a coating with high adhesion strength and high density.

30 [45] FIG. 1 schematically shows a plasma spray apparatus according to an embodiment of the present disclosure.

[46] Referring to FIG. 1, a plasma spray apparatus 100 includes a plasma torch 110 or a plasma gun, and a feedstock powder injector 120. The apparatus may also include a stage 140 configured to mount a substrate 12 for coating formation thereon.

35 [47] In the present disclosure, the substrate 120 may be composed of any material. For example, a material, such as aluminum, Al_2O_3 , quartz, stainless steel, AlN , or Y_2O_3 , may be used.

[48] In the present disclosure, the substrate 12 may be a substrate used for components for a semiconductor process such as plasma etching, for example, a nozzle, an injector, a focus ring, an edge ring, a cover ring, an electrostatic chuck, a heater, and a liner.

[49] In the present disclosure, the separation distance between the plasma torch and the substrate may be appropriately set. In the present disclosure, the separation distance indicates the distance from a nozzle 112 of the plasma torch to the surface of the substrate 12, and the separation distance is preferably maintained in the range of 130 to 160 mm in order to provide molten powder droplets without loss, thus improving the yield.

[50] The plasma torch 110 is configured to generate an arc discharge between a negative electrode and a positive electrode while flowing a large volume of gas, thereby spraying plasma in a jet state. The plasma sprayed from the plasma torch forms a plasma stream toward the substrate. A feedstock powder, when injected into the plasma stream, may be melted in a short time.

[51] In the present disclosure, the powder injector 120 is configured to supply a feedstock powder as a material for a thermal sprayed coating. The present disclosure contains yttrium and magnesium sources as the feedstock powder from the injector. In the present disclosure, an yttrium salt and a magnesium salt or an yttrium magnesium salt may be used as the yttrium and magnesium sources. Preferably, the yttrium and magnesium sources may be in the form of an oxide, but are not limited thereto, and appropriate sources capable of forming yttrium and magnesium compounds after thermal spray may be used. In addition, the sources may be composed of an yttrium oxide and a magnesium oxide, or may contain an yttrium magnesium oxide.

[52] In the present disclosure, the feedstock powder may be a powder molded in the form of granules. The feedstock may be, for example, a molded body obtained by spray drying of a powder of yttrium oxide and magnesium oxide. Additionally, the feedstock powder may be prepared by melting a portion of the spray-dried molded body through heat treatment or plasma treatment.

[53]

[54] The present disclosure provides a plasma sprayed coating containing a composite of a magnesium compound and an yttrium compound. In the present disclosure, the composite of the coating may contain a monoclinic yttrium oxide.

[55] As described below, the yttrium oxide is a compound having a cubic crystal structure in a stable state. The composite coating of the present disclosure contains a monoclinic yttrium oxide, and preferably contains, as a main phase, a monoclinic yttrium oxide among the crystalline yttrium oxides. In the present disclosure, the term "main phase" refers to a phase, of which the weight fraction is 50% or more among the phases constituting a specific compound. According to an embodiment of the present disclosure,

the monoclinic yttrium oxide may be contained in a content of 60 wt% or more, 70 wt% or more, 80 wt% or more, 90 wt% or more, or 95 wt% or more of the crystalline yttrium oxide. Extremely, yttrium oxide having crystalline structures other than the monoclinic structure may not be substantially detected in the yttrium oxide.

[56] Additionally, the composite coating of the present disclosure may contain sub-micron- or nano-sized grains. Herein, the nano-size indicates having a grain size of 100 nm or less. Herein, the term "grain size" refers to a grain size converted from the volume, surface area, or cross-sectional area of a corresponding grain, and for example, may refer to the diameter when converted into a three-dimensional sphere having the same volume or surface area as the grain, or a two-dimensional circle having the same cross-sectional area as the grain.

[57] In the present disclosure, the size of grains can be obtained by computationally analyzing the diffraction patterns obtained by electron backscatter diffraction (EBSD). Hereinafter, the size of grains obtained thereby is referred to as the EBSD grain size. EBSD refers to an experimental technique for analyzing the crystal structure and crystallographic orientation of a specimen by irradiating electrons onto the specimen and measuring the electrons reflected at a specific angle (backscattered electrons).

[58] The Y₂O₃-based composite of the present disclosure shows a maximum frequency peak at 200 nm or less, more preferably 100 nm or less, in the EBSD grain size distribution.

【Mode for Invention】

[59] Hereinafter, the present disclosure will be described in more detail as examples, but the present disclosure is not limited by the examples.

[60]

[61] A. Preparation examples of feedstock powder for spray

[62] Respective granular powder specimens were prepared by varying the mixing ratio of cubic Y₂O₃ powder with a particle size of 3-5 μm and cubic MgO powder with a particle size of 0.1-1.0 μm. The contents and granule size of the Y₂O₃ powder and MgO powder in the prepared granular powder specimens are shown in Table 1.

[63]

[64] The component proportions and granule sizes of Y₂O₃ and MgO in the prepared feedstock powders are shown in Table 1.

[65] TABLE 1

Classification	Y ₂ O ₃ (wt%)	MgO (wt%)	Average granule size (μm, D50)
Preparation Example 1	100	-	35
Preparation Example 2	10	90	35

Preparation Example 3	70	30	35
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[66] B. Manufacturing of plasma sprayed coatings Thermal sprayed coatings were manufactured by atmospheric plasma spraying (APS) using the feedstock powders for thermal spray prepared in Preparation Examples 1 to 3. Particularly, Al 6061 (20 mm * 20 mm * 3 mm (t)) was used as a substrate.

5 [67] Plasma spraying conditions for manufacturing thermal sprayed coatings are shown in Table 2.

[68] TABLE 2

Classification	Voltage (V)	Current (A)	Power (kW)	Powder delivery rate (g/min)	Separation distance from substrate (mm)
Preparation Example 1	60~80	400~700	35	10	130 - 180
Preparation Example 2				8.2	130 - 180
Preparation Example 3				9.1	130 - 180

[69] The thermal sprayed coatings thus obtained were subjected to EDS component analysis. The EDS analysis was conducted using the JSM-IT700HR model from JEOL, with a magnification of 10,000x and an electron beam voltage of 15 kV. The thermal sprayed coating specimens were mounted, polished, and then plated with Au, followed by EDS analysis. The EDS analysis results are shown in Table 3.

[70] TABLE 3

Classification	Y (at%)	Mg (at%)	O (at%)
#1 (Manufacturing Example 1)	40	-	60
#2 (Manufacturing Example 2)	23	34	43
#3 (Manufacturing Example 3)	7	50	43

[71] The thermal sprayed coatings thus obtained were subjected to XRD analysis. XRD (model name: Empyrean) from Malvern Panalytical was used for the analysis. Cu Ka was used as an X-ray source, with a voltage of 40 kV and a current of 30 mA. FIGS. 2A to 2C show graphs of X-ray diffraction analysis results of Specimen #1 to #3. For reference, FIGS. 3A to 3B show JCPDS XRD patterns of cubic Y₂O₃ and monoclinic Y₂O₃. The phase fractions were quantified from the XRD diffraction results. The phase fractions were calculated by the reference intensity ratio (RIR) method. Table 4 shows the phase fraction calculation results. In Table 4, the base indicates the intensity of a baseline represented by a fourth-order polynomial of the measured intensity, which is a value calculated using “pybaselines”, a library of the Python programming language, and the absolute intensity is a value obtained by subtracting the base from the measured

intensity at the same angle.

[72]

[73] TABLE 4

Classification	Composition	Crystalline structure	Peak position (°)	Measured intensity (Count, $\times 10^3$)	Base (Count, $\times 10^3$)	Absolute intensity (Count, $\times 10^3$)	Fracti on (wt%)
#1	Y ₂ O ₃	Cubic	29.27	6.38	0.01	6.37	100
#2	Y ₂ O ₃	Monoclinic	28.91	3.04	1.62	1.42	8
			30.72	3.51	1.58	1.93	
	MgO	Cubic	42.96	21.37	1.37	20.00	92
#3	Y ₂ O ₃	Cubic	29.23	8.38	3.65	4.73	9
		Monoclinic	28.86	8.06	3.67	4.39	27
			30.77	7.95	3.65	4.30	
	MgO	Cubic	42.89	13.71	3.35	10.36	64

[74] As shown in Table 3, the Y₂O₃ grains of Specimen #1 had a cubic crystal structure showing a peak around $2\theta = 29.3^\circ$. However, the Y₂O₃ grains of Specimen #2 had a monoclinic crystal structure showing peaks around $2\theta = 28.9^\circ$ and 30.7° . Specimen #3 also had, as a main phase, monoclinic Y₂O₃ showing peaks at similar positions.

[75]

[76] The crystal structures and grain sizes of the thermal sprayed coatings obtained were analyzed by EBSD. The EBSD analysis was conducted using the e-Flash FS model from Bruker Optik GmbH. Specifically, the measurement was conducted at a magnification of 10,000x, with a scanning area of $20.76 \times 15.52 \mu\text{m}^2$ and a resolution of 500×375 pixels.

[77] FIGS. 4A and 4B show images of EBSD maps for Specimen #1, where FIG. 4A shows an image of the crystal structure, and FIG. 4B shows an image of the crystallographic orientation. In each image, the black background indicates a non-measurable area.

[78] Referring to FIG. 4A, Specimen #1 was composed of cubic yttria. In addition, FIG. 4B shows the crystallographic orientations of the grains within the area shown in FIG. 4A using shading, where a part appearing as a single large area in FIG. 4A is actually composed of fine grains with different crystallographic orientations, such as (100), (111), and (001).

[79] FIGS. 5 and 6 show images of EBSD maps for Specimen #3, where FIG. 5 shows an image of the crystal structure, and FIG. 6 shows an image of the crystallographic orientation. In FIGS. 5 and 6, the black background indicates a non-measurable area.

[80] As shown in FIG. 5, the Y₂O₃ phase of Specimen #3 was composed of a monoclinic crystal structure and a cubic crystal structure, where the grains of the monoclinic crystal structure accounts for a wider area than the grains of the cubic crystal

structure. Similar to FIG. 4B, FIG. 6 shows the orientations of the grains constituting each crystal structure are represented by shading, where the monoclinic and cubic crystals are actually composed of fine-sized grains with different orientations

[81] Table 5 below summarizes the fractions of the crystal structures in the above-described EBSD maps.

[82] TABLE 5

Classification	Material	Crystal structure	Overall distribution (%)	Fraction in crystalline area (%)
#1	Y ₂ O ₃	Cubic	68.5	100.0
	Non-measurable area	-	31.5	-
#3	Y ₂ O ₃	Cubic	0.2	16.2
		Monoclinic	0.4	37.6
	MgO	Cubic	0.6	46.2
	Non-measurable area	-	98.8	-

[83] The Vickers hardness of the thermal sprayed coatings obtained was measured. Each specimen for measurement was prepared by forming a 150 μm-thick coating on a hexahedral aluminum specimen with 20 mm x 20 mm x 3 mm (t), and then are subjected to mounting and polishing to allow for cross-sectional measurement. The Vickers hardness measurement was conducted was measured using a Vickers hardness tester (Mitutoyo, model: HM) and was defined as the Vickers hardness (Hv0.05) obtained by applying a test load of 0.05 kgf with a diamond indenter having a face angle of 136°. The measurements were conducted at the center of the cross-section of the coating, and 30 times of measurements were conducted, and the median value was determined as the representative value. The measurement results are shown in Table 6.

[84] TABLE 6

Classification	Vickers hardness
#1	400
#2	500
#3	800

[85] As shown in Table 6, the Y₂O₃ sprayed coating containing MgO showed higher hardness. FIGS. 7A and 7B show grain size distributions obtained by calculation from EBSD computational analysis for Specimens #1 and #2.

[86] Referring to FIG. 7, from the EBSD analysis, a large number of grains with a size of 1 μm or more as well as sub-microns were observed in Specimen #1, and only grains with sub-micron size were observed in Specimen #2. Especially, Specimen #2 was composed of grains with a size of less than 0.5 μm, with a maximum frequency peak appearing at 0.1 μm or less.

[87]

[88] The present disclosure has been described above with exemplary embodiments and drawings, but these are only provided to help a more general understanding of the present disclosure, and the present disclosure is not limited to the exemplary embodiments.

5 A person skilled in the art to which the present disclosure pertains will recognize that various modifications and variations can be made without departing from the essential characteristics of the present disclosure. The spirit of the present disclosure is defined by the appended claims rather than by the described exemplary embodiments above, and all changes and modifications that fall within metes and bounds of the claims, or
10 equivalents of such metes and bounds are therefore intended to be embraced by the range of the spirit of the present disclosure.

【Industrial Applicability】

[89] The present disclosure can be applied to semiconductor manufacturing
15 apparatuses and components constituting the semiconductor manufacturing apparatuses.

【CLAIMS】

【Claim 1】

A plasma sprayed coating comprising a composite of a magnesium compound and an yttrium compound, wherein the composite contains a monoclinic yttrium oxide.

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【Claim 2】

The plasma sprayed coating of claim 1, wherein the monoclinic yttrium oxide constitutes the main phase of crystalline yttrium oxide.

10 **【Claim 3】**

The plasma sprayed coating of claim 1, wherein the yttrium compound further contains a cubic yttrium oxide.

【Claim 4】

15 The plasma sprayed coating of claim 1, wherein the composite comprises grains with an EBSD grain size of 250 nm or less.

【Claim 5】

20 The plasma sprayed coating of claim 1, wherein the composite comprises grains with an EBSD grain size of 100 nm or less.

【Claim 6】

The plasma sprayed coating of claim 1, wherein the weight ratio of the yttrium compound to the magnesium compound in the composite is 1:9 to 9:1.

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【Claim 7】

The plasma sprayed coating of claim 1, wherein the composite shows a maximum frequency peak at 200 nm or less in the EBSD grain size distribution.

30 **【Claim 8】**

The plasma sprayed coating of claim 1, wherein the composite shows a maximum frequency peak at 100 nm or less in the EBSD grain size distribution.

【Claim 9】

35 The plasma sprayed coating of claim 1, wherein the composite further contains Al_2O_3 .

【Claim 10】

The plasma sprayed coating of claim 1, wherein the yttrium compound includes YF_3 .

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【Claim 11】

The plasma sprayed coating of claim 1, wherein the yttrium compound includes Y-O-F.

10 **【Claim 12】**

A method for manufacturing a plasma sprayed coating, the method comprising:

(a) introducing a feedstock powder containing yttrium and magnesium sources into a plasma stream to melt at least a portion of the feedstock powder; and

15 (b) exposing a substrate to an atmospheric plasma stream containing the yttrium and magnesium sources to form a plasma sprayed coating containing a composite of a magnesium compound and an yttrium compound.

【Claim 13】

20 The method of claim 12, wherein in step (a), the yttrium and magnesium sources are composed of a mixture of yttrium oxide and magnesium oxide.

【Claim 14】

The method of claim 13, wherein in the magnesium and yttrium sources, the weight ratio of magnesium and yttrium, converted to MgO and Y_2O_3 , is 1:9 to 9:1.

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【Claim 15】

The method of claim 13, wherein the yttrium and magnesium sources contain cubic yttria.

30 **【Claim 16】**

The method of claim 13, wherein the composite contains a monoclinic yttrium oxide.

【Claim 17】

35 The method of claim 16, wherein the monoclinic yttrium oxide constitutes the main phase of crystalline yttrium oxide.

【Claim 18】

The method of claim 12, wherein the yttrium compound further contains a cubic yttrium oxide.

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