

MOLYBDENUM ALLOY TARGET AND METHOD OF PREPARING THE SAME AND MOLYBDENUM ALLOY LAYER

The present invention relates to a target of a magnetic recording media, a method of preparing the same, and a layer, more particularly to a

5 molybdenum alloy target and a molybdenum alloy layer used for a heat-assisted magnetic recording media.

Magnetic recording media is one application of magnetic materials, which is mainly used for information backup and storage. According to the orientation of the magnetization, the magnetic recording media are classified
10 into longitudinal magnetic recording media and perpendicular magnetic recording media. The longitudinal magnetic recording media have been developed to reach the limit; therefore, the research turns to throw in the perpendicular magnetic recording media. In particular, perpendicular heat-assisted magnetic recording (HAMR) media have high storage capacity, so it
15 has received a lot of attention in related fields.

Generally, a perpendicular HAMR media comprises a substrate, an adhesion layer, a soft under layer, a heat sink layer, an inter layer, a recording layer, and an overcoat from bottom to top. The heat sink layer can promote the thermal conductivity of the perpendicular HAMR media.

20 A conventional heat sink layer is mainly composed of molybdenum. In order to promote heat resistance and corrosion resistance of the heat sink layer, the conventional heat sink layer is mainly doped with an additive metal such as chromium of high melting point. However, such high-melting-point additive metal also has high oxidizability and easily reacts with oxygen to form oxides,

such that the formation of undesired particles or abnormal discharging occurs during sputtering. As a result, the molybdenum alloy layer produced from sputtering also has excessively rough surface due to excessive oxygen content, thus failing to promote the thermal conductivity of the perpendicular HAMR media. There is still a need to provide other materials for the heat sink layer to overcome the aforesaid problems.

In view of the aforesaid problems, an objective of the present invention is to develop a molybdenum alloy target, which can be used to prepare a molybdenum alloy layer that has good thermal conductivity, heat resistance, and corrosion resistance as well.

Another objective of the present invention is to develop the molybdenum alloy target, which allows the molybdenum alloy layer sputtered by the molybdenum alloy target to be used for a perpendicular HAMR media.

In order to achieve the above objectives, the present invention provides a molybdenum alloy target comprising molybdenum and a first additive metal. The first additive metal comprises rhenium, ruthenium or a combination thereof. Based on the total atoms of the molybdenum alloy target, an amount of total atoms of the first additive metal is higher than or equal to 3 atomic percent (at%) and less than or equal to 10 at%. The molybdenum alloy target is higher than or equal to 2 metallographic phases, and an oxygen content of the molybdenum alloy target is less than or equal to 600 parts per million (ppm).

By controlling the composition, the oxygen content, and the number of the metallographic phase of the molybdenum alloy target, the molybdenum alloy layer sputtered by the molybdenum alloy target that has good thermal

conductivity, heat resistance and corrosion resistance, and can be used as a heat sink layer of the perpendicular HAMR media.

In an embodiment, besides the first additive metal, the molybdenum alloy target may comprise a second additive metal. The second additive metal
5 may be, but is not limited to, chromium (Cr), tantalum (Ta), tungsten (W), niobium (Nb), vanadium (V), or any combination thereof.

In an embodiment, based on the total atoms of the molybdenum alloy target, the amount of total atoms of the second additive metal may be higher than 0 at% and less than or equal to 3 at%, and the amount of total atoms of the
10 first additive metal and the second additive metal may be higher than or equal to 3 at% and less than or equal to 10 at%.

Preferably, based on the total atoms of the molybdenum alloy target, the amount of total atoms of the first additive metal may be higher than or equal to 4 at% and less than or equal to 10 at%.

15 Preferably, the oxygen content of the molybdenum alloy target may be less than or equal to 500 ppm.

Preferably, a relative density of the molybdenum alloy target may be higher than or equal to 98%. More preferably, the relative density of the molybdenum alloy target may be higher than or equal to 98.5%. Much more
20 preferably, the relative density of the molybdenum alloy target may be higher than or equal to 99%. Accordingly, the molybdenum alloy target of the present invention has another advantage of high relative density.

In order to achieve the objectives, the present invention provides a method for manufacturing the molybdenum alloy target. The method comprises

the steps of: mixing a molybdenum powder with a first additive metal to obtain a mixing powder; sintering the mixing powder at a temperature between 1000°C and 1500°C for more than or equal to 1 hour to obtain a sintered body; and processing the sintered body by wire electrical discharge machining and lathing to obtain the molybdenum alloy target. Herein, the first additive metal comprises rhenium, ruthenium or a combination thereof, an oxygen content of the molybdenum powder is less than or equal to 1500 ppm, and an amount of total atoms of the first additive metal is higher than or equal to 3 at% and less than or equal to 10 at% based on the total atoms of the mixing powder.

By using the molybdenum powder with a specific oxygen content and controlling the sintering conditions, the molybdenum alloy target having a specific composition, two or more metallographic phases, and a low oxygen content can be obtained. The molybdenum alloy layer sputtered by the molybdenum alloy target that has good thermal conductivity, heat resistance and corrosion resistance, and can be used as the heat sink layer of the perpendicular HAMR media.

Preferably, the grain size of the mixing powder may be higher than or equal to 10 micrometers (μm) and less than or equal to 100 μm .

Preferably, the oxygen content of the molybdenum powder may be higher than or equal to 800 ppm and less than or equal to 1500 ppm. More preferably, the oxygen content of the molybdenum powder may be higher than or equal to 800 ppm and less than or equal to 1300 ppm. Much more preferably, the oxygen content of the molybdenum powder may be higher than or equal to 800 ppm and less than or equal to 1000 ppm.

Preferably, the sintering temperature may be higher than or equal to 1050°C and less than or equal to 1450°C. Preferably, the sintering time may be higher than or equal to 2 hours and less than or equal to 5 hours.

Preferably, the mixing powder of the present invention can be sintered
5 by a well-known sintering method, such as, but is not limited to, hot pressing (HP), hot isostatic pressing (HIP), or any combination thereof.

In an embodiment, the mixing powder may comprise a second additive metal, for example, but is not limited to, chromium, tantalum, tungsten, niobium, vanadium, or any combination thereof.

10 Preferably, based on the total atoms of the mixing powder, the amount of total atoms of the second additive metal may be higher than 0 at% and less than or equal to 3 at%, and the amount of total atoms of the first additive metal and the second additive metal may be higher than or equal to 3 at% and less than or equal to 10 at%.

15 Preferably, based on the total atoms of the mixing powder, the amount of total atoms of the first additive metal may be higher than or equal to 4 at% and less than or equal to 10 at%.

In order to achieve the above objectives, the present invention provides a molybdenum alloy layer, which is sputtered from the above molybdenum
20 alloy target.

The molybdenum alloy layer sputtered by the molybdenum alloy target has the composition and the low oxygen content similar to the molybdenum alloy target, so the molybdenum alloy layer that has good thermal conductivity, heat resistance and corrosion resistance, and can be used as the heat sink layer

of the perpendicular HAMR media.

Regarding the composition of the molybdenum alloy layer, based on the total atoms of the molybdenum alloy layer, an amount of total atoms of the second additive metal may be higher than 0 at% and less than or equal to 3 at%,
5 and an amount of total atoms of the first additive metal and the second additive metal may be higher than or equal to 3 at% and less than or equal to 10 at%.

Preferably, based on the total atoms of the molybdenum alloy layer, the amount of total atoms of the first additive metal may be higher than or equal to 4 at% and less than or equal to 10 at%.

10 Preferably, a surface roughness (Ra) of the molybdenum alloy layer may be less than or equal to 1.5 nanometers (nm). More preferably, the surface roughness of the molybdenum alloy layer may be less than or equal to 1.45 nm. Much more preferably, the surface roughness of the molybdenum alloy layer may be less than or equal to 1 nm. Compared to the conventional heat sink
15 layer, the present invention can solve the problem of lacking good thermal conductivity, and thus makes the molybdenum alloy layer suitable as the heat sink layer of the perpendicular HAMR media.

IN THE DRAWINGS:

Figs. 1A to 1B are respectively scanning electron microscope images of
20 molybdenum alloy targets of Example 5 and Comparative Example 2.

Examples were made to prove the influences of the compositions and the manufacturing parameters on thermal conductivity, heat resistance and corrosion resistance of the molybdenum alloy layers sputtered by the molybdenum alloy targets. Comparative Examples of molybdenum alloy

targets were made to compare with the Examples. One person skilled in the arts can easily realize the advantages and effects of the molybdenum alloy target in accordance with the present invention from the comparison of the Examples and the Comparative examples. The descriptions proposed herein are just for the purpose of illustrations only, not intended to limit the scope of the invention. Various modifications and variations could be made in order to practice or apply the present invention without departing from the spirit and scope of the invention.

Preparation of molybdenum alloy target

The molybdenum alloy target materials of Examples 1 to 10 and Comparative Examples 1 to 9 were each obtained by using an appropriate amount of a first additive metal such as rhenium, ruthenium and a second additive metal such as chromium, tantalum through the process described below. In Table 1, the amount of each component of the molybdenum alloy target was expressed in at%.

Firstly, a molybdenum powder with an oxygen content less than 1500 ppm, a first additive metal powder and a second additive metal powder in an appropriate amount as described in Table 1 were weighed and mixed by rolling to get a mixing powder with a grain size of 25 μm .

Subsequently, the mixing powder was filled into a graphite mold, and then sintered through hot pressing (HP) and hot isostatic pressing (HIP) under a protective atmosphere such as argon gas at a temperature between 1050°C and 1450°C, and a pressure between 250 and 2000 bars for 60 to 300 minutes, so as to obtain a sintered body.

Finally, the aforesaid sintered body was processed by wire electrical discharge machining and computer numerical control (CNC) lathe to obtain a round molybdenum alloy target with a diameter of 165 millimeters (mm) and a thickness of 4 mm.

5 The parameters of the molybdenum alloy targets of all Examples and Comparative Examples were listed in Table 1. The sintering temperature refers to the temperature conditions of both HP and HIP, and the sintering time refers to the total sintering period of both HP and HIP.

Test Example 1: Oxygen content

10 The molybdenum powders as raw material and molybdenum alloy targets of Examples 1 to 10 and Comparative Examples 1 to 9 were adopted as test samples, and measured by an Oxygen/Nitrogen analyzer (instrument model: EMGA-620W, purchased from HORIBA).

15 50 to 100 mg of the test samples were placed in a graphite crucible and burned under a continuous atmosphere of helium gas, so that the oxygen contained in the samples was converted into carbon monoxide, and then measured by non-dispersive infrared absorption to obtain the oxygen content. The results of the oxygen content of each sample were listed in Table 1 below.

20 As listed in Table 1 below, the oxygen content of the molybdenum powders of Examples 1 to 10 were less than 1500 ppm. However, the oxygen content of the molybdenum powders of Comparative Examples 2 and 7 were higher than 1500 ppm.

 As listed in Table 1 below, the oxygen content of the molybdenum alloy targets of Examples 1 to 10 were less than the oxygen content of the

molybdenum alloy targets of Comparative Examples 1 to 9, and the oxygen content of the molybdenum alloy targets of Examples 1 to 10 were less than 600 ppm. In other words, the results proved that using the specific oxygen content of the molybdenum powder and controlling the composition and the manufacturing parameters of the molybdenum alloy target can effectively reduce the oxygen content of the molybdenum alloy target.

In addition, comparing the results of the molybdenum alloy targets of Examples 1 to 10, when the molybdenum alloy target comprises 4 at% to 10 at% of one single first additive metal such as rhenium or ruthenium and without any second additive metal, the oxygen content of the molybdenum alloy target can be further reduced. Specifically, the oxygen contents of the molybdenum alloy targets of Examples 4, 5, 7, 9 and 10 were less than 500 ppm.

Test Example 2: Relative density

Each of the molybdenum alloy targets of Examples 1 to 10 and Comparative Examples 1 and 9 was cut by wire electrical discharge machining to obtain the samples sized in 20 mm × 20 mm × 4 mm. Each sample was immersed in water of 25°C and the density thereof was measured by Archimedes' method. The relative density of the molybdenum alloy targets was calculated from dividing the measured density by the theoretical density. Results of the relative density were listed in Table 1 below.

As listed in Table 1 below, the relative densities of the molybdenum alloy targets of Examples 1 to 10 were higher than the relative densities of the molybdenum alloy targets of Comparative Examples 1 to 9. Specifically, the relative densities of the molybdenum alloy targets of Examples 1 to 10 were

higher than 98%, and the relative densities of the molybdenum alloy targets of Examples 1 to 7, 9 and 10 were higher than 98.5%. However, the relative densities of the molybdenum alloy targets of Comparative Examples 2 to 9 were less than 98%. In other words, controlling the composition and the manufacturing parameters of the molybdenum alloy target can effectively improve the relative density of the molybdenum alloy target.

Test example 3: Number of metallographic phase

Each of the molybdenum alloy targets was cut by wire electrical discharge machining to obtain the samples sized in 10 mm × 10 mm, and then ground and polished. The microstructure of each sample was observed by a scanning electron microscope (instrument model: JEOL S-3400N SEM), and the results were listed in Table 1 below.

As listed in Table 1 below, the numbers of the metallographic phases of the molybdenum alloy targets of Examples 1 to 10 were higher than or equal to 2. However, the numbers of the metallographic phases of the molybdenum alloy targets of Comparative Examples 1, 2, 5 and 9 were only 1.

Take the results of the molybdenum alloy targets of Example 5 and Comparative Example 2 as the representative of Examples and Comparative Examples for illustration. As shown in FIGs. 1A to 1B, no holes could be found in the microstructure of the molybdenum alloy target of Example 5; however, with reference to FIG. 1B, there were holes in the microstructure of the molybdenum alloy target of Comparative Example 2. As a result, the relative density of the molybdenum alloy target of Comparative Example 2 was reduced to only 95.8%.

Table 1: the results of the composition, the manufacturing parameters, the characteristics of the molybdenum alloy targets and the characteristics of the molybdenum alloy layers of Examples 1 to 10 (E1 to E10) and Comparative Examples 1 to 9 (C1 to C9).

Example No.	Composition of molybdenum alloy targets				Manufacturing parameters of molybdenum alloy targets			Characteristics of molybdenum alloy targets				Characteristics of molybdenum alloy layers		
	Mo (at%)	1 st additive metal		2 nd additive metal		Oxygen content of Mo powder (ppm)	Sintering time (hours)	Sintering temp. (°C)	Oxygen content (ppm)	Relative density (%)	Number of metallic phase	Heat resistance	Corrosion resistance	Surface roughness (nm)
		Ru (at%)	Re (at%)	Cr (at%)	Ta (at%)									
E1	97	3	-	-	-	1393	3	1050	597	98.9	2	△	△	1.48
E2	93	5	-	2	-	1327	3.5	1300	539	99.0	2	△	△	1.38
E3	90	8	-	-	2	1280	2.5	1150	510	98.5	2	O	O	1.45
E4	90	10	-	-	-	1244	4	1100	488	98.3	2	O	O	1.30
E5	96	-	4	-	-	1053	3	1300	398	99.6	2	O	△	1.12
E6	94	-	4	2	-	1391	3.5	1100	558	98.6	3	O	△	1.35
E7	93	-	7	-	-	1402	5	1100	325	99.2	2	O	O	0.82
E8	92	1	5	2	-	1335	2	1450	502	98.4	3	O	O	0.91
E9	90	-	10	-	-	1159	3	1200	387	98.5	2	O	O	0.55
E10	90	1	9	-	-	1310	3.5	1200	417	98.7	3	O	O	0.72
C1	98	2	-	-	-	1420	5	1025	842	98.1	1	X	X	2.08
C2	98	-	-	2	-	1532	3	1000	950	96.1	1	X	X	2.44
C3	93	5	-	2	-	1375	1	1300	784	95.5	3	△	X	1.58
C4	92	3	-	5	-	1466	1.5	1400	922	97.5	2	△	X	1.91
C5	99	-	1	-	-	1349	1.5	1150	783	95.8	1	X	X	2.10
C6	98	-	2	-	-	1297	1.5	1200	631	96.3	2	X	X	1.71
C7	88	-	4	-	8	1551	3	1025	852	96.5	3	△	X	2.81
C8	90	-	3	7	-	1447	1.5	1450	1031	97.3	2	△	X	2.23
C9	98	1	-	-	1	1330	1.5	1300	679	96.4	1	X	X	2.35

Preparation of molybdenum alloy layer

The molybdenum alloy layers of Examples 1 to 10 and Comparative Examples 1 to 9 were each obtained by sputtering the aforesaid molybdenum alloy targets of Examples 1 to 10 and Comparative Examples 1 to 9 with the process described below.

Firstly, the aforesaid molybdenum alloy targets were processed by wire electrical discharge machining and CNC lathe to obtain the samples each having a diameter of 3 inch and a thickness of 4 mm. Subsequently, each of the samples was put into a magnetron sputtering machine to carry out a pre-sputtering for surface decontamination, and then sputtered through magnetron sputtering at a continuous argon flow rate of 30 standard cubic centimeters per minute (sccm) under a pressure of 3 millitorr (mtorr) and with a sputtering power of 150 watts (W) for 150 seconds, so as to respectively form the molybdenum alloy layers of Examples and Comparative Examples on a 20 mm × 20 mm polycrystal silicon substrate, each having a thickness between 120 nm and 140 nm.

Test example 4: Thermal conductivity

The surface roughness (Ra) of each aforesaid molybdenum alloy layer sized in 20 mm × 20 mm was analyzed by an atomic force microscope (AFM, instrument model: Veeco DI-3100, laser intensity: 1.0 mW, the maximum wavelength of laser: 670 nm, probe purchased from Nanoworld). The atomic force interaction between tip of the probe and the surface of the molybdenum alloy layer leads to the deflection of the arm of the probe. Subsequently, the back side of the arm of the probe was illuminated by laser to record the

deflections of the arm of the probe. Finally, the aforesaid deflections were analyzed by feedback circuit and computer aided graphics, and the results of the surface roughness of the aforesaid molybdenum alloy layers were listed in Table 1 above. By controlling the composition of the molybdenum alloy layer, there was a negative correlation between the surface roughness and the thermal conductivity of the molybdenum alloy layer, which represents the lower the surface roughness is, the better the thermal conductivity is.

As listed in Table 1 above, the surface roughnesses of the molybdenum alloy layers of Examples 1 to 10 were less than 1.5 nm, which were significantly lower than the surface roughnesses of the molybdenum alloy layers of Comparative Examples 1 to 9. It was demonstrated that the molybdenum alloy layer sputtered by the molybdenum alloy target of the present invention could have lower surface roughness.

According to the results of Test example 4, the surface roughnesses of the molybdenum alloy layers of Examples 1 to 10 were lower than the surface roughnesses of the molybdenum alloy layers of Comparative Examples 1 to 9, so the molybdenum alloy layers of Examples 1 to 10 should have good thermal conductivity and could be used as a heat sink layer of a perpendicular HAMR media.

20 **Test example 5: Heat resistance**

Each of the aforesaid molybdenum alloy layers sized in 20 mm × 20 mm was put into a vacuum environment at a pressure less than 10^{-6} torr, and then put under 500°C for 2 hours for high temperature test. The surface roughness of each molybdenum alloy layers after the high temperature test was

analyzed by atomic force microscope with the analytical method described above in the aforesaid Test example 4.

The increment of the surface roughness of the molybdenum alloy layer before and after the high temperature test was taken as a basis for evaluating the heat resistance of the molybdenum alloy layer. When the surface roughness of the molybdenum alloy layer after the high temperature test increased by less than 10% compared with the surface roughness of the molybdenum alloy layer before the high temperature test (i.e. the surface roughness measured in Test Example 4), it means that the heat resistance of the molybdenum alloy layer was excellent and was marked as “O” in Table 1 above. When the surface roughness of the molybdenum alloy layer after the high temperature test increased in a range of 10% to 20% compared with that of the molybdenum alloy layer before the high temperature test, it means that the heat resistance of the molybdenum alloy layer was good and was marked as “△” in Table 1 above. When the surface roughness of the molybdenum alloy layer after the high temperature test increased by higher than 20% compared with that of the molybdenum alloy layer before the high temperature test, it means that the heat resistance of the molybdenum alloy layer was poor and was marked as “X” in Table 1 above.

As listed in Table 1 above, the molybdenum alloy layers of Examples 1 to 10 had good heat resistance, and particularly, the molybdenum alloy layers of Examples 3 to 10 had excellent heat resistance. In contrast, as listed in Table 1 above, the molybdenum alloy layers of Comparative Examples 1, 2, 5, 6 and 9 had poor heat resistance, which could not be used as the heat sink layer of the

perpendicular HAMR media.

Test example 6: Corrosion resistance

Each of the aforesaid molybdenum alloy layers sized in 20 mm × 20 mm was put into a vacuum environment at a pressure of 760 torr; and stood
 5 under a humidity of 85% and a temperature of 100°C for 120 hours for test. The discoloration of each molybdenum alloy layers was observed by naked eyes, so as to obtain the corrosion resistance of each molybdenum alloy layer.

The ratio of discoloration area to the total area of the molybdenum alloy layer after the high temperature and high humidity test was taken as a
 10 basis for evaluating the corrosion resistance of the molybdenum alloy layer. When the discoloration area of the molybdenum alloy layer after the high temperature and high humidity test accounted for less than 20% of its total area, it means that the corrosion resistance of the molybdenum alloy layer was excellent and was marked as “O” in Table 1 above. When the discoloration area
 15 of the molybdenum alloy layer accounted for a range of 20% to 50% of its total area, it means that the corrosion resistance of the molybdenum alloy layer was good and was marked as “△” in Table 1 above. When the discoloration area of the molybdenum alloy layer accounted for higher than 50% of its total area and was peeling off, it means that the corrosion resistance of the molybdenum alloy
 20 layer was poor and was marked as “X” in Table 1 above.

As listed in Table 1 above, the molybdenum alloy layers of Examples 1 to 10 had good corrosion resistance, particularly to the molybdenum alloy layers of Examples 3, 4, 7 and 10 had excellent corrosion resistance. In contrast, the molybdenum alloy layers of Comparative Examples 1 to 9 had

poor corrosion resistance, which could not be used as the heat sink layer of the perpendicular HAMR media.

According to the results of Test Examples 1 to 6, the molybdenum alloy target having a specific composition, two or more metallographic phases and a low oxygen content can be obtained by controlling the composition and sintering conditions of the molybdenum alloy target and using the molybdenum powder with a specific oxygen content. The molybdenum alloy layer sputtered by the molybdenum alloy target that has good thermal conductivity, heat resistance and corrosion resistance, and can be used as the heat sink layer of the perpendicular HAMR media.

In addition, even though further using an appropriate amount of the second additive metal, controlling the composition and the sintering conditions of the molybdenum alloy target and using the molybdenum powder with a specific oxygen content. The molybdenum alloy target having a specific composition, two or more metallographic phases and a low oxygen content can also be obtained. The molybdenum alloy layer sputtered by the molybdenum alloy target that also has good thermal conductivity, heat resistance and corrosion resistance, and can be used as the heat sink layer of the perpendicular HAMR media.

Even though numerous characteristics and advantages of the instant disclosure have been set forth in the foregoing description, together with details of the composition and features of the disclosure, the disclosure is illustrative only. Changes may be made in the details, especially in matters of material within the principles of the disclosure to the full extent indicated by the broad

general meaning of the terms in which the appended claims are expressed.

CLAIMS:

1. A molybdenum alloy target, comprising molybdenum and a first additive metal, wherein the first additive metal comprises rhenium, ruthenium or a combination thereof; based on the total atoms of the molybdenum alloy target, an amount of total atoms of the first additive metal is higher than or equal to 3 atomic percent and less than or equal to 10 atomic percent; a number of metallographic phase of the molybdenum alloy target is higher than or equal to 2; an oxygen content of the molybdenum alloy target is less than or equal to 600 ppm.

2. The molybdenum alloy target as claimed in claim 1, wherein the molybdenum alloy target comprises a second additive metal, and the second additive metal comprises chromium, tantalum, tungsten, niobium, vanadium, or any combination thereof.

3. The molybdenum alloy target as claimed in claim 2, wherein based on the total atoms of the molybdenum alloy target, the amount of total atoms of the second additive metal is higher than 0 atomic percent and less than or equal to 3 atomic percent, and the amount of total atoms of the first additive metal and the second additive metal is higher than or equal to 3 atomic percent and less than or equal to 10 atomic percent.

4. The molybdenum alloy target as claimed in any one of claims 1 to 3, wherein based on the total atoms of the molybdenum alloy target, the amount of total atoms of the first additive metal is higher than or equal to 4 atomic percent and less than or equal to 10 atomic percent.

5

5. The molybdenum alloy target as claimed in any one of claims 1 to 4, wherein a relative density of the molybdenum alloy target is higher than or equal to 98%.

10

6. A method for manufacturing a molybdenum alloy target, comprising the steps of:

mixing a molybdenum powder with a first additive metal to obtain a mixing powder, wherein the first additive metal comprises rhenium, ruthenium or a combination thereof, an oxygen content of the molybdenum powder is less than or equal to 1500 ppm, and an amount of total atoms of the first additive metal is higher than or equal to 3 atomic percent and less than or equal to 10 atomic percent based on the total atoms of the mixing powder;

15

sintering the mixing powder at a temperature between 1000°C and 1500°C for more than or equal to 2 hours and less than or equal to 5 hours to obtain a sintered body; and

20

processing the sintered body by wire electrical discharge machining and lathing to obtain the molybdenum alloy target.

7. The method as claimed in claim 6, wherein the mixing powder comprises a second additive metal, and the second additive metal comprises chromium, tantalum, tungsten, niobium, vanadium, or any combination thereof.

5 8. The method as claimed in claim 7, wherein based on the total atoms of the mixing powder, the amount of total atoms of the second additive metal is higher than 0 atomic percent and less than or equal to 3 atomic percent, and the amount of total atoms of the first additive metal and the second additive metal is higher than or equal to 3 atomic percent and less than or equal to 10
10 atomic percent.

 9. A molybdenum alloy layer, which is sputtered from the molybdenum alloy target as claimed in any one of claims 1 to 5, wherein a surface roughness of the molybdenum alloy layer is less than or equal to 1.5
15 nanometers.