Claims

1. A sputtering target comprising:

a solidified target comprising consolidated spherical titanium particles in a composition in the range of 5 to 15 wt% and a balance of consolidated tungsten, wherein the target has a microstructure consisting essentially of a tungsten phase interdispersed with a titanium phase and further characterized by having no β (titanium-tungsten) alloy lamellar phase based on the microstructure;

the consolidated spherical titanium particles are characterized by a first particle size distribution having a particle size of 20 micrometers or less, and the consolidated tungsten particles are characterized by a second particle size distribution, wherein the first particle size is matched with the second particle size so that a difference between a median particle size (D50) of the consolidated spherical titanium particles and a median particle size (D50) of the consolidated tungsten particles is about 15 micrometers or less;

wherein the target is characterized by a reduction or absence of nodule formation visually observed during sputtering compared to a conventional consolidated tungsten-titanium target without particle size matching, and

further characterized by an average surface roughness (Ra) of the sputtered side of the target of 100 microinches (μ-in) or less after sputtering at 20 kWh.

2. The sputtering target of claim 1, wherein the microstructure is further characterized by an absence of W interdiffused into a beta (Ti, W) phase.

3. The sputtering target of claim 1, wherein the consolidated spherical titanium particles have a first median particle size (D50) and the consolidated tungsten particles have a second median particle size (D50), and a difference between the first median particle size (D50) and the second median particle size (D50) is 11 micrometers or less.

4. The sputtering target of claim 1, wherein the difference between the first median particle size (D50) of the consolidated spherical titanium particles and the

second median particle size (D50) of the consolidated tungsten particles is 5 micrometers or less.

5. The sputtering target of claim 1, wherein the consolidated spherical titanium particles are included in an amount of 7 to 12 wt% based on the weight of the target, and further the consolidated spherical titanium particles have a purity level of 99.9 wt% or higher.

6. The sputtering target of claim 1, wherein the oxygen content is 1500 ppm or lower.

7. A titanium-tungsten sputtering target configured to be sputtered to produce improved titanium-tungsten films having reduced in-film particle defects, the titanium-tungsten sputtering target comprising:

a solidified target comprising consolidated spherical titanium particles in a compositional range of the target having 5 to 15 wt% titanium based on a total weight of the solidified target and a balance of consolidated tungsten particles, wherein the target has a microstructure consisting essentially of a tungsten phase continuously interdispersed with a titanium phase and further characterized by having no β (titanium-tungsten) alloy lamellar phase based on the microstructure;

the consolidated spherical titanium particles are characterized by a first particle size distribution having a first median particle size (D50) and further the number of consolidated spherical titanium particles per 200 micrometer square unit area of the target before sputtering is 50 to 200;

the consolidated tungsten particles are characterized by a second particle size distribution having a second median particle size (D50), the first particle size distribution is matched with the second particle size distribution so that a difference between the first median particle size (D50) and the second median particle size (D50) is 15 micrometers or less, and

further characterized by an average surface roughness (Ra) of the sputtered side of the target of 100 microinches (μ-in) or less after sputtering at 20 kWh.

8. The titanium-tungsten sputtering target of claim 7, wherein the consolidated tungsten particles have a particle size in the range of 3 to 10 micrometers.

9. The titanium-tungsten sputtering target of claim 7, wherein the target is configured to be sputtered while forming a sputter side having a reduced formation of nodules compared to a conventional WTi sputter without particle size matching of Ti with W.

10. The titanium-tungsten sputtering target of claim 1, wherein the target is configured to be sputtered while forming a sputter side having a lower surface roughness (Ra) compared to a conventional WTi without particle size matching of Ti with W.

11. A WTi film produced by the target of claim 1, characterized by a reduction or elimination of particle defects contained in the film compared to a film produced by a conventional WTi without particle size matching of Ti with W.

12. The sputtering target of claim 1, further comprising a density greater than 98%.

13. A sputtering target comprising:

a solidified target comprising consolidated spherical titanium particles in a compositional range of the target having 5 to 15 wt% based on a total weight of the solidified target, and a balance of consolidated tungsten particles, wherein the target has a titanium characterized by the absence of hydrogenation;

the solidified target has a multi-phase microstructure consisting essentially of a tungsten phase continuously interdispersed with a titanium phase, wherein the multi-phase microstructure is further characterized by having no β (titanium-tungsten) alloy laminar phase based on the microstructure,

the consolidated spherical titanium particles are characterized by a first particle size distribution of 5 to 20 micrometers and the consolidated tungsten particles are characterized by a second particle size distribution of 3 to 10 micrometers, wherein the consolidated spherical titanium particles are matched with the consolidated tungsten particles to a degree so that a difference between a median particle size (D50) of titanium and a median particle size (D50) of tungsten is 15 micrometers or less;

wherein the target is configured to be sputtered while forming a sputter target side having a reduction or elimination of nodules visually observed during sputtering compared to a conventional titanium-tungsten sputtering target without particle size matching, thereby reducing or eliminating particle generation onto TiW films produced from sputtering of the sputtering target, and

further characterized by an average surface roughness (Ra) of the sputtered side of the target of 100 microinches (μ-in) or less after sputtering at 20 kWh.

14. The sputtering target of claim 13, wherein the consolidated spherical titanium particles have a size of 20 micrometers or less and further, the consolidated spherical titanium particles have a titanium purity level of 99.9 wt% or higher.

15. The sputtering target of claim 13, wherein the sputtered side after 20 kWh is characterized by a cross sectional area in which 5% or less of the cross-sectional area contains a β (titanium-tungsten) alloy laminar phase.

16. The sputtering target of claim 13, wherein the oxygen content is 1500 ppm or lower.

17. The sputtering target of claim 13, wherein the consolidated spherical titanium particles are not hydrogenated and derived from an atomization process having the oxygen content of less than 500 ppm.

18. The sputtering target of claim 13, wherein the absence of β (titanium-tungsten) alloy laminar phase based on the microstructure is defined as the target without containing any precipitated phases of tungsten particles interdiffused within the titanium phase.

19. The sputtering target of claim 18, wherein the interdiffused tungsten particles within the titanium phase do not exceed a predetermined solubility limit of the titanium phase