CLAIMS

1. A wet etching method comprising pretreating a metal-containing film on a substrate with a surface modification liquid and then etching the metal-containing film with an etching liquid,

wherein the etching liquid is a solution comprising: a β-diketone with a trifluoromethyl group bonded to a carbonyl group; and an organic solvent,

wherein the metal-containing film comprises a metal element capable of forming a complex with the β-diketone,

wherein the surface modification liquid comprises an oxidizing substance against the metal element and a solvent,

wherein the solvent contains water used in an amount of 50 wt% or more per 100 parts by weight of the solvent,

wherein the wet etching method is carried out through: a first step of bringing the surface modification liquid into contact with the metal-containing film, thereby forming an oxide layer of the metal element at a surface of the metal-containing film; and a second step of bringing the etching liquid into contact with the metal-containing film on which the oxide layer has been formed,

wherein the wet etching method comprises, between the first step and the second step, a rinsing step of rinsing a surface of the substrate, using the organic solvent, and

wherein an amount of the oxidizing substance contained in the etching liquid is 0.001 mass% or less per 100 parts by mass of the etching liquid, when the etching liquid is brought into contact with the metal-containing film in the second step.

2. The wet etching method according to claim 1,

wherein the oxidizing substance is not brought into contact with the metal-containing film in the second step.

3. The wet etching method according to claim 1 or 2,

wherein a time for contact of the metal-containing film with the surface

modification liquid is 2 minutes or less, and

wherein a time for contact of the metal-containing film with the etching liquid is 2 minutes or less.

4. The wet etching method according to any one of claims 1 to 3,

wherein a concentration of the β-diketone in the etching liquid is 0.5 to 15 mass%.

5. The wet etching method according to any one of claims 1 to 4,

wherein the oxidizing substance is at least one kind selected from the group consisting of oxygen, ozone, peroxides, oxidizing acids and salts thereof, persulfonic acids and salts thereof, peracetic acid, percarbonic acid and salts thereof, persulfuric acid and salts thereof, perchloric acid and salts thereof, and periodic acid and salts thereof.

6. The wet etching method according to any one of claims 1 to 5,

wherein the oxidizing substance is at least one kind selected from the group consisting of oxygen, ozone, hydrogen peroxide, nitric acid, and sulfuric acid.

7. The wet etching method according to any one of claims 1 to 6,

wherein an amount of the oxidizing substance contained in the surface modification liquid is 0.01 to 20 mass% per 100 parts by weight of the surface modification liquid.

8. The wet etching method according to any one of claims 1 to 7, wherein a material of the substrate is a silicon semiconductor material or a silicate glass material.

9. The wet etching method according to claim 1,

wherein the second step is carried out without a drying operation after the rinsing step.

10. The wet etching method according to claim 1,

wherein, before the first step, the metal-containing film is treated by contact with the etching liquid.

11. The wet etching method according to claim 1,
wherein a Ra is 9 nm or less after etching the metal-containing film by 6 nm or more.

12. The wet etching method according to claim 1,
wherein a ΔRa is ±1 nm or less after etching the metal-containing film by 6 nm or more.