Claims

1. A method of treating a copper film on a bevel edge of a substrate to covert the copper film to a copper compound to be removed by a wet etch, comprising:

placing the substrate on a substrate support in the plasma treatment chamber;

flowing a treatment gas through a gas feed located embedded in a gas distribution plate, disposed at a distance from the substrate support;

generating a treatment plasma near the bevel edge of the substrate to convert the copper film on the bevel edge of the substrate to a copper compound, wherein the generated treatment plasma converts copper film is less than about 2 mm from a very edge of the substrate to the copper compound; and

placing the substrate in a wet etching apparatus with a wet etching fluid to remove the copper compound on the bevel edge~~.~~

~~2. The method of claim 1~~, wherein the copper compound on the bevel edge is etched by the wet etching fluid at a wet etch selectivity greater than about 20:1 to the copper film away from the bevel edge.

2~~3~~. The method of claim 1~~2~~, wherein the copper compound is selected from a group consisting of CuO_E, CuO_XF_Y, or CuO_CCl_D, and wherein E, X, Y, C and D are numbers.

3~~4~~. The method of claim 1, wherein the treatment gas includes an oxygen-containing gas, and either a fluorine-containing or a chlorine-containing gas.

4~~5~~. ~~The method of claim 1~~A method of treating a copper film on a bevel edge of a substrate to covert the copper film to a copper compound to be removed by a wet etch, comprising:

placing the substrate on a substrate support in the plasma treatment chamber;

flowing a treatment gas through a gas feed located embedded in a gas distribution plate, disposed at a distance from the substrate support;

generating a treatment plasma near the bevel edge of the substrate to convert the copper film on the bevel edge of the substrate to a copper compound, wherein the generated treatment plasma converts copper film is less than about 2 mm from a very edge of the substrate to the copper compound; and

placing the substrate in a wet etching apparatus with a wet etching fluid to remove the copper compound on the bevel edge, wherein the wet etching fluid includes an

etchant selected from a group consisting of ammonium citrate, hydrogen fluoride, a nitric acid, and a citric acid.

56. ~~The method of claim 1~~A method of treating a copper film on a bevel edge of a substrate to covert the copper film to a copper compound to be removed by a wet etch, comprising:

placing the substrate on a substrate support in the plasma treatment chamber;

flowing a treatment gas through a gas feed located embedded in a gas distribution plate, disposed at a distance from the substrate support;

generating a treatment plasma near the bevel edge of the substrate to convert the copper film on the bevel edge of the substrate to a copper compound, wherein the generated treatment plasma converts copper film is less than about 2 mm from a very edge of the substrate to the copper compound; and

placing the substrate in a wet etching apparatus with a wet etching fluid to remove the copper compound on the bevel edge, wherein the generated treatment plasma converts copper film equal to or less than about 1 mm with a spatial control of +/1 about 0.1 mm from the very edge of the substrate to the copper compound.

67. ~~The method of claim 1~~A method of treating a copper film on a bevel edge of a substrate to covert the copper film to a copper compound to be removed by a wet etch, comprising:

placing the substrate on a substrate support in the plasma treatment chamber;

flowing a treatment gas through a gas feed located embedded in a gas distribution plate, disposed at a distance from the substrate support;

generating a treatment plasma near the bevel edge of the substrate to convert the copper film on the bevel edge of the substrate to a copper compound, wherein the generated treatment plasma converts copper film is less than about 2 mm from a very edge of the substrate to the copper compound; and

placing the substrate in a wet etching apparatus with a wet etching fluid to remove the copper compound on the bevel edge, wherein the substrate has a barrier layer, a copper seed layer over the barrier layer, and a plated copper layer over the copper seed layer, the copper film including both the copper seed layer and the plated copper layer.

78. A method of treating a copper film on a bevel edge of a substrate to covert the copper film to a copper compound to be removed by a wet etch, comprising:

~~The method of claim 1, further comprising:~~

removing the copper film on a backside of the substrate ~~prior to placing the substrate in the plasma treatment chamber~~;

placing the substrate on a substrate support in the plasma treatment chamber;

flowing a treatment gas through a gas feed located embedded in a gas distribution plate, disposed at a distance from the substrate support;

generating a treatment plasma near the bevel edge of the substrate to convert the copper film on the bevel edge of the substrate to a copper compound, wherein the generated treatment plasma converts copper film is less than about 2 mm from a very edge of the substrate to the copper compound; and

placing the substrate in a wet etching apparatus with a wet etching fluid to remove the copper compound on the bevel edge.

8~~9~~. ~~The method of claim 1~~A method of treating a copper film on a bevel edge of a substrate to covert the copper film to a copper compound to be removed by a wet etch, comprising:

placing the substrate on a substrate support in the plasma treatment chamber;

flowing a treatment gas through a gas feed located embedded in a gas distribution plate, disposed at a distance from the substrate support;

generating a treatment plasma near the bevel edge of the substrate to convert the copper film on the bevel edge of the substrate to a copper compound, wherein the generated treatment plasma converts copper film is less than about 2 mm from a very edge of the substrate to the copper compound; and

placing the substrate in a wet etching apparatus with a wet etching fluid to remove the copper compound on the bevel edge, wherein the treatment plasma near the bevel edge is capactiviely or inductively generated by a bottom edge electrode surrounding the substrate support in the plasma treatment chamber and a top edge electrode surrounding a gas delivery plate opposing the substrate support.

9~~10~~. The method of claim 8~~9~~, wherein a distance between the top edge electrode and the bottom edge electrode is less than about 1.5 cm to confine the treatment plasma.

10~~1~~. A method of treating a copper film on a bevel edge of a substrate to covert the copper film to a copper compound to be removed by a wet etch, comprising:

placing the substrate on a substrate support in the plasma treatment chamber;

flowing a treatment gas through a gas feed located embedded in a gas distribution plate, disposed at a distance from the substrate support;

generating a treatment plasma near the bevel edge of the substrate to convert the copper film on the bevel edge of the substrate to a copper compound, wherein the generated treatment plasma converts copper film is less than about 2 mm from a very edge of the substrate to the copper compound; and

placing the substrate in a wet etching apparatus with a wet etching fluid to remove the copper compound on the bevel edge~~The method of claim 1~~, wherein the treatment gas is delivered to the plasma treatment chamber by a gas feed disposed near a center of the substrate, near the bevel edge of the substrate, or near the center of the substrate with an additional gas feed near the bevel edge of the substrate.

11~~2~~. The method of claim 8~~9~~, wherein a distance between the gas delivery plate and the surface of the substrate facing the distribution plate is less than about 0.6 mm to prevent plasma being generated between the gas deliver plate and the surface of the substrate.

12~~3~~. The method of claim 1~~2~~, wherein the copper compound on the bevel edge is etched by the wet etching fluid at a wet etch selectivity greater than about 100:1 to the copper film away from the bevel edge.

13~~4~~. A method of treating a copper film on a bevel edge of a substrate to covert the copper film to a copper compound to be removed by a wet etch, comprising:

removing the copper film on a backside of the substrate;

placing the substrate on a substrate support in the plasma treatment chamber, after the copper film on the backside of the substrate is removed;

flowing a treatment gas through a gas feed located embedded in a gas distribution plate, disposed at a distance from the substrate support;

generating a treatment plasma near the bevel edge of the substrate to convert the copper film on the bevel edge of the substrate to a copper compound, wherein the generated treatment plasma converts copper film is less than about 2 mm from a very edge of the substrate to the copper compound; and

placing the substrate in a wet etching apparatus with a wet etching fluid to remove the copper compound on the bevel edge, wherein the copper compound on the bevel edge is etched by the wet etching fluid at a wet etch selectivity greater than about 20:1 to the copper film away from the bevel edge.

145. The method of claim 134, wherein the copper compound is selected from a group consisting of CuO_E, CuO_XF_Y, or CuO_CCl_D, and wherein E, X, Y, C and D are numbers.

156. The method of claim 134, wherein the treatment gas includes an oxygen-containing gas, and either a fluorine-containing or a chlorine-containing gas.

167. The method of claim 134, wherein the wet etching fluid includes an etchant selected from a group consisting of ammonium citrate, hydrogen fluoride, a nitric acid, and a citric acid.

178. The method of claim 134, wherein the generated treatment plasma converts copper film equal to or less than about 1 mm with a spatial control of about 0.1 mm from the very edge of the substrate to the copper compound.

189. The method of claim 134, wherein the treatment plasma near the bevel edge is capactiviely or inductively generated by a bottom edge electrode surrounding the substrate support in the plasma treatment chamber and a top edge electrode surrounding a gas delivery plate opposing the substrate support.

1920. The method of claim 134, wherein the copper compound on the bevel edge is etched by the wet etching fluid at a wet etch selectivity greater than about 100:1 to the copper film away from the bevel edge.