

PLASMA ETCHING METHOD OF MODULATING HIGH FREQUENCY BIAS POWER TO PROCESSING TARGET OBJECT

TECHNICAL FIELD

[0001] The embodiments described herein pertain generally to a plasma etching method.

BACKGROUND

[0002] Conventionally, there is known a plasma etching method (for example, Patent Document 1). In this plasma etching method, a processing gas containing fluorocarbon is introduced into a processing vessel in which a processing target object is provided, and a first high frequency power for exciting the processing gas into plasma and a second high frequency power for attracting ions to the processing target object are applied between electrodes within the processing vessel. The second high frequency power has a frequency lower than that of the first high frequency power, and the processing target object is etched by the generated plasma.

[0003] Patent Document 1: Japanese Patent No. 3,681,533

[0004] When forming a deep hole or groove by plasma etching (comparative example: **FIG. 6A**), however, twisting of a hole H is observed. In the comparative example, a two-step etching process is performed by using hexafluoro-1,3-butadiene (C_4F_6), difluoromethane (CH_2F_2), oxygen (O_2) and carbon monoxide (CO) as a processing gas. In a first process, while applying the first high frequency power to an electrode, the second high frequency power is applied to the electrode while being switched ON and OFF cyclically. In a second process, while applying the first high frequency power to the electrode, the second high frequency power is applied to the electrode while being maintained ON continuously. In the respective processes, the ON/OFF

stuck to an inner surface of a hole or a groove formed by the etching, are uniformly formed from a vicinity of a top portion of the hole or the groove to a bottom portion of the hole or the groove. A first period during which the first process is performed and a second period during which the second process is performed are set to have a range from 10 sec to 60 sec and have a range 10 sec to 60 sec, respectively

[0007] In this method, if deposits are formed on the inner surface of the hole or the groove formed by the etching, the inner surface of the hole or the groove is protected by the deposits from ions introduced into the hole or the groove, so that the etching of the inner surface (sidewall surface) of the hole or the groove is suppressed, and the twisting of the hole or the groove can be suppressed.

[0008] According to the present exemplary embodiment, the inner surface of the hole or the groove is protected from the ions introduced therein, so that the etching of the inner surface (sidewall surface) of the hole or the groove can be suppressed, and the twisting of the hole or the groove can be suppressed.

[0009] The processing gas containing the fluorocarbon may contain a C_4F_6 gas, a CH_2F_2 gas and an O_2 gas.

[0010] ON/OFF switching of the first high frequency power may be synchronized with ON/OFF switching of the second high frequency power in the first process and the second process. In this case, plasma can be stabilized, as compared to a case where the ON/OFF switching of the first high frequency power is not synchronized with the ON/OFF switching of the second high frequency power.

[0011] The first film may be a silicon oxide film, and the second film may be a silicon nitride film. Further, the first film may be a silicon oxide film, and the second film may be a

WE CLAIM

1. A plasma etching method of introducing a processing gas containing fluorocarbon into a processing vessel in which a processing target object is provided; applying a first high frequency power for excitation of the processing gas into plasma and a second high frequency power for attraction of ions to the processing target object, which has a frequency lower than a frequency of the first high frequency power, between electrodes within the processing vessel; and etching the processing target object by the generated plasma, the plasma etching method comprising:

a first process of applying, while applying the first high frequency power to the electrode, the second high frequency power to the electrode while switching ON/OFF of the second high frequency power cyclically; and

a second process of applying, while applying the first high frequency power to the electrode, the second high frequency power to the electrode while maintaining the second high frequency power ON continuously,

wherein the processing target object includes a multilayered film in which a first film and a second film having different permittivities are alternately stacked on top of each other; and a mask formed on the multilayered film,

the first process and the second process are alternately performed such that deposits, which are originated from the processing gas and stuck to an inner surface of a hole or a groove formed by the etching, are uniformly formed from a vicinity of a top portion of the hole or the groove to a bottom portion of the hole or the groove, and

a first period during which the first process is performed and a second period during which the second process is performed are set to have a range from 10 sec to 60 sec and have a range 10 sec to 60 sec, respectively.

2. The plasma etching method of Claim 1,
wherein the processing gas containing the fluorocarbon contains a C_4F_6 gas, a CH_2F_2 gas
and an O_2 gas.
3. The plasma etching method of Claim 1,
wherein ON/OFF switching of the first high frequency power is synchronized with ON/OFF
switching of the second high frequency power in the first process and the second process.
4. The plasma etching method of Claim 1,
wherein the first film is a silicon oxide film, and the second film is a silicon nitride film.
5. The plasma etching method of Claim 1,
wherein the first film is a silicon oxide film, and the second film is a polysilicon film.
6. The plasma etching method of Claim 1,
wherein the first film and the second film are stacked in twenty four layers or more in
total.
7. The plasma etching method of Claim 1,
wherein the mask is made of amorphous carbon.