

CLAIMS

What is claimed is

1. An apparatus for catalyst influenced chemical etching, comprising:

a process chamber to house a semiconductor wafer with lithographic structures; and

one or more actuators configured to control one or more environmental properties at one or more locations on the semiconductor wafer, wherein the one or more environmental properties comprise temperature, vapor pressure, electric field, etchant concentration, etchant composition and illumination;

one or more windows to allow light transmission for one or more of the following: optical metrology and ohmic contact creation, wherein the one or more windows are inert to catalyst influenced chemical etching (CICE) etchants; and

an in-situ optical metrology system configured to determine an etch state on one or more of a front and a back of the semiconductor wafer, wherein the in-situ optical metrology system comprises an optical imaging system configured to acquire images using visible wavelengths on the front of the semiconductor wafer and IR wavelengths on the back of the semiconductor wafer to create 3D images of an etch front at any stage of an etch process;

wherein the apparatus is utilized for etching semiconductor structures in the semiconductor wafer corresponding to the lithographic structures.

2. The apparatus as recited in claim 1, wherein actuators of the one or more actuators configured to control temperature comprise one or more of the following: thermal chucks, micromirrors and electrodes to locally heat a solution.

3. The apparatus as recited in claim 1, wherein the process chamber comprises an electrode on one or both sides of the semiconductor wafer.

4. The apparatus as recited in claim 3, wherein the electrode is designed to allow transmission of light to one or both sides of the semiconductor wafer.
5. The apparatus as recited in claim 1, wherein the in-situ optical metrology system is configured to monitor a current state of catalyst influenced chemical etching (CICE) at on one or more of the front and back of the semiconductor wafer, wherein the optical metrology system comprises at least one of an infrared (IR) metrology component and a visible light imaging component.
6. The apparatus as recited in claim 1, wherein an etchant is in vapor state.
7. The apparatus as recited in claim 1, wherein an etchant is in liquid state.
8. The apparatus as recited in claim 1, wherein the process chamber corresponds to a rinsing station used to remove an etchant.
9. The apparatus as recited in claim 1 further comprising:
 - a plurality of sensors to detect the etch state.
10. The apparatus as recited in claim 9, wherein the etch state comprises one or more of the following: an etch depth, a material porosity, a number of alternating layers etched, electrical conductivity of doped semiconducting material in contact with an etchant, optical properties of features, and electrical properties of features measured during and/or after an etching process.
11. The apparatus as recited in claim 1, wherein the optical imaging system is configured to take images as snapshots at regular time intervals, ranging from 1 ms to 1 minute.
12. The apparatus as recited in claim 1 further comprising:
 - a send ahead wafer that is processed through equipment; and
 - an offline metrology system to sense an etch state of the send ahead wafer.
13. The apparatus as recited in claim 12, wherein the offline metrology system estimates process excursions noticed in the send ahead wafer.

14. The apparatus as recited in claim 1, wherein the process chamber comprises one or more optic fiber cables on one or both sides of the semiconductor wafer.

15. The apparatus as recited in claim 1, wherein the process chamber comprises a sapphire window on one or both sides of the semiconductor wafer.

16. The apparatus as recited in claim 15, wherein the sapphire window transmits illumination from a light source to a back of a substrate.

17. The apparatus as recited in claim 16, wherein the light source is a lamp with tunable wavelength and intensity.

18. The apparatus as recited in claim 3 further comprising:

an electrolyte on the back of the electrode, wherein the electrolyte comprises one or more of the following: hydrogen peroxide, PVA, PLA, sulphuric acid, ammonium sulphate, and water.