DRY REACTIVE ION ETCHING

FIELD OF INVENTION

The invention relates to dry reactive ion etching for wafers and in particular to dry reactive ion etching using a dry film photoresist.

BACKGROUND

Various techniques are used to etch wafers in the production of wafer products, for example in the production of the MEMS. Etching can be used to form patterns in the surface of a wafer onto which other structures can be formed. Etching is also used to remove portions of a wafer and expose other layers below the wafer surface. Known techniques include electro chemical etching to an etch stop. This technique is widely used for etching cavities. Other techniques involve providing in implant in the bottom surface of a wafer and etching a cavity in the upper surface to the implant. This technique is called electrochemical etch stop.

Conventional photoresist is used in etching processes to define areas to be etched. This photoresist is typically layered on the wafer with a thickness of between 1 and 3 microns. The photoresist is in liquid from and is spin coated or spray coated onto the substrate. The photoresist is then patterned to mark out the pattern of areas that will not be etched. An etchant is then applied that etches away the unmarked areas. Etching using convention photoresist has the disadvantage of poor control of the etching process which can lead to failure of the device being etched.

SUMMARY OF THE INVENTION

It is the object of the present invention to provide an improved method of dry reactive ion etching, or to at least provide the public with a useful choice.

In broad terms the invention comprises a method of etching a wafer including the steps of applying a dry film resist to a surface to be etched, curing the dry film resist, patterning the dry film resist to expose areas of the wafer to be etched, etching the wafer with a dry reactive ion etch and removing the remaining dry film resist.

Preferably the thickness of the dry film resist is between 12 and 50 microns. More preferably the thickness of the dry film resist is between 15 and 30 microns.

Preferably the dry film resist includes an adhesive layer with is adhered to the substrate. Preferably the dry film resist includes a laminate layer which can be peeled from the dry film resist after the dry film resist is applied to the substrate.

Preferably the dry film resist is oven cured.

Preferably the dry film resist is patterned by placing a mask over the resist, exposing the mask and resist of UV light, developing the substrate and resist with a developer and curing the substrate and resist.

The dry reactive ion etch is a time etch.

BRIEF DESCRIPTION OF DRAWINGS

The invention will be further described by way of example only and without intending to be limiting with reference to the following drawings, wherein:

Figure 1 shows a silicon wafer;

Figure 2 shows the wafer with a cavity etched in one surface;

Figure 3 shows the wafer with a dry film resist coat;

Figure 4 shows the wafer of Figure 3 with the dry film resist coat patterned to expose part of the wafer; and

Figure 5 shows wafer after a dry reactive ion etch.

DETAILED DESCRIPTION

Figure 1 shows a silicon wafer 1 before any etching has occurred. In Figure 2 wafer 1 has been subjected to an electrochemical etch to etch a cavity 2 in one surface of the wafer. To deepen the cavity around a raised area in the centre of the cavity a further etch step is needed.

Figure 3 shows wafer 1 with a dry film resist coat 3 applied to the surface of the wafer with the cavity. In preferred embodiments the dry film resist is a film with a layer of adhesive on one side of the film. The adhesive layer is applied to the substrate to adhere the dry film resist to the substrate. In preferred embodiments the dry film resist also includes a laminate layer on the side of the dry film resist that does not include the adhesive layer. Once the dry film resist is applied to the substrate the laminate layer can be removed from the dry film resist leaving the substrate with dry film resist on one surface. The layer of dry film resist may be up to 50 microns thick. In preferred embodiments the dry film resist is between 12 and 50 microns thick. In more preferred embodiments the dry film resist is between 15 and 30 microns thick.

After the dry film photoresist is applied to the surface of wafer 1 the dry film resist is cured. Curing the dry film resist involves heating the resist and substrate. In one embodiment the resist is oven cured by being heated in an oven for a predetermined period of time.

Following curing of the dry film resist is patterned to define the areas that will be etched. To pattern the resist a mask is aligned over the resist and substrate in a n aligner. The aligner aligns the mask and substrate so that the correct areas will be patterned. Patterning the dry film resist includes exposing the resist to an ultraviolet

light source with a mask on top of the resist that prevents the UV light from penetrating all of the dry film resist. After a predetermined exposure time the wafer is then developed in a solution sodium carbonate (Na_2CO_3) that washes away either the exposed or the unexposed areas of the dry film resist. The dry film resist is now patterned and any areas no longer covered by the resist will be etched away in the etch step. The final step in patterning is a further curing step in which the patterned resist is heated.

Figure 4 shows the wafer after the dry film resist has been patterned and etched. The wafer is now subject to a dry reactive ion etch to etch away areas of the wafer not covered by the dry film resist. The dry film resist provides a good covering of resist over the covered areas and does not wear away quickly under the dry reactive ion etch. This means that the dry reactive ion etch can continue for as long as required to etch away the cavity without etching away any resist or wafer covered by resist. The control gained by using the dry film resist allows the accuracy of dry reactive ion etching to be improved to between about 3 and 5%. This means that structures on a wafer can be more accurately etching leading to the ability to reduce tolerance margins around structures and therefore a reduction in size of a device formed on a silicon wafer.

Figure 5 shows the results of the dry reactive ion etch. In the example shown in Figure 5 the cavity has been etched to a depth of 530 microns. Once the etch is completed the dry film resist can be removed. The dry film resist can be removed using sodium carbonate (Na_2CO_3). The dry film resist can be removed either during the developing stage or in a separate dry film resist removal stage.

It should be noted that none of the figures are shown to scale and the thickness of the dry film resist is not in proportion to the thickness of the wafer.

The foregoing describes the invention including preferred forms thereof. Alterations and modifications as will be obvious to those skilled in the art are intended to be incorporated in the scope hereof as defined by the accompanying claims.

CLAIMS

1. A method of etching a wafer including the steps of:
applying a dry film resist to a surface to be etched,
curing the dry film resist,
patterning the dry film resist to expose areas of the wafer to be etched,
etching the wafer with a dry reactive ion etch, and
removing the remaining dry film resist.

2. A method of etching a wafer as claimed in claim 1 wherein the thickness of the dry film resist is between 12 and 50 microns.

3. A method of etching a wafer as claimed in claim 1 or claim 2 wherein the thickness of the dry film resist is between 15 and 30 microns.

4. A method of etching a wafer as claimed in any one of claims 1 to 3 wherein the dry film resist includes an adhesive layer with is adhered to the substrate.

5. A method of etching a wafer as claimed in any one of claims 1 to 4 wherein the dry film resist includes a laminate layer which can be peeled from the dry film resist after the dry film resist is applied to the substrate.

6. A method of etching a wafer as claimed in any one of claims 1 to 5 further including the step of oven curing the dry film resist.

7. A method of etching a wafer as claimed in any one of claims 1 to 6 wherein the step of patterning the dry film resist includes by placing a mask over the resist, exposing the mask and resist of UV light, developing the substrate and resist with a developer and curing the substrate and resist.