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Method for the production of a spacer layer in a structure

Description

The present invention relates to a method for the production of a spacer layer in a structure.

Spacer layers, so-called spacers, have acquired great importance in semiconductor technology.

Spacers are produced, for example, in a structure, for example a hole or a trench, in order to bring about lateral electrical insulation of holes, passages or trenches, to deposit so-called seed layers or to incorporate diffusion barriers.

Silicon dioxide (SiO_2) is typically used as the material for the production of an insulating spacer.

A conventional method for the production of an SiO_2 spacer is described below with reference to Fig. 1.

Fig. 1 illustrates a structure 100, which in this case may be a trench, for example, prior to the deposition of the material forming the spacer. In the example shown in Fig. 1a, the structure 100 is formed in a multilayer structure comprising a first layer 102 and a second layer 104.

The first layer 102 is typically a silicon substrate with transistors (front end), and the second layer 104 is used for the interconnection (metallization) of the transistors (back end), the second layer being composed of SiO_2 into which metal tracks are embedded.

After the formation of the structure 100, SiO_2 is deposited, thereby forming an SiO_2 layer 106 on the surface of the layer 104, on the side walls of the structure 100 and on the bottom of the structure 100, as is shown in Fig. 1b.

The spacer is completed by carrying out anisotropic plasma etching, by means of which the bottom 108 of the structure 100 is exposed, as can be seen in Fig. 1c.

At the same time, the SiO_2 layer 106 above the

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layer 104 and a small part of the layer 104 are removed by the plasma etching, since the etching rate on the surface of the wafer is greater than on the bottom of the structure, as can likewise be gathered from Fig. 1c.

It is evident from the above description of the method known from the prior art that this known method for the production of a spacer in a structure encompasses a complicated sequence of steps, comprising the steps of producing the structure, depositing the material from which the spacer is to be produced, and the step of exposing the bottom of the structure by an etching process, the different etching rates on the surface of the wafer and on the bottom of the structure becoming increasingly problematic in the context of present-day structures which are becoming ever deeper.

Reference is made to the fact that the above-described conventional method from the prior art is not suitable solely for removing an SiO_2 layer from a bottom 108 of a structure 100, rather SiO_2 layers are generally removed from horizontal regions in this way.

Taking the prior art described above as a starting point, the present invention is based on the object of providing a simplified method for the production of a spacer layer in a structure.

This object is achieved by means of a method according to Claim 1.

The present invention provides a method for the production of a spacer layer in a structure having the following steps:

- anisotropic dry etching of a layer to be structured, in order to produce the structure;
- cleaning etching residues from the structure; and
- deposition of silicon dioxide with an organic silicon precursor and ozone at a pressure of p = 0.2 - 1 bar and a temperature of 200°C to 400°C.

The present invention is based on the insight that the anisotropic dry etching for producing the structure brings about the occurrence of instances of damage, modification and/or contamination or implantation

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primarily on the bottom of a structure. The duration of a following wet etching step for cleaning etching residues from all of the surfaces, typically by means of 1-3% strength hydrofluoric acid (HF), must be chosen to be short enough for the side walls of the structure to be cleaned, but not for the modification of the structure bottom to be completely removed. Suitable process control during the subsequent conformal deposition of the layer forming the spacer has the effect that deposition on the bottom of the structure does not happen, with the result that only the desired lateral spacer is produced by the deposition process. An additional etching step such as is required to conclude the known method acknowledged above is consequently dispensed with.

According to a preferred exemplary embodiment of the present invention, the wet-chemical cleaning is typically carried out by means of a 1-3% strength hydrofluoric acid (HF).

According to a further preferred exemplary embodiment of the present invention, the deposition of the silicon precursors takes place by means of an O_3-TEOS-CVD process.

Further preferred refinements of the invention are defined in the subclaims.

Preferred exemplary embodiments of the present invention are described in more detail below with reference to the appended drawings, in which:

Fig. 1 shows an illustration of the steps necessary for producing a spacer according to a method of the prior art; and

Fig. 2 shows an illustration of the steps necessary for producing the spacer according to the method of the present invention.

The method according to the invention is described in more detail below with reference to Fig. 2.

Anisotropic dry etching of a layer 200 to be structured is carried out in a first step, in order to produce the structure 202.

This first step yields a structure such as the

one illustrated in Fig. 2a.

The structure 202 illustrated in Fig. 2a, for example in the form of a trench or a hole, includes side walls 204 and a bottom 206.

The layer 200 is a substrate or a wafer, for example.

Reference is made to the fact that the layer 200 to be structured does not have to be produced from a single layer, rather it can also be formed from a plurality of layers, as has already been described with reference to Fig. 1.

It is also possible to use wafers which have already been ready processed.

The selection of the type of the layer 200 to be structured depends directly on the intended application and consequently differs in different semiconductor production technologies.

In the exemplary embodiment described here, the anisotropic dry etching is performed by means of anisotropic plasma etching.

The anisotropic plasma etching process by which the structure 202 is produced, on the side walls 204 of which the spacer is to be produced, brings about, on account of the anisotropy of the plasma etching processes, the occurrence of instances of damage, modification and/or contamination or implantation primarily on the bottom 206 of the structure 202. The result of this is that already, during the production of the structure, the bottom 206 of the structure 202 is pretreated differently from the side walls 204.

This different pretreatment constitutes a first essential feature of the method according to the present invention. Reference is made to the fact that this different pretreatment can also be effected by other anisotropic dry etching processes.

The contamination and etching residues that arise must be removed after the etching process. This can be done, for example, by a wet-chemical cleaning step or an isotropic plasma cleaning step.

In a next step, silicon dioxide (SiO_2) is deposited with an organic silicon precursor and ozone, at a pressure of p = 0.2 - 1 bar and a temperature of 200°C - 400°C, on the layer 200 to be structured and in the regions of the structure 202. Organic silicon precursors are known per se by those skilled in the art and designate materials which form silicon precursors.

This deposition of organic silicon precursors with the process parameters specified above constitutes suitable process control for the conformal deposition of the spacer.

On account of the process control, described above with reference to Fig. 2a, during the production of the structure 202, the conformal deposition has the effect that deposition does not happen on the bottom 206 of the structure 202. As a result, only the spacer 208 is produced by the deposition, as can be seen in Fig. 2b.

Lateral electrical insulation is realized, for example, by this spacer.

According to a preferred exemplary embodiment, the SiO_2 deposition is carried out by means of a so-called TEOS process using TEOS (TEOS = tetraethyl orthosilicate) as silicon precursor.

Yet again in accordance with a further preferred exemplary embodiment of the present invention, the abovementioned TEOS process is carried out by means of an O_3-TEOS-CVD process. The process parameters required for this process are as follows:

Distance between the wafer and gas spray: 5-25 mm

(A device for carrying out the O_3-TEOS-CVD process is known per se by those skilled in the art, so that the abovementioned distance between the wafer and the gas spray does not have to be explained in more detail.)

(Oxygen+ozone) flow: 1000 - 10,000 sccm

(TEOS+helium) flow: 100 - 3000 sccm

Proportion of ozone in the oxygen/ozone mixture: 5 - 20 % by weight

The O_3-TEOS-CVD process is a so-called SACVD process (SACVD = subatmospheric chemical vapour deposition).

Reference is made to the fact that, in addition to the trenches or holes described above, it is also possible to use other structures in the case of which it is desired to keep a bottom region of these structures free, whereas spacers or oxide spacers are to be formed on side walls.

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Patent Claims

1. Method for the production of a spacer layer in a structure, characterized by the following steps:
   - anisotropic dry etching of a layer (200) to be structured, in order to produce the structure (202);
   - cleaning etching residues from the structure (202); and
   - deposition of silicon dioxide with an organic silicon precursor and ozone at a pressure of p = 0.2 - 1 bar and a temperature of 200°C to 400°C.

2. Method according to Claim 1, characterized in that the layer (200) to be structured is a wafer.

3. Method according to Claim 1 or 2, characterized in that, in the cleaning step, etching residues are removed from the side walls of the structure and modifications of the bottom of the structure (202) are not removed.

4. Method according to one of Claims 1 to 3, characterized in that the layer (200) to be produced is a trench or a hole.

5. Method according to one of Claims 1 to 4, characterized in that the deposition step includes a deposition process with organic precursors.

6. Method according to Claim 5, characterized in that the deposition process is carried out by means of an O_3-TEOS-CVD process, the O_3-TEOS-CVD process having the following process parameters:

Distance between the wafer and gas spray	= 5 - 25 mm
(Oxygen+ozone) flow	= 1000 - 10,000 sccm
(TEOS+helium) flow	= 100 - 3000 sccm
Proportion of ozone in the oxygen/ozone mixture	= 5 - 20 % by weight

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