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Specification

1. Title of the Invention

Method for manufacturing Semiconductor Device

2. Claims

1. A method for manufacturing a semiconductor device, comprising:

a step of forming a metal film on a semiconductor substrate;

a step of forming a photoresist film pattern of a desired wiring pattern and a photoresist film pattern of a dummy wiring on this metal film; and

a step of etching the metal film by reactive ion etching method using these photoresist film pattern and dummy pattern as masks,

wherein the etching is performed, by the dummy pattern, in a state that an area density of the photoresist film pattern for forming the wiring pattern.

3. Detailed Description of the Invention

<Field of Industrial Application>

The present invention relates to a method for manufacturing a semiconductor device, specifically relates to a formation method of a wiring pattern constituted of a metal film such as an aluminum film.

<Prior Art>

Conventionally, a wiring pattern constituted of metal films such as an aluminum film has been formed by forming a photoresist film of a desired patten on the entirely formed metal film and selectively etching this photoresist film by reactive ion etching.

One example of the prior art will be explained using vertical cross-sectional views shown in Fig. 3(a) and 3(b).

First, as shown in Fig. 3(a), aluminum film 3 is formed on oxide film 2 on semiconductor substrate 1, and further thereon photoresist film 7 having a desired pattern is formed.

Next, as shown in Fig. 3(b), a wiring pattern is formed by selectively etching the aluminum film 3 by performing a reactive ion etching using this photoresist film 7 as a mask.

Thereafter, an aluminum wiring pattern is completed by removing the photoresist film 7.

<Problem to be solved by the invention>

In the above conventional method, the shape of the aluminum film 3 obtained by etching is greatly influenced by the pattern density of the photoresist film 7 (the ratio of the area occupied by the photoresist film toward the area of the wafer), and side etching and undercut occur more easily as the pattern density becomes small. This is because that, in the reactive ion etching of the aluminum film, anisotropic nature can be sustained by depositing of a reaction product on the side wall during etching, and the product from the photoresist film greatly contributes to this deposition.

Therefore, as shown in Fig. 3(b), it becomes hard to obtain a desired wiring pattern because the width dimension of the aluminum film 3 formed becomes smaller than that of the photoresist film 7 due to side etching and undercut.

The pattern density at which side etching and undercut are easy to occur, depending on etching conditions, is almost the case of 25% or lower.

Therefore, as shown in Fig.4, in the case where the pattern density of the photoresist film 7 on the same wafer substantially differs depending on places, the aluminum film 3 in the region A where the pattern density is small (for example 20%) is formed with a width smaller than that of the aluminum film 3 in the region B where the pattern density is large (for example 60%) due to undercut and side etching, thereby it becomes difficult to obtain an even wiring pattern.

As a result, lowering of productivity of semiconductor elements and decrease of reliability are caused, and there arises a problem that it becomes disadvantageous in terms of microfabrication of the element.

The present invention aims to provide a method for manufacturing a semiconductor device which enables to easily obtain a wiring pattern having a desired wiring width as well as uniform and highly accurate wiring pattern on the wafer.

<Means for Solving the Problems>

The method for manufacturing a semiconductor device according to the present invention includes a step of forming a metal film on a semiconductor substrate; a step of forming a photoresist film pattern of a desired wiring pattern and a photoresist film pattern of a dummy wiring on this metal film; a step of etching the metal film by reactive ion etching method using these photoresist film pattern and dummy pattern as masks, and etching is performed, by this dummy pattern, in a state that the area density of the photoresist film pattern for forming the wiring pattern.

<Functions>

In the above mentioned manufacturing method, manufacturing of highly accurate wiring pattern can be realized by increasing the pattern density of the photoresist film by the dummy pattern and suppressing side etching and undercut on the occasion of etching.

<Examples>

Next, the present invention will be explained below with reference to the drawings.

Fig. 1 (a) to (d) are vertical cross-sectional views showing the first example of the present invention in an order of the manufacturing processes. Here, an example where a wiring pattern is formed of aluminum film will be explained.

First, as shown in Fig. 1 (a), aluminum film 3 is formed on all over the surface of silicon oxide film 2 which has been grown on the surface of semiconductor substrate 1, and thereon photoresist film 4 in formed by patterning. Here, the photoresist film 4 forms dummy pattern 4b in the part which is essentially unnecessary, in addition to pattern 4 which is necessary for forming the wiring pattern.

This dummy pattern 4b can arbitrarily be formed. However, in the case where it needs to subsequently remove the aluminum pattern which is formed by this dummy pattern 4b, it needs to adequately separate the pattern from the essential pattern 4a so that the pattern can easily be removed. For example, it is sufficient if it is kept off about 3 μm or more.

By providing this dummy pattern 4b, the density of the whole pattern can be increased to 60%, even in the case where the pattern density of the essential pattern 4a is 10%.

Next, as shown in Fig. 1 (b), wiring pattern 3a and dummy wiring pattern 3b are formed with the aluminum film 3 by performing reactive ion etching using each of patterns 4a and 4b of the above photoresist films as masks. At this time, as explained above, the density of the photoresist film 4 is sufficiently large, therefore undercut and side etching in the wiring pattern 3a and dummy wiring pattern 3b are suppressed, and they are formed with almost the same width of the pattern 4a and 4b.

Subsequently, patterns 4a and 4b of the photoresist are removed. Further, in the case where dummy wiring pattern 3b is also removed, as shown in Fig. 1 (c), the top part and the side surfaces of the essential wiring pattern 3a are completely covered by new photoresist film 5. On the contrary, the dummy wiring pattern 3b is exposed as it is, and only the dummy wiring pattern 3b is removed by performing etching using the photoresist film 5 as a mask. This can easily be performed by wet-etching.

If the photoresist film 5 is subsequently removed, as shown in Fig. 1 (d), the desired wiring pattern 3a can be obtained.

Besides, selectivity ratio of the etching ratio of aluminum film and silicon oxide film is extremely high in the reactive ion etching of aluminum film, and the selectivity ratio of about 100 can usually be obtained. For this reason, generation of concavity and convexity of the silicon oxide film 2 as a foundation in the part of the dummy wiring pattern 3b is almost suppressed.

Besides, it does not always have to remove the dummy wiring 3b, in this case, the steps of Fig. 1 (c) and (d) become unnecessary.

Fig. 2 (a) to (c) are vertical cross-sectional views showing the second example of the present invention in an order of the manufacturing processes. In this example, the case where the densities of the desired wiring pattern are different on the wafer will be explained.

First, as shown in Fig. 2 (a), aluminum film 3 is formed on silicon oxide film 2 on semiconductor substrate 1, and thereon photoresist film 6 are formed by patterning. With regard to the pattern of this photoresist film 6, the density of the pattern 6a which is essentially necessary differs depending on places; 20% in area A and 60% in area B. For this reason, in area A, dummy pattern 6b which is similar to the pattern in area A is provided so that the pattern density of area A becomes nearly equal to that of the area B.

Accordingly, if reactive ion etching is performed to the aluminum film 3 using these patterns 6a and dummy pattern 6b as masks, as shown in Fig. 2 (b), it becomes possible to etch the essential wiring pattern 3a to a uniform shape in both areas A and B. As a matter of course, the dummy wiring pattern 3a is also uniformly formed by etching.

Besides, even in this case, it does not always have to remove the dummy wiring 3b. However, in the case where it needs to remove the pattern, the pattern may be removed in a similar way to the first example 1. As a result, as shown in Fig. 2 (c), the wiring pattern 3 having a desired density in each of area A and B can be formed.

<Effect of the Invention>

As explained above, the present invention has an effect that a highly accurate wiring pattern can easily obtained by increasing the pattern density to a predetermined level or more by arranging a dummy pattern in an area where the pattern density of a photoresist film is small, thereby suppressing side etching and undercut on the occasion of etching of a metal film.

4. Brief Description of the Drawings

Fig. 1 (a) to (d) are vertical cross-sectional views showing the first example of the manufacturing method according to the present invention in an order of the manufacturing processes; Fig. 2 (a) to (c) are vertical cross-sectional views showing the second example of the manufacturing method according the present invention in an order of the manufacturing processes; Fig. 3 (a) and (b) are vertical cross-sectional views showing one example of the conventional manufacturing method; and Fig. 4 is a vertical cross-sectional view for explaining defects in the conventional manufacturing method.

1.....semiconductor substrate, 2.....silicon oxide film, 3.....aluminum film, 3a.....wiring pattern, 3b.....dummy wiring pattern, 4.....photoresist film, 4a.....pattern, 4b.....dummy pattern, 5.....photoresist film, 6.....photoresist film, 6a.....pattern, 6b.....dummy pattern, 7.....photoresist film

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