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EXHIBIT A

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Tan

(10) **Patent No.:** **US 7,829,364 B2**
(45) **Date of Patent:** **Nov. 9, 2010**

(54) **METHOD OF FABRICATING A SUSPENSION MICROSTRUCTURE**

(75) Inventor: **Siew-Seong Tan**, Hsinchu (TW)

(73) Assignee: **MEMSMART Semiconductor Corporation**, Hsinchu (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 148 days.

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Dec. 14, 2007 (TW) .... 96148028 A

(51) **Int. Cl.**
H01L 21/00 (2006.01)
H01L 29/84 (2006.01)
C23F 1/00 (2006.01)

(52) **U.S. Cl.** **438/51**; 438/706; 257/415; 257/E21.218; 257/E21.249; 257/E21.613; 257/E29.324; 216/2; 216/72; 216/79

(58) **Field of Classification Search** .... None
See application file for complete search history.

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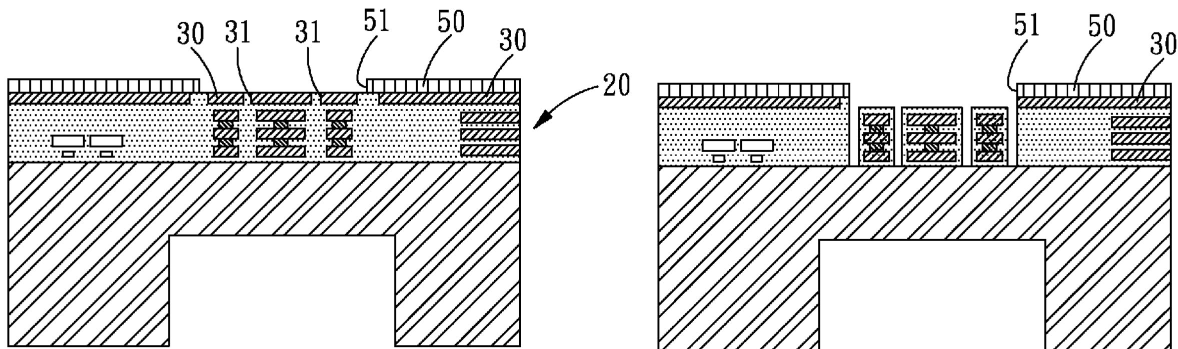
Primary Examiner—Alonzo Chambliss
(74) *Attorney, Agent, or Firm*—Banger Shia

(57) **ABSTRACT**

A suspension microstructure and its fabrication method, in which the method comprises the steps of: forming at least one insulation layer with inner micro-electro-mechanical structures on an upper surface of a silicon substrate, the micro-electro-mechanical structure includes at least one microstructure and a plurality of metal circuits that are independent from each other, the micro-electro-mechanical structures have an exposed portion on the surface of the insulation layer, and the exposed portion is provided with through holes or stacked metal-via layers correspondingly to the predetermined etching spaces of the micro-electro-mechanical structures, the above predetermined etching spaces and the stacked metal-via layers only penetrate the insulation layer; forming a photoresist with an opening on the upper surface of the exposed portion, and the opening of the photoresist is located outside all the through holes or the stacked metal-via layers; subsequently, conducting etching to realize the suspension of the microstructures.

13 Claims, 7 Drawing Sheets



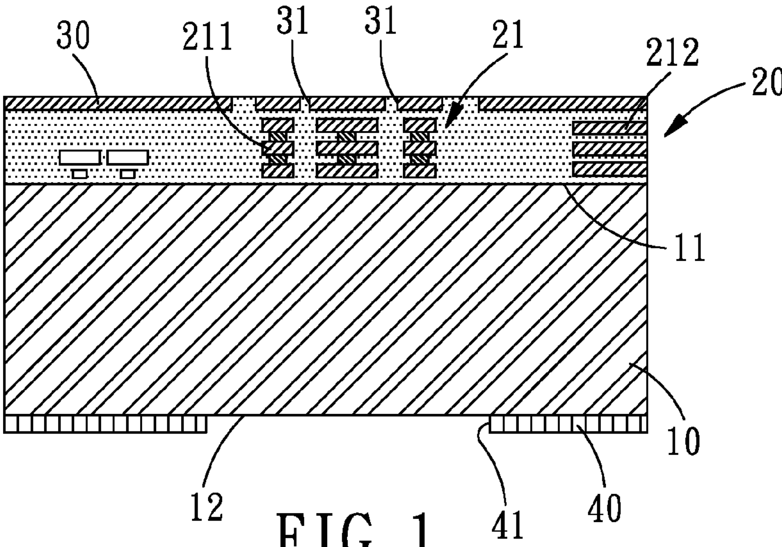


FIG. 1

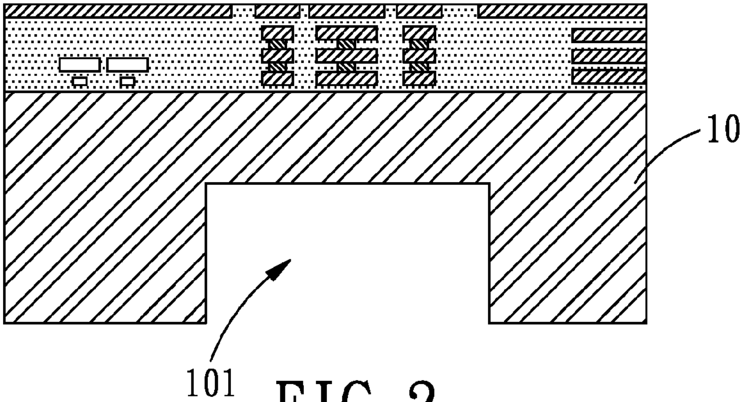


FIG. 2

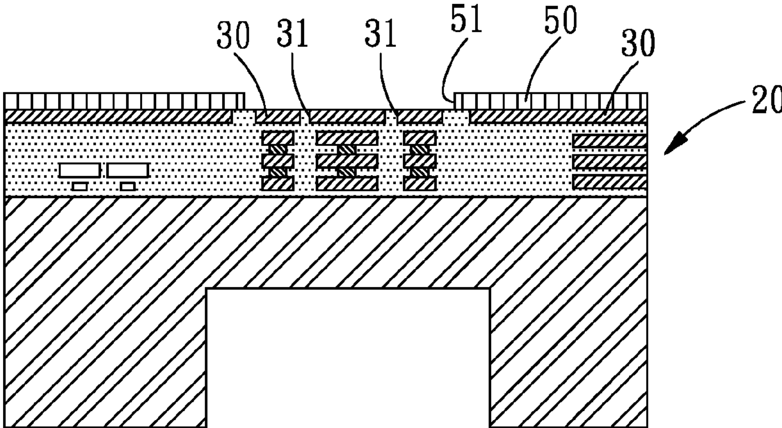


FIG. 3

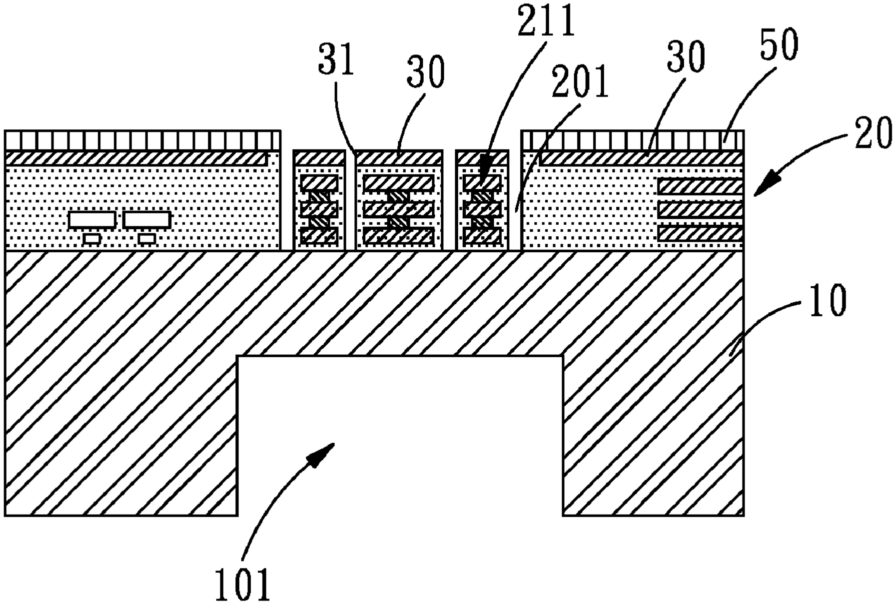


FIG. 4

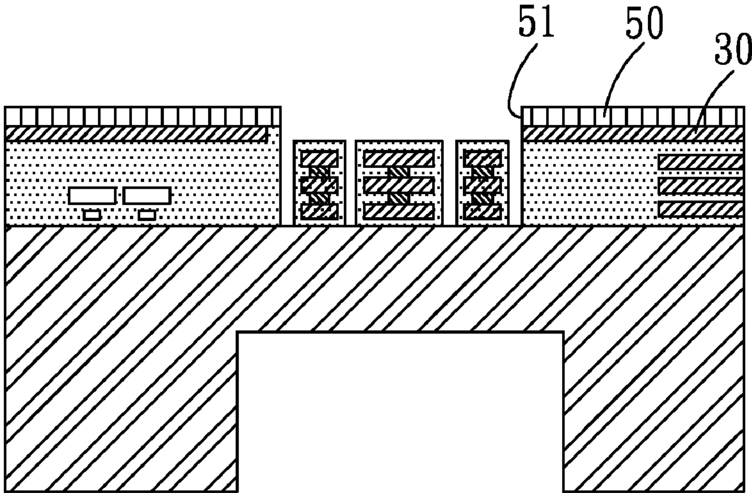


FIG. 5

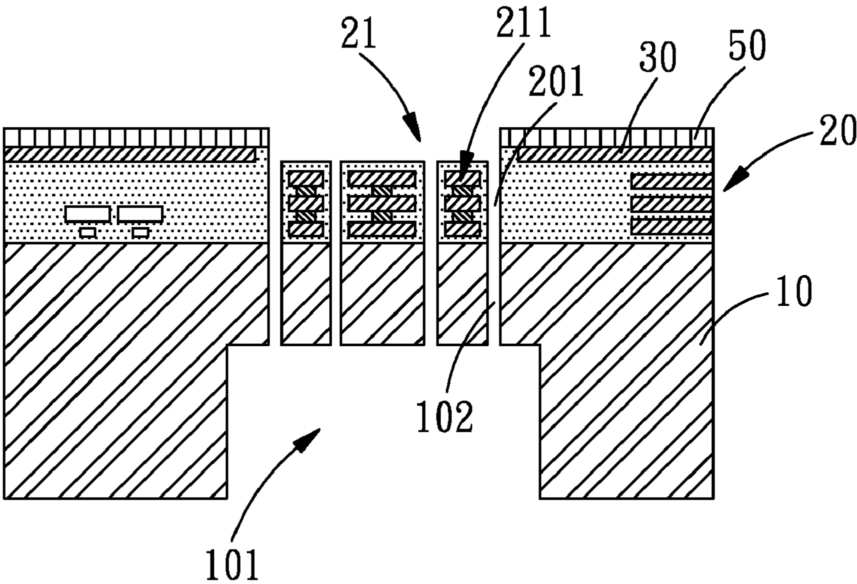


FIG. 6

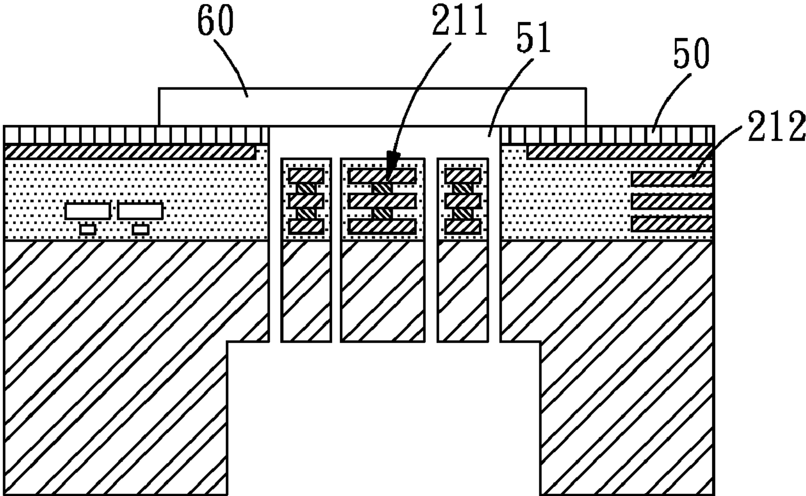


FIG. 7

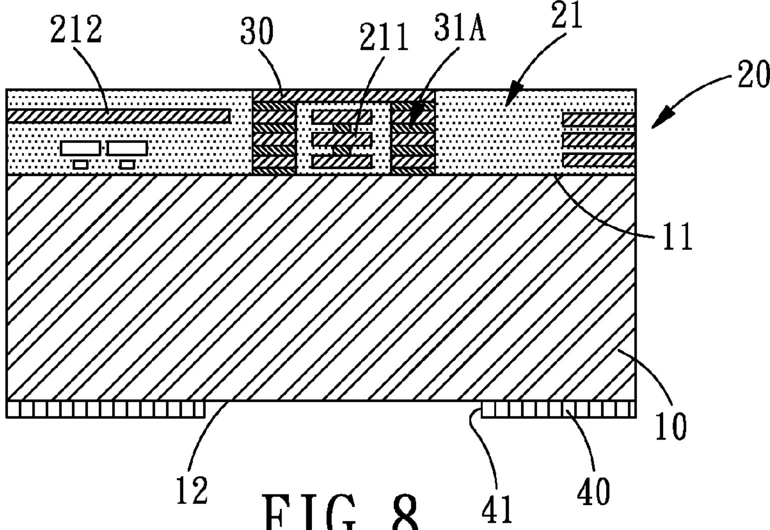


FIG. 8

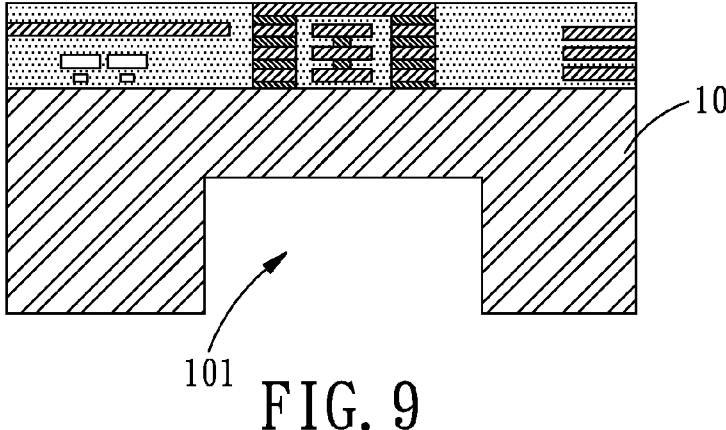


FIG. 9

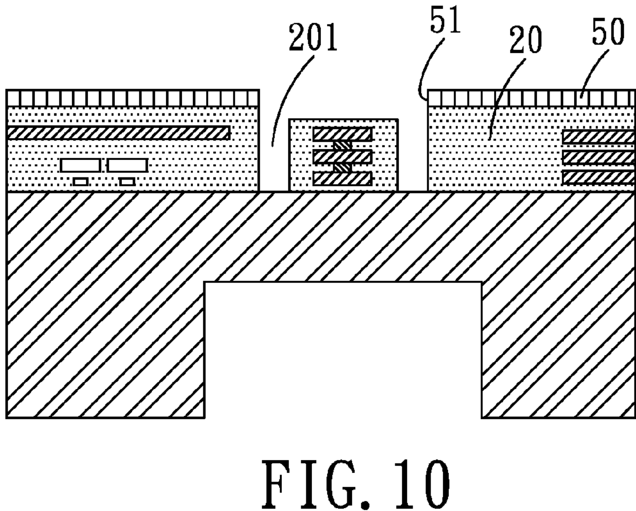


FIG. 10

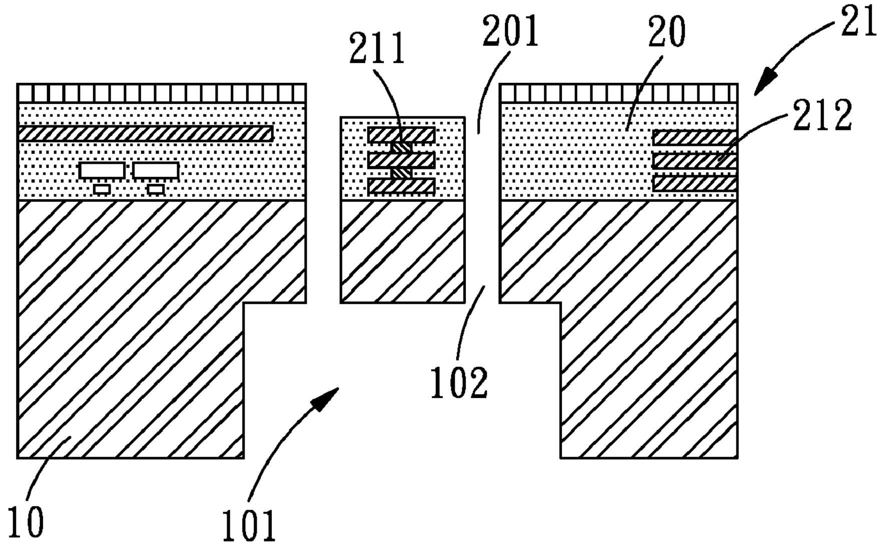


FIG. 11

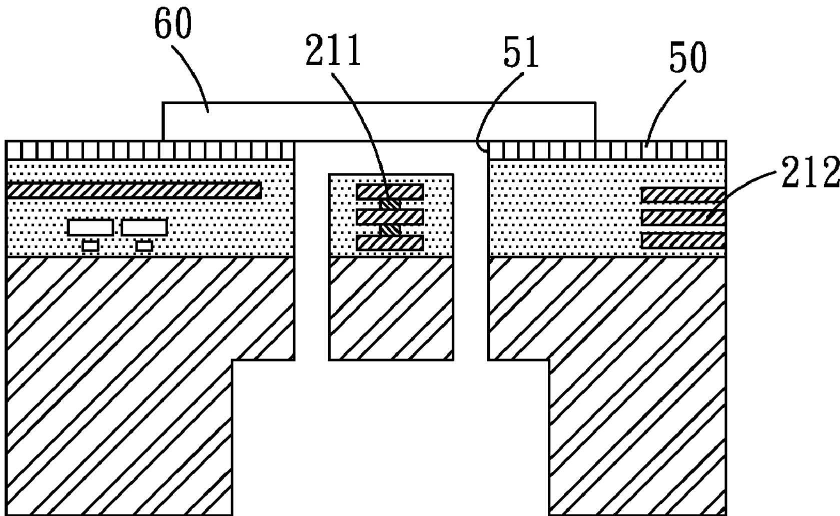


FIG. 12

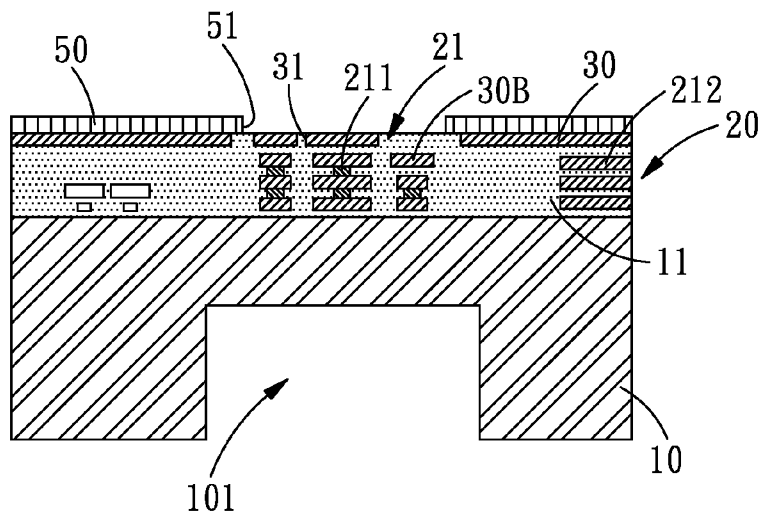


FIG. 13

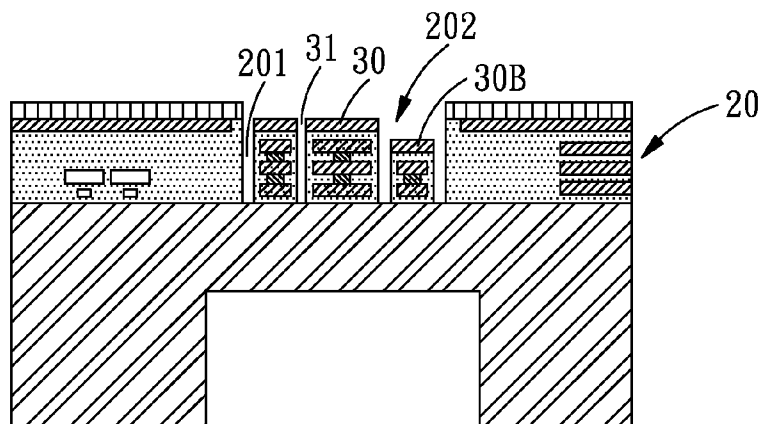


FIG. 14

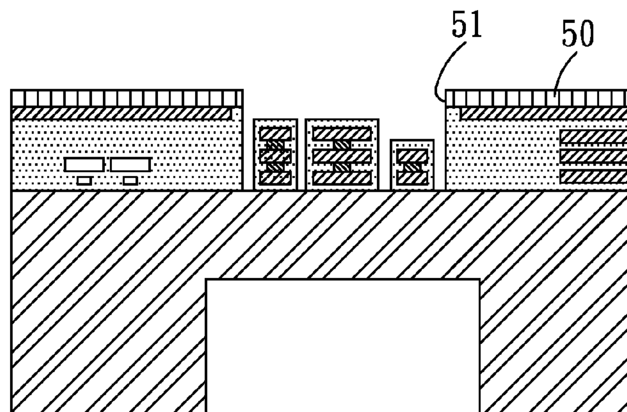


FIG. 15

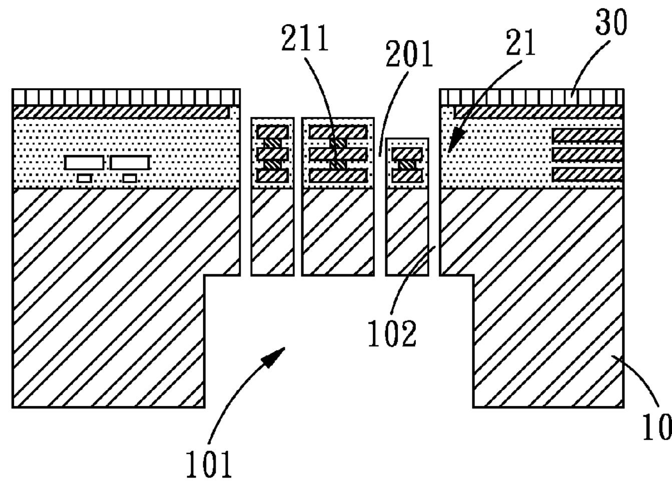


FIG. 16

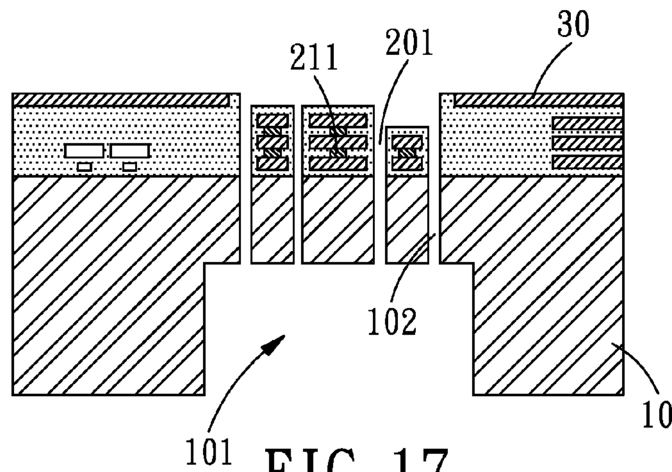


FIG. 17

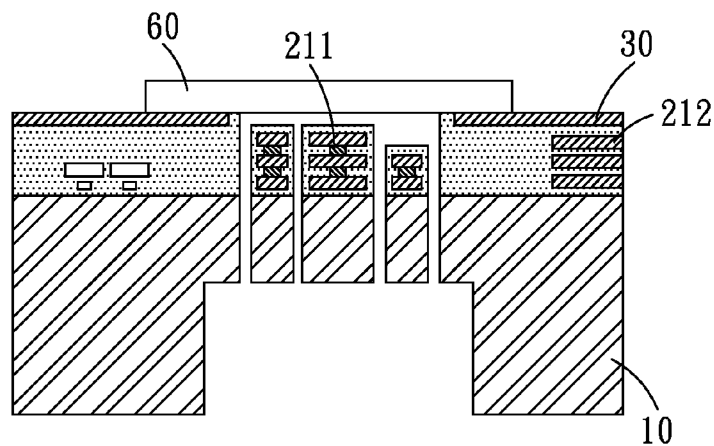


FIG. 18

METHOD OF FABRICATING A SUSPENSION MICROSTRUCTURE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method for fabricating a micro-electro-mechanical structure, and more particularly to a suspension microstructure and its fabrication method, which can effectively avoid improper erosion, and further simplify the mask and reduce the package cost.

2. Description of the Prior Art

The existing semiconductor micro-electro-mechanical systems comprises various semiconductor microstructures, such as the unmovable probe, channel, chamber structure, or the movable spring, linkage rod, gear (rigid body movement or flexible deformation), etc.

Integrating the above different structures with the related semiconductor circuit can form various semiconductor applications. Thus, how to utilize the fabricating method to improve the various functions of the microstructure is the key index of the semiconductor electromechanical system in the future and is also a rigorous challenge of further developing the chip in the future.

The existing method for fabricating the micro-electro-mechanical sensor and actuator system is often required to fabricate a suspension structure on a silicon substrate. The above process must adopt the advanced semiconductor technology, such as: wet etching, dry etching and sacrificial layer removing technology, etc.

The wet etching is a fast and effective etching without etching the etchants of other materials. Thus, the wet etching has a quite selectivity according to different materials. However, excluding that the crystallization direction is likely to affect the etching rate, because the chemical reaction doesn't vary in some specific directions, the wet etching is an isotropic etching in essence. The isotropic etching implies that the wet etching can have both the longitudinal etching effect and the transverse etching effect. The transverse etching will cause the undercut problems.

On the contrary, in the dry etching (plasma etching), the plasma is partially-dissociated gas. The greatest advantage of the dry etching is anisotropic etching. However, the selectivity of the dry etching is lower than that of the wet etching (the etching process of the dry etching is generally a physical interaction, so the ion collision can not only remove the etched film, but synchronously remove the photoresist).

The conventional fabrication method of the micro-electro-mechanical structures must need fabricating a layer of precision mask for restricting the etching, but the mask technology is different from the technology of the deposition of the insulation layer. The precision mask fabrication must apply the complicated technology and equipment (such as exposure machine, optical draft machine) to map the patterns of the masks on the insulation layers of the wafers precisely. Therefore, the recent micro-electro-mechanical structure manufacturers mostly apply another process (or different manufacturer) to fabricate the masks, so that the mask becomes more and more elaborate, thus increasing the manufacturing cost and limiting the dimension and precision of the microstructures.

A first conventional method disclosed in U.S. Pat. No. 6,458,615 B1 is to form at least one insulation layer including inner micro-electro-mechanical structures on an upper surface of a silicon substrate, and then conduct a layer-by-layer etching operation from the upper surface until the lateral edge of the micro-electro-mechanical structure, and finally, conduct an isotropic dry etching to the silicon substrate to realize the suspension of the micro-electro-mechanical structures.

The first conventional method can be used to fabricate a suspension micro-electro-mechanical structure, but it has the following disadvantages:

1. It adopts anisotropic dry chemical etching and uses chemical reaction to remove the isolation layer, however, after the side edge of the micro-electro-mechanical structure is etched, the silicon substrate still needs to be massively etched by isotropic chemical etching, and this technique will produce serious undercut problems;

2. In the process of this conventional technology, the micro-electro-mechanical structure is exposed in the process at first, after a long time of multi-layer processing, the exposed micro-electro-mechanical structure is likely to be contaminated and damaged, causing an excessively low yield rate;

3. The exposure of the metal layer during the process of etching is likely to cause contamination of the chamber of the etching machine by metal and cause unstable etching rate.

With the rapid development of the above technology, in order to improve many problems, a second conventional method disclosed in U.S. Pat. No. 6,712,983 B2 taught the use of a reactive ion etch (hereinafter referred to as RIE) technology. This technology is capable of greatly reducing occurrence of undercut, but since it also conducts a layer-by-layer etching from up down, and the last etching operation of the silicon substrate must apply the transverse etching technology, this improved conventional technology is still complicated and has the undercut problem. It is important that, some problems still have not been improved, such as: the exposure of the micro-electro-mechanical structure and affecting yield rate, etc.

The problem that cannot be solved by the existing technologies is that, a layer of precision mask is still needed for precisely finishing the etching operation, but the micro-electro-mechanical structure has become more and more elaborate, so the fabrication of the mask becomes more and more difficult, thus not only increasing the manufacturing cost, but also causing troubles in transmission, error, cost and particle contamination.

In addition, the shorter the distance between the mask patterns is, the smaller the etching hole will be. The reactant and the ion with energy in the etching system cannot reach and contact the predetermined bottom, or the reaction products cannot be fully discharged out of the hole, thus leading to the reduction of the etching rate. The smaller the etching hole is, the more serious the above phenomena will be, which is the so-called micro loading effect.

The present invention has arisen to mitigate and/or obviate the afore-described disadvantages.

SUMMARY OF THE INVENTION

The primary objective of the present invention is to provide a suspension microstructure and its fabrication method, which can effectively avoid improper erosion and exposure.

In order to achieve the above objective, the suspension structure and its fabrication method in accordance with the present invention are to form at least one insulation layer including inner micro-electro-mechanical structures on an upper surface of a silicon substrate, the micro-electro-mechanical structure includes at least one microstructure and metal circuits that are independent from each other, the micro-electro-mechanical structures have an exposed portion on the surface of the insulation layer, and the exposed portion is provided with through holes or stacked metal-via layers

correspondingly to the predetermined etching space of the micro-electro-mechanical structures, the above predetermined etching space or the stacked metal-via layers only extends through the insulation layer.

Hence, the metal material of the respective microstructures cannot be directly exposed in the etching space at all during etching but clad in the insulation layer, thus effectively avoiding the improper erosion and exposure of the micro-electro-mechanical structures.

The secondary objective of the present invention is to provide a suspension microstructure and its fabrication method, which can greatly simplify the precision requirement of the mask and reduce the total cost.

In order to achieve the objective, the present invention is to form at least one insulation layer with inner micro-electro-mechanical structures on an upper surface of a silicon substrate, the micro-electro-mechanical structure includes at least one microstructure and metal circuits that are independent from each other, the micro-electro-mechanical structures have an exposed portion on the surface of the insulation layer, and the exposed portion is provided with through holes or stacked metal-via layers correspondingly to the predetermined space of the micro-electro-mechanical structures, in addition, a photoresist with an opening is formed on the upper surface of the insulation layer, and the opening of the photoresist is located outside the through holes or the stacked metal-via layers of the exposed portion.

Hence, the exposed portion of the present invention can be directly formed by deposition during the deposition of multilayer micro-electro-mechanical structures, and the exposed portion utilizes the through holes or the stacked metal-via layers to replace the precision mask during etching, and it only needs to cooperate the opening of the simplified mask with the sequent etching to realize the suspension of the microstructures of the micro-electro-mechanical structures.

Particularly, the exposed portion can be removed at any moment to reduce the micro loading effect and prevent the machine chamber from being contaminated by metal.

Hence, the present invention can simplify the mask, reduce the precision requirements of the mask and further lower the cost.

It is to be noted that, the metal material in the microstructures of the present invention is clad in the insulation layer, so that the present invention can exert the same effect no matter in the bottom-up etching or the top-down etching.

In addition, the opening of the simplified mask only covers the periphery of the through holes or the stacked metal-via layers of the exposed portion and located outside the through holes or the stacked metal-via layers of the exposed portion, so that the photoresist of the present invention is impossible to affect the circuit package design, and it can be selectively removed or remained according to the requirements.

For the same reason, since the photoresist can be removed or remained, the photoresist of the present invention can be also made of different materials according to the requirements without being limited to a fixed material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross sectional view showing a first step of a method for fabricating a suspension microstructure in accordance with a first embodiment of the present invention;

FIG. **2** is a cross sectional view showing a second step of the method for fabricating a suspension microstructure in accordance with the first embodiment of the present invention;

FIG. **3** is a cross sectional view showing a third step of the method for fabricating a suspension microstructure in accordance with the first embodiment of the present invention;

FIG. **4** is a cross sectional view showing a fourth step of the method for fabricating a suspension microstructure in accordance with the first embodiment of the present invention;

FIG. **5** is a cross sectional view showing a fifth step of the method for fabricating a suspension microstructure in accordance with the first embodiment of the present invention;

FIG. **6** is a cross sectional view showing a sixth step of the method for fabricating a suspension microstructure in accordance with the first embodiment of the present invention;

FIG. **7** is a cross sectional view showing a seventh step of the method for fabricating a suspension microstructure in accordance with the first embodiment of the present invention;

FIG. **8** is a cross sectional view showing a first step of a method for fabricating a suspension microstructure in accordance with a second embodiment of the present invention;

FIG. **9** is a cross sectional view showing a second step of the method for fabricating a suspension microstructure in accordance with the second embodiment of the present invention;

FIG. **10** is a cross sectional view showing a third step of the method for fabricating a suspension microstructure in accordance with the second embodiment of the present invention;

FIG. **11** is a cross sectional view showing a fourth step of the method for fabricating a suspension microstructure in accordance with the second embodiment of the present invention;

FIG. **12** is a cross sectional view showing a fifth step of the method for fabricating a suspension microstructure in accordance with the second embodiment of the present invention;

FIG. **13** is a cross sectional view showing a first step of a method for fabricating a suspension microstructure in accordance with a third embodiment of the present invention;

FIG. **14** is a cross sectional view showing a second step of the method for fabricating a suspension microstructure in accordance with the third embodiment of the present invention;

FIG. **15** is a cross sectional view showing a third step of the method for fabricating a suspension microstructure in accordance with the third embodiment of the present invention;

FIG. **16** is a cross sectional view showing a fourth step of the method for fabricating a suspension microstructure in accordance with the third embodiment of the present invention;

FIG. **17** is a cross sectional view showing a fifth step of the method for fabricating a suspension microstructure in accordance with the third embodiment of the present invention; and

FIG. **18** is a cross sectional view showing a sixth step of the method for fabricating a suspension microstructure in accordance with the third embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be clearer from the following description when viewed together with the accompanying drawings, which show, for purpose of illustrations only, the preferred embodiment in accordance with the present invention.

Referring to FIGS. **1-7**, a suspension microstructure and its fabrication method in accordance with a first embodiment of the present invention are illustrated in detail as follows:

As shown in FIG. **1**, an insulation layer **20** including inner micro-electro-mechanical structures **21** is formed on an upper

surface **11** of a silicon substrate **10** first. The micro-electro-mechanical structure **21** includes at least one microstructure **211** and a plurality of metal circuits **212** that are independent from each other. The micro-electro-mechanical structures **21** have an exposed portion **30** on the surface of the insulation layer **20**, and the exposed portion **30** is provided with plural through holes **31** correspondingly to the predetermined etching spaces of the micro-electro-mechanical structures **21**. The predetermined etching spaces only penetrate the insulation layer **20** without contacting the micro-electro-mechanical structures **21**. A barrier layer **40** with an opening **41** is formed on the lower surface of the silicon substrate **40**, and the opening **41** is located correspondingly to the microstructures **211**.

As shown in FIG. **2**, a deep reactive ion etching (DRIE) is subsequently conducted from the opening **41** of the barrier layer **40** to etch a space **101** in the silicon substrate **10** quickly, and then the barrier layer **40** is removed.

As shown in FIG. **3**, a photoresist **50** with an opening **51** is formed on the upper surface of the insulation layer **20** and the exposed portion **30**. The opening **51** is located outside all the through holes **31** of the exposed portions **30**.

As shown in FIG. **4**, a reactive ion etching (RIE) is subsequently conducted downwards from the through holes **31** of the exposed portion **30**. The insulation layer **20** will be interiorly formed with etching spaces **201**. The etching spaces **201** only penetrate the insulation layer **20** without contacting the micro-electro-mechanical structures **21**, so the micro-electro-mechanical structures **21** are clad in the insulation layer **20** in such a manner that the microstructures **211** and the metal circuits **212** in the micro-electro-mechanical structures **21** cannot be exposed at all.

As shown in FIG. **5**, the part of the exposed portion **30** within the opening **51** of the photoresist **50** is removed by etching (wet or dry), so as to prevent the deep reactive ion etching (DRIE) machine chamber from being contaminated by the metal material.

As shown in FIG. **6**, a deep reactive ion etching (DRIE) is conducted from the etching spaces **201** to the space **101** in the silicon substrate **10** to form through spaces **102**. The etching spaces **201**, the through spaces **102** and the space **101** communicate with one another to realize the suspension of the microstructures **211** of the micro-electro-mechanical structures **21**.

Ultimately, as shown in FIG. **7**, a protective cap **60** (for example, glass) is covered outside the opening **51** of the photoresist **50** to seal the suspension microstructures **211**.

The suspension microstructures and its fabrication method in accordance with the first embodiment of the present invention have the following advantages:

1. Reducing the exposure of the micro-electro-mechanical structure, reducing the damage probability, and effectively avoiding undercut: the micro-electro-mechanical structures **21** are clad in the insulation layer **20** in such a manner that the microstructures **211** and the metal circuits **212** in the micro-electro-mechanical structures **21** cannot be exposed at all, so that the present invention can avoid the damage caused during etching and the exposure of the micro-electro-mechanical structures **21**, thus effectively increasing the yield rate of the products;

2. The micro-electro-mechanical structures **21** include an exposed portion **30** on the surface of the insulation layer **20**, and the exposed portion **30** is provided with through holes **31** correspondingly to the predetermined etching spaces between the micro-electro-mechanical structures **21** and can be directly formed by deposition, the exposed portion **30** substitutes for the precision mask during etching, and it only needs to cooperate the opening **51** of the simplified photoresist **50** with the sequent etching, the suspension of the microstructures **211** can be realized, so that the fabrication complexity is reduced and the production efficiency is increased, thus reducing the cost and improving competitiveness.

Referring to FIGS. **8-12**, a suspension microstructure in accordance with a second embodiment of the present invention is slightly different (the stacked metal-via layers replace the through holes) from the first embodiment, and a method for fabricating a suspension microstructure for a compatible integrated circuit in accordance with the second embodiment of the present invention is illustrated as follows:

As shown in FIG. **8**, an insulation layer **20** with inner micro-electro-mechanical structures **21** is formed on an upper surface **11** of a silicon substrate **10** first. The micro-electro-mechanical structure **21** includes at least one microstructure **211** and a plurality of metal circuits **212** that are independent from each other. Under the exposed portion **30** is provided a plurality of mutually-conducted stacked metal-via layers **31**A correspondingly to the predetermined etching spaces. The stacked metal-via layers **31**A reach the upper surface **11** of the silicon substrate **10** and only penetrate the insulation layer **20** without contacting the micro-electro-mechanical structures **21**. A barrier layer **40** with an opening **41** is formed on the lower surface **12** of the silicon substrate **10**, and the opening **41** is located correspondingly to the microstructures **211**.

Next, as shown in FIG. **9**, a deep reactive ion etching (DRIE) is conducted from the opening **41** of the barrier layer **40** to etch a space **101** in the silicon substrate **10** quickly, and then the barrier layer **40** is removed.

Subsequently, as shown in FIG. **10**, a photoresist **50** with an opening **51** is formed on the upper surface of the insulation layer **20**, and the opening **51** is located outside all the stacked metal-via layers **31**A of the exposed portion **30**, the exposed portion **30** and all the stacked metal-via layers **31**A are removed by etching (wet or dry) in order to form etching spaces **201**, which only penetrate the insulation layer **20**, so the micro-electro-mechanical structures **21** are clad in the insulation layer **20** in such a manner that the microstructures **211** and the metal circuits **212** in the micro-electro-mechanical structures **21** cannot be exposed at all.

As shown in FIG. **11**, a deep reactive ion etching (DRIE) is conducted from the etching spaces **201** to the space **101** in the silicon substrate **10** to form through spaces **102**, the etching spaces **210**, the through spaces **102** and the space **101** communicate with one another to realize the suspension of the microstructures **211** of the micro-electro-mechanical structures **21**.

Ultimately, as shown in FIG. **12**, a protective cap **60** (for example, glass) is covered outside the opening **51** of the photoresist **50** to seal the suspension microstructures **211**.

The present embodiment in accordance with the present invention is characterized in that: under the exposed portion **30** is provided a plurality of mutually-conducted stacked metal-via layers **31**A, which reach the upper surface **11** of the silicon substrate **10**, and these stacked metal-via layers **31**A replace the through holes in the first embodiment in accordance with the present invention.

Hence, the suspension microstructures and its fabrication method in accordance with the second embodiment have the following advantages:

1. Reducing the exposure of the micro-electro-mechanical structure, reducing the probability of damage, and effectively avoiding undercut (as described previously);

2. The exposed portion **30** and the stacked metal-via layers **31**A are directly formed by deposition, so as to substitute for the precision mask effectively during etching, and it only

needs to cooperate the opening **51** of the simplified photoresist **50** with the sequent etching to realize the suspension of the microstructures **211**, so that the fabrication complexity is reduced and the production efficiency is increased, thus reducing the cost and improving competitiveness.

Referring to FIGS. **13-18**, the suspension microstructure for a compatible integrated circuit in accordance with a second embodiment of the present invention is slightly different (through holes cooperate with an exposed portion and an embedded portion that are located in different depths), and a method for fabricating a suspension microstructure for a compatible integrated circuit in accordance with the third embodiment of the present invention is illustrated as follows:

As shown in FIG. **13**, an insulation layer **20** with inner micro-electro-mechanical structures **21** is formed on an upper surface **11** of a silicon substrate **10** first. The micro-electro-mechanical structure **21** includes at least one microstructure **211** and a plurality of metal circuits **212** that are independent from each other. Moreover, the micro-electro-mechanical structures **21** have an exposed portion **30** and an embedded portion **30**B. The exposed portion **30** is provided with through holes **31** correspondingly to the predetermined etching spaces of the micro-electro-mechanical structures **21**. The embedded portion **30**B is lower than the exposed portion **30** and located in the predetermined etching space of the through holes **31**, which only penetrates the insulation layer without contacting the micro-electro-mechanical structures **21**. A space **101** is further formed in the silicon substrate **10** (the same technical details are omitted). A photoresist **50** with an opening **51** is formed on the upper surface of the insulation layer **20** and the exposed portion **30**, and the opening **51** is located outside all the through holes **31** of the exposed portions **30**.

Next, as shown in FIG. **14**, a reactive ion etching (RIE) is conducted downwards from the through holes **31** of the exposed portion **30** to form etching spaces **201**, since the embedded portion **30**B is lower than the exposed portion **30** and located in the predetermined etching space of the through holes **31**, a sunken space **202** is etched above the embedded portion **30**B of the present embodiment in accordance with the present invention. The etching spaces **201** and the sunken space **202** only penetrate the insulation layer **20** without contacting the micro-electro-mechanical structures **21**, so the micro-electro-mechanical structures **21** are clad in the insulation layer **20** in such a manner that the microstructures **211** and the metal circuits **212** in the micro-electro-mechanical structures **21** cannot be exposed at all.

Subsequently, as shown in FIG. **15**, the part of the exposed portion **30** within the opening **51** of the photoresist **50** and the embedded portion **30**B are removed by etching (wet or dry), thus preventing the deep reactive ion etching (DRIE) machine chamber from being contaminated by the metal material.

As shown in FIG. **16**, a deep reactive ion etching (DRIE) is conducted from the etching space **201** to the space **101** in the silicon substrate **10** to form a through space **102**, the etching space **201**, the through space **102** and the space **101** communicate with one another to realize the suspension of the microstructures **211**.

As shown in FIG. **17**, the photoresist **50** on the upper surface of the exposed portion **30** is subsequently removed.

Ultimately, as shown in FIG. **18**, a protective cap **60** is covered outside the exposed portion **30** to seal the suspension microstructures **211** while the metal circuits **212** and the exposed portion **30** are partially exposed to act as a plating substrate which is directly electrically conducted via a standard chip structure for circuit connection.

The suspension microstructures and its fabrication method in accordance with the third embodiment have the following advantages:

1. Reducing the exposure of the micro-electro-mechanical structure, reducing the probability of damage, and effectively avoiding undercut (as described previously);

2. The exposed portion **30** and the embedded portion **30**B can be directly formed by deposition, so as to replace the precision mask during etching effectively, and it only needs to cooperate the opening **51** of the simplified photoresist **50** with the sequent etching to realize the suspension of the microstructures **211**, so that the fabrication complexity is reduced and the production efficiency is increased, thus reducing the cost and improving competitiveness;

3. The sunken space **202** above the embedded portion **30**B can effectively increase the configuration variation of the future circuit application in accordance with the present invention.

To summarize, the creative feature of the present invention is that, at least one insulation layer including inner micro-electro-mechanical structures is formed on an upper surface of a silicon substrate, the micro-electro-mechanical structure includes at least one microstructure and a plurality of metal circuits that are independent from each other, moreover, the micro-electro-mechanical structures have an exposed portion on the surface of the insulation layer, and the exposed portion is provided with through holes or stacked metal-via layers correspondingly to the predetermined etching spaces of the micro-electro-mechanical structures, the above etching spaces and the stacked metal-via layers only penetrate the insulation layer, in addition, a photoresist with an opening is formed on the upper surface of the exposed portion, and the opening of the photoresist is located outside all the through holes or the stacked metal-via layers of the exposed portion, next etching is successively conducted in order to realize the suspension of the microstructures.

By such arrangements, the present invention can effectively avoid improper erosion, and further simplify the mask and reduce the package cost.

While we have shown and described various embodiments in accordance with the present invention, it is clear to those skilled in the art that further embodiments may be made without departing from the scope of the present invention.

What is claimed is:

1. A method for fabricating a suspension microstructure comprising the steps of:

forming an insulation layer including inner micro-electro-mechanical structures on an upper surface of a silicon substrate, the micro-electro-mechanical structure including at least one microstructure and a plurality of metal circuits that are independent from each other, the micro-electro-mechanical structures having an exposed portion on a surface of the insulation layer, the exposed portion being provided with through holes correspondingly to predetermined etching spaces of the micro-electro-mechanical structures, which only penetrates the insulation layer without contacting the micro-electro-mechanical structures;

next, forming a photoresist with an opening on the insulation layer, the opening of the photoresist being located outside the through holes of the exposed portion;

subsequently, conducting an etching from the through holes of the exposed portion downwards to form etching spaces which only penetrate the insulation layer, the microstructures of the micro-electro-mechanical structures being clad in the insulation layer; and

realizing suspension of the microstructures by etching.

2. The method for fabricating a suspension microstructure as claimed in claim **1** further comprising the steps of:

forming a barrier layer with an opening on a lower surface of the silicon substrate, the opening of the barrier layer being located correspondingly to the microstructures of the micro-electro-mechanical structures;

subsequently, conducting a deep reactive ion etching from the opening of the barrier layer and quickly etching a space in the silicon substrate; and

removing the barrier layer.

3. The method for fabricating a suspension microstructure as claimed in claim **1** further comprising the step of: removing a part of the exposed portion within the opening of the photoresist by etching.

4. The method for fabricating a suspension microstructure as claimed in claim **3**, wherein the step of realizing suspension of the microstructures by etching further comprises:

conducting a deep reactive ion etching from the etching spaces to the space in the silicon substrate to form through spaces, the respective spaces connect with each other to realize the suspension of the microstructures of the micro-electro-mechanical structures.

5. The method for fabricating a suspension microstructure as claimed in claim **1** further comprising removing the photoresist in the step of realizing suspension of the microstructures by etching.

6. A method for fabricating a suspension microstructure comprising the steps of:

forming an insulation layer including inner micro-electro-mechanical structures on an upper surface of a silicon substrate, the micro-electro-mechanical structure including at least one independent microstructure, the micro-electro-mechanical structures having an exposed portion on a surface of the insulation layer, under the exposed portion being provided a plurality of mutually-conducted stacked metal-via layers correspondingly to predetermined etching spaces, the stacked metal-via layers reaching the upper surface of the silicon substrate and only penetrating the insulation layer without contacting the micro-electro-mechanical structures;

next, forming a photoresist with an opening on the insulation layer, the opening of the photoresist being located outside the exposed portion;

subsequently, removing the exposed portion and all the stacked metal-via layers by etching to form etching spaces only penetrating the insulation layer; and

conducting an etching from the etching spaces downwards to realize suspension of the microstructures.

7. The method for fabricating a suspension microstructure as claimed in claim **6** further comprising the steps of:

forming a barrier layer with an opening on a lower surface of the silicon substrate, the opening of the barrier layer being located correspondingly to the microstructures of the micro-electro-mechanical structures;

subsequently, conducting a deep reactive ion etching from the opening of the barrier layer and quickly etching a space in the silicon substrate; and

removing the barrier layer.

8. The method for fabricating a suspension microstructure as claimed in claim **6** further comprising removing the photoresist in the step of conducting the etching downwards to realize suspension of the microstructures.

9. The method for fabricating a suspension microstructure as claimed in claim **6** further comprising in the step of conducting the etching downwards to realize suspension of the microstructures: conducting a deep reactive ion etching from the etching spaces to the space in the silicon substrate to form through spaces, the respective spaces connect with each other to realize the suspension of the microstructures of the micro-electro-mechanical structures.

10. A method for fabricating a suspension microstructure comprising the steps of:

forming an insulation layer including inner micro-electro-mechanical structures on an upper surface of a silicon substrate, the micro-electro-mechanical structure including at least one microstructure and a plurality of metal circuits that are independent from each other, the micro-electro-mechanical structures having an exposed portion and an embedded portion, the exposed portion being provided with through holes correspondingly to predetermined etching spaces of the micro-electro-mechanical structures, the embedded portion being lower than the exposed portion and located in a predetermined etching space of the through holes, which only penetrates the insulation layer without contacting the micro-electro-mechanical structures;

next, forming a photoresist with an opening on the insulation layer, the opening of the photoresist being located outside all the through holes of the exposed portion;

subsequently, conducting an etching from the through holes of the exposed portion downwards to etch etching spaces in the insulation layer, the embedded portion is lower than the exposed portion and located in the predetermined etching space of the through holes, so that a sunken space is etched above the embedded portion, the etching spaces and the sunken space only penetrate the insulation layer without contacting the micro-electro-mechanical structures;

removing a part of the exposed portion within the opening of the photoresist and the exposed embedded portion; and

etching a predetermined space toward the silicon substrate to realize suspension of the microstructures of micro-electro-mechanical structures.

11. The method for fabricating a suspension microstructure as claimed in claim **10** further comprising the steps of:

forming a space in the silicon substrate;

next, conducting a dry reactive ion etching (RIE) from the through holes of the exposed portion downwards;

removing the exposed portion and the embedded portion by etching; and

conducting a deep reactive ion etching from the etching space toward the space in the silicon substrate.

12. The method for fabricating a suspension microstructure as claimed in claim **10** further comprising the steps of:

forming a barrier layer with an opening on a lower surface of the silicon substrate, the opening of the barrier layer being located correspondingly to the microstructures of the micro-electro-mechanical structures;

subsequently, conducting a deep reactive ion etching from the opening of the barrier layer and quickly etching the space in the silicon substrate; and

removing the barrier layer.

13. The method for fabricating a suspension microstructure as claimed in claim **10** further comprising the step of: covering a protective cap outside the opening of the photoresist.

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