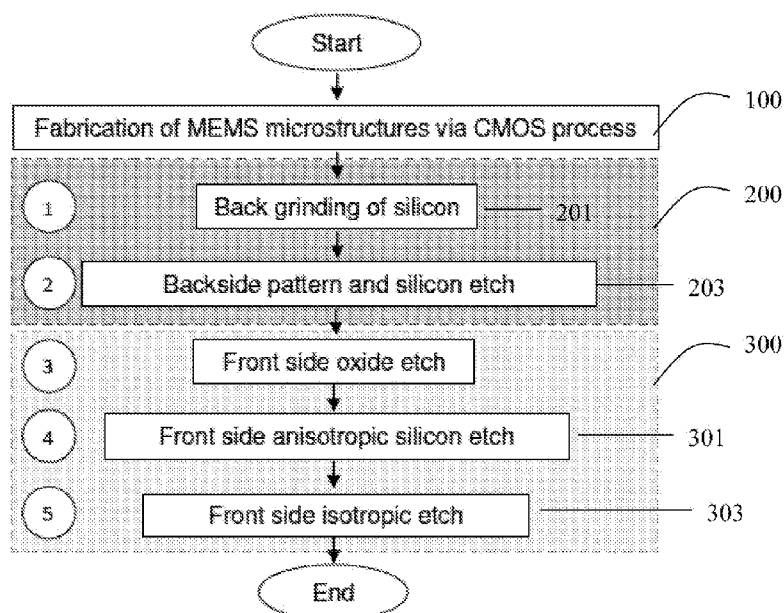




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[Continued on next page]

(54) Title: A METHOD FOR RELEASING MEMS DEVICE



(57) Abstract: The present invention relates to a method for releasing a MEMS device which provides a complete dry release method to prevent stiction or adhesion problem during the MEMS device release process. Adopting an all-dry processing avoids the need to perform rinsing and drying process steps during fabrication. The release process is divided into two parts i.e. the backside release (200) and the front side release process (300).

Figure 1



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Description

Title of Invention: A METHOD FOR RELEASING MEMS DEVICE

[1] **FIELD OF INVENTION**

[2] The present invention relates to a method for releasing microelectromechanical system (MEMS) devices to form free-hanging structures.

[3] **BACKGROUND OF THE INVENTION**

[4] Conventional methods of releasing microelectromechanical devices are either using wet etching process or a combination of wet and dry processing. One of the example is in US20100044807 which the invention addresses the aims and issues of making multi layer microstructures including 'metal-shell-oxide-core' structures and 'oxide-shell-metal-core' structures, and mechanically constrained structures and the constraining structures using CMOS (complimentary metal-oxide-semiconductor transistors) materials and layers processed during the standard CMOS process and later released into constrained and constraining structures by etching away those CMOS materials used as sacrificial materials. The combinations of possible constrained structures and methods of fabrication are described.

[5] Releasing microelectromechanical systems and device sensor and actuator devices to form free-hanging structures via wet etching method usually leads to problems such as stiction or adhesion, a condition where the substrate and the microstructures adhere together causing the microelectromechanical systems and device to fail. Adhesion can occur during processing when the suspended structure is exposed to an aqueous rinsing and drying cycle. Strong attractive capillary forces can develop during the dehydration process due to the very small gap of the device-to-substrate, causing it to collapse and subsequently pinned to the substrate. Separating the two surfaces is often complicated due to the fragile nature of the microstructure. This type of device failure develops both in fabrication and during device operation, being a dominant source of yield loss in MEMS.

[6] Adopting wet etching process for the sacrificial oxide removal step would expose the microstructures to an aqueous rinsing and drying cycle. This would later cause the substrate and the microstructure surfaces to adhere together and not able to be separated due to the fragile nature of the microstructure.

[7] **SUMMARY OF THE INVENTION**

[8] According to an aspect of the present invention, the present invention provides a method for releasing MEMS device comprising: forming a MEMS structures wafer using complimentary metal-oxide-semiconductor fabrication technique (100), the

MEMS structures wafer having dielectric film and silicon substrate; characterized in that providing partial release process from backside of the wafer (200); and providing partial release process from front side of the wafer (300). The above provision is advantageous as it is a complete dry release method to prevent stiction or adhesion problem during the MEMS device release process. Adopting an all-dry processing avoids the need to perform rinsing and drying process steps during fabrication.

[9] **BRIEF DESCRIPTION OF THE DRAWINGS**

[10] **Figure 1** illustrates sequence of the method for releasing MEMS device of the present invention.

[11] **Figure 2** illustrates schematics of the cross-section view of the method of the present invention.

[12] **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT**

[13] Generally, the present invention relates to a method for releasing MEMS device comprising: forming a MEMS structures wafer using complimentary metal-oxide-semiconductor fabrication technique (100), the MEMS structures wafer having dielectric film and silicon substrate; characterized in that providing partial release process from backside of the wafer (200); and providing partial release process from front side of the wafer (300). The present invention is a fabrication method whereby the microelectromechanical systems and device structures are built on a silicon substrate via CMOS compatible process flow. MEMS sensors and actuators have a wide variety of applications performing basic signal transduction operations. Suspended micro-machined structures such as plates and beams are commonly used in the manufacturing of pressure and acceleration sensors. In practice, the sensing elements must be relatively small in size, reliable with excellent selectivity, and high sensitivity and should not require a large sensing volume. However, the most important is the fabrication technique that should give higher yield without unwanted fabrication issues such as stiction or adhesion. In fact it should be reliable for mass production solutions in term of fabrication technology. Thus, dry etching methods for microelectromechanical systems and device release is opted to address the issues. The main challenge is to produce free-hanging microstructures with minimum critical dimension of 1 micrometer. A complete dry release method is proposed to prevent stiction or adhesion problem during the MEMS device release process. Adopting an all-dry processing would avoid the need to perform rinsing and drying process steps during fabrication.

[14] The release process is divided into two parts i.e. the backside release (200) and the frontside release process (300). The backside processing partially releases the device through back grinding (201) and etching of the silicon under the designated device area (203). The backside grinding is to reduce Si thickness to half and then proceed with etch depth of 40% from original thickness. The front side release is a self-aligned

etching process (301) where the inter-dielectric layers are removed by anisotropic etching followed by a final isotropic etching (303) to remove the remaining 7% of silicon for full release of the hanging device structures. The dry etch processing is performed solely by an inductively coupled deep reactive ion etcher (DRIE) that is capable of performing anisotropic and isotropic etching on the same chamber.

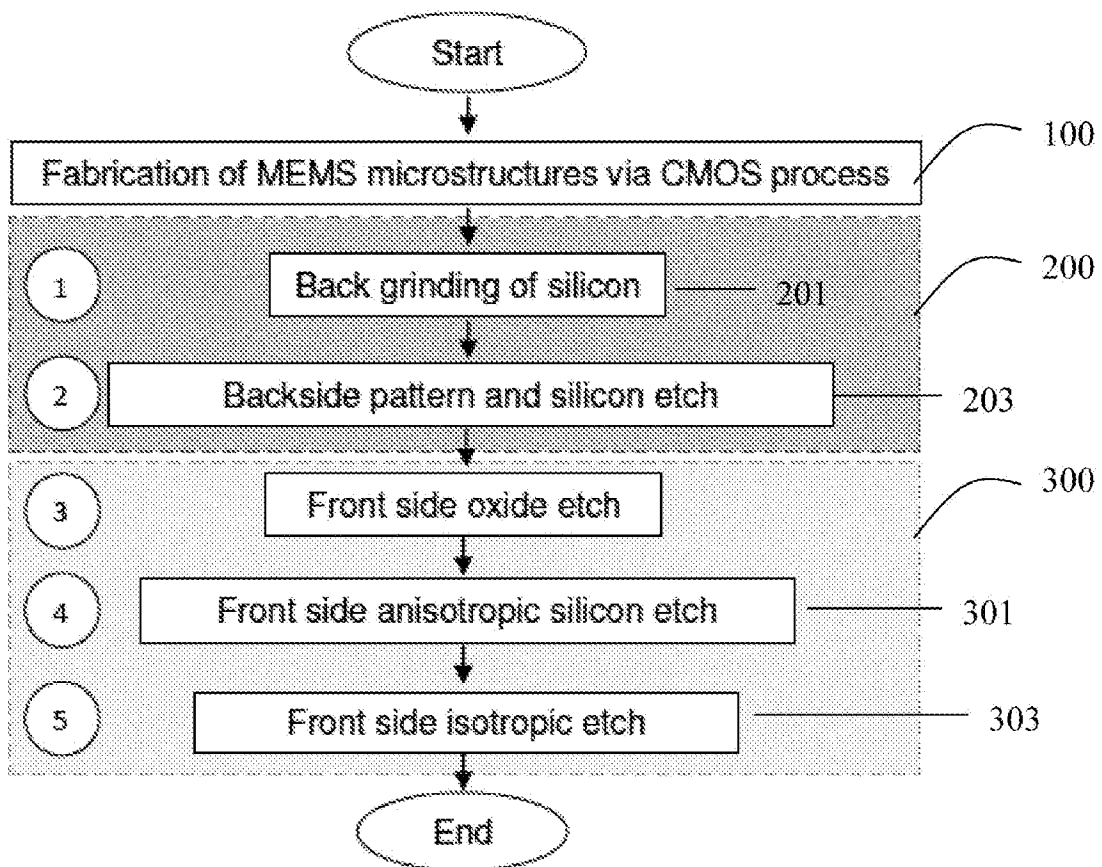
[15] The release process of the microelectromechanical systems and devices is achieved by a complete dry etching process. The sequence of the release process flow is as shown in **Figure 1**. The schematics of the cross-section view of the process flow are as depicted in **Figure 2**.

[16] Although the invention has been described with reference to particular embodiment, it is to be understood that the embodiment is merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiment that other arrangements may be devised without departing from the scope of the present invention as defined by the appended claims.

Claims

- [Claim 1] A method for releasing MEMS device comprising:
forming a MEMS structures wafer using complimentary metal-oxide-semiconductor fabrication technique (100), the MEMS structures wafer having dielectric film and silicon substrate;
characterized in that
providing partial release process from backside of the wafer (200); and
providing partial release process from front side of the wafer (300).
- [Claim 2] A method for releasing MEMS device as claimed in Claim 1, wherein the step of providing partial release process from backside of the wafer (200) further comprising:
forming backside grinding to reduce substratethickness (201); and
forming backside etching of silicon using photoresist as masking layer by deep reactive ion etcher (203).
- [Claim 3] A method for releasing MEMS device as claimed in Claim 1, wherein the step of providing partial release process from front side of the wafer (300) further comprising:
forming etching of silicon oxide for removal of interlayer dielectrics and pre-metal dielectric layer using deep reactive ion etcher without masking layer (301); and
forming final release processes step wherein the remaining silicon is removed by anisotropic and isotropic etching by deep reactive ion etching (303).

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**Figure 1**

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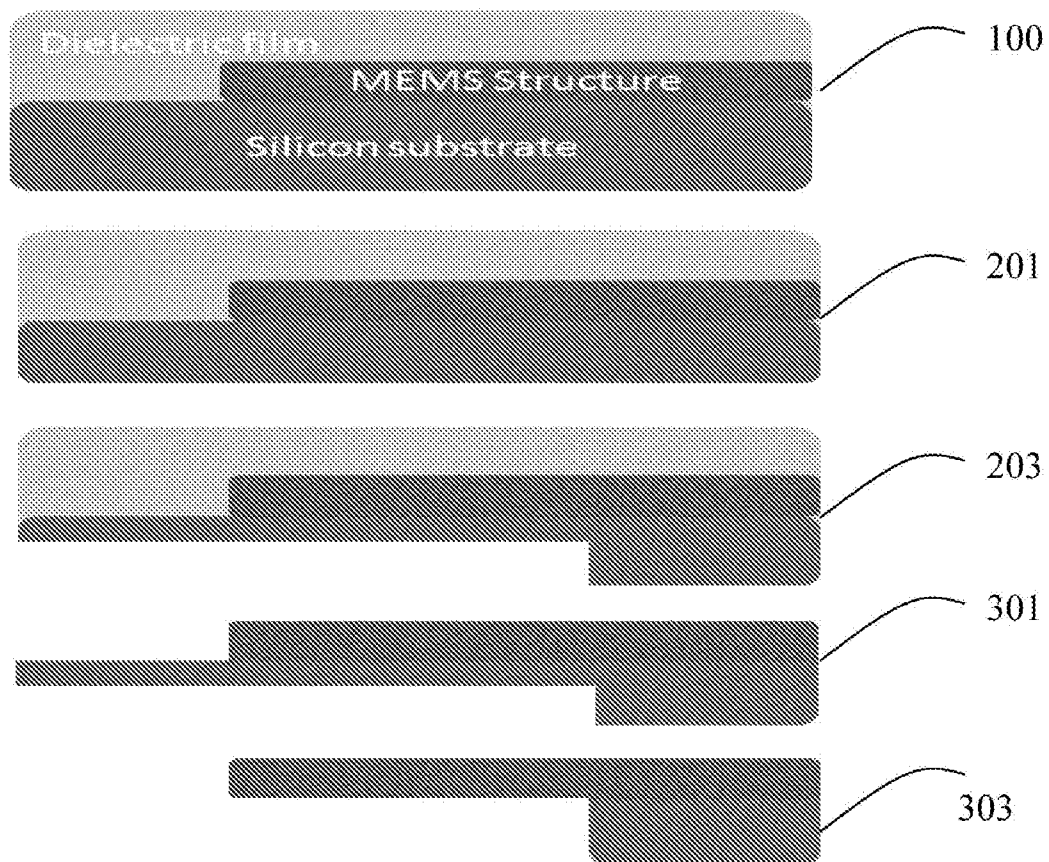


Figure 2

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
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ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B81C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	EP 1 441 561 A2 (AKUSTICA INC [US]) 28 July 2004 (2004-07-28) abstract column 3, paragraph 10 - column 5, paragraph 17 column 6, paragraph 23 figures 1-9,16,17 ----- -/--	1-3



Further documents are listed in the continuation of Box C.



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Name and mailing address of the ISA/

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Ekoué, Adamah

INTERNATIONAL SEARCH REPORT

International application No
PCT/MY2013/000242

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No

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