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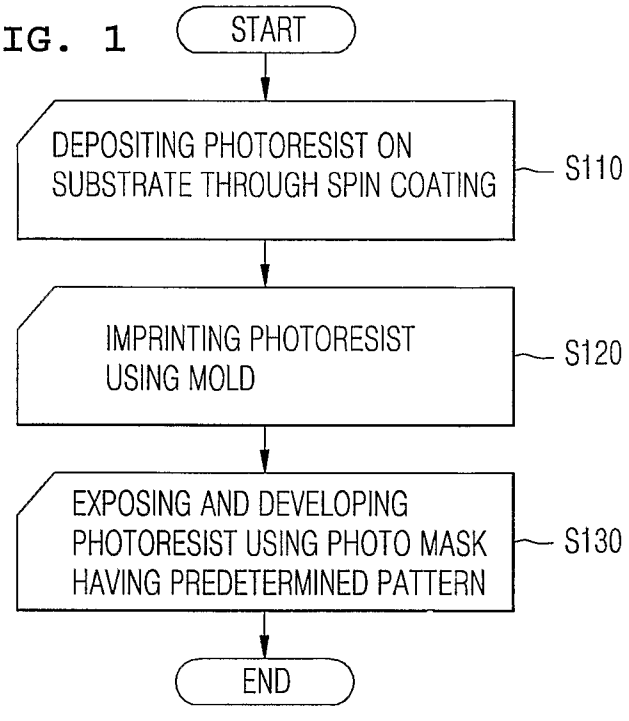
(54) Title: METHOD OF FABRICATING THREE-DIMENSIONAL PATTERNED STRUCTURE USING IMPRINTING LITHOGRAPHY PROCESS AND PHOTO LITHOGRAPHY PROCESS

FIG. 1



(57) Abstract: Disclosed herein is a method of fabricating a three-dimensional patterned structure using an imprint lithography process and a photolithography process, in which the height of a residual photoresist layer, which is problematic to control, is controlled by controlling only a process time in an imprint lithography process, and then a photolithography process is additionally performed, thus fabricating a new three-dimensional patterned structure without performing an additional process for removing the residual photoresist layer. The method of fabricating a three-dimensional patterned structure includes: (a) depositing a photoresist on a substrate through spin coating; (b) imprinting the deposited photoresist using a mold having a predetermined pattern at a predetermined temperature and pressure to fabricated a structure; and (c) providing a photo mask having a predetermined pattern on the fabricated structure and then exposing and developing the structure to form a three-dimensional patterned structure having a specific pattern.

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[DESCRIPTION]

[Invention Title]

METHOD OF FABRICATING THREE-DIMENSIONAL PATTERNED STRUCTURE USING IMPRINTING LITHOGRAPHY PROCESS AND PHOTO LITHOGRAPHY PROCESS

[Technical Field]

The present invention relates to a method of fabricating a three-dimensional patterned structure, which can fabricate an uneven photoresist having various heights from an even photoresist, can be fabricated by controlling process conditions such as temperature, pressure, time, etc. which are applied in an imprint lithography process, and, more particularly, to a method of fabricating a three-dimensional patterned structure, in which an imprint lithography process is performed by controlling only the process time, and then the height of a residual photoresist layer, which is problematic to control, is controlled, thus fabricating a three-dimensional patterned structure without requiring that an additional process for removing the residual photoresist layer be performed.

[Background Art]

Currently, research in the industrial fields of microelectromechanical systems (MEMS), microoptomechanical systems (MOMS), sensors, and semiconductor, using a semiconductor process, is progressing. In these industrial

fields, a three-dimensional patterned structure is increasingly required in order to fabricate complicated and highly functional devices.

However, generally, the three-dimensional patterned structure is fabricated using various materials through many processes. In order to solve this problem, research on gray mask photolithography, imprint lithography, etc. is widely conducted. Among them, imprint lithography is a next-generation process, and is intensively researched. Imprint lithography has more advantages than conventional photolithography, but also has a problem in that, since a residual photoresist layer is left after an imprint lithography process is performed, an additional process for removing the residual photoresist layer using O_2 plasma is required.

[Disclosure]

[Technical Problem]

Accordingly, the present invention has been made keeping in mind the above problems occurring in the prior art, and an object of the present invention is to provide a method of fabricating a three-dimensional patterned structure using an imprint lithography process and a photolithography process, in which the height of a residual photoresist layer, which is problematic to control, is controlled by controlling only the process time in an imprint lithography process, and then a photolithography process is additionally performed, thus fabricating a new three-dimensional patterned structure without

requiring that an additional process for removing the residual photoresist layer be performed.

[Technical Solution]

In order to accomplish the above object, the present invention provides a method of fabricating a three-dimensional patterned structure using imprint lithography and photolithography, including: (a) depositing a photoresist on a substrate through spin coating; (b) imprinting the deposited photoresist using a mold having a predetermined pattern at a predetermined temperature and pressure to fabricated a structure; and (c) providing a photo mask having a predetermined pattern on the fabricated structure and then exposing and developing the structure to form a three-dimensional patterned structure having a specific pattern.

[Advantageous Effects]

The method of fabricating a three-dimensional patterned structure according to the present invention is advantageous in that a complicated three-dimensional pattern of a photoresist can be easily fabricated through an imprint lithography process as well as through a photolithography process, and an additional process for removing a residual photoresist layer is not required, thus ultimately increasing the reliability of the entire process.

[Description of Drawings]

FIG. 1 is a flow chart illustrating a method of fabricating a three-dimensional patterned structure using an imprint lithography process and a photolithography process according to the present invention;

FIG. 2A is a state view corresponding to FIG. 1 according to the present invention;

FIG. 2B is a state view corresponding to FIG. 1 according to the present invention;

FIG. 3 is a photograph showing a photoresist imprinted through a mold according to the present invention; and

FIG. 4 is a graph showing the change in height of a residual photoresist layer depending on imprint process time according to the present invention.

[Best Mode]

The specific features and advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings. Here, when it is determined that the detailed description on commonly known functions and constitutions related to the present invention made the essential elements of the present invention obscure, it is to be noted that the detailed description thereon may be omitted.

Hereinafter, the present invention will be described in detail with reference to the attached drawings.

A method of fabricating a three-dimensional patterned structure using an imprint lithography process and a

photolithography process will be described as follows with reference to FIGS. 1 to 4.

FIG. 1 is a flow chart illustrating a method of fabricating a three-dimensional patterned structure using an imprint lithography process and a photolithography process according to the present invention, and FIGS. 2A and 2B are state views corresponding to FIG. 1.

[First process] Deposition of photoresist

As shown in FIG. 1 and (a) of FIG. 2A, a photoresist is deposited on a silicon substrate through spin coating (S110). Here, the photoresist, which is a novolak-based photoresist (AZ-9260, AZ Electronic Materials), is layered on the silicon substrate at a thickness of 20 μm, and then soft-baked at a temperature of 95℃. In this case, in addition to the photoresist, polymers, which can be patterned through photolithography, may be used.

[Second process] Imprint lithography

As shown in (b) of FIG. 2A, the photoresist deposited on the silicon substrate in the first process is imprinted at a predetermined temperature and pressure using a mold having a predetermined pattern (S120). Here, the imprinting temperature may range from 80℃ to 100℃, and is preferably 90℃, but the present invention is not limited thereto. Further, the imprinting pressure may range from 5 bar to 10 bar, and is preferably 8 bar, but the present invention is not limited thereto.

Here, as shown in (b) of FIG. 2A, the mold has a three-dimensional intaglio structure, in which gold (Au) is deposited on a silicon substrate using chromium (Cr) as an adhesion layer.

Further, as shown in (b) of FIG. 2A, the mold has a length of 8 cm, an upper width of 60 μm, a lower width of 50 μm, a section height of 60 μm and a gradient of 5° between the upper width and lower width. Since the photoresist is imprinted by the mold, the upper portion of the photoresist, as shown in FIG. 3, has the same length, upper width, lower width, section height and gradient between upper with and lower width as the mold.

Here, the thickness of a residual photoresist layer is controlled by adjusting imprint process time. Further, the thickness of a residual photoresist layer can be predicted using a squeeze flow equation. The height of the residual photoresist layer depending on the imprint process time was determined based on process variables in this equation.

FIG. 4 is a graph showing the change in the height of the residual photoresist layer depending on the imprint process time. As shown in FIG. 4, it was found that the height of the residual photoresist layer was decreased in proportion to the imprint process time during the period from 0 to 30 seconds, and was further slowly decreased during the period from 30 to 50 seconds. That is, from the result, it can be seen that the height of the residual photoresist layer can be simply controlled merely by adjusting the imprint process time. Here, the imprint process time is set within the range of 1 to 60, but is not limited thereto.

[Third process] Photolithography

As shown in (c) of FIG. 2B, a photo mask having a predetermined pattern is provided on the patterned structure fabricated through the second process, and then the patterned structure is exposed and developed to form a three-dimensional patterned structure having a specific pattern, as shown in (d) of FIG. 2B (S130).

As described above, the method of fabricating a three-dimensional patterned structure according to the present invention is advantageous in that an additional process of removing a residual photoresist layer is not required because part of the three-dimensional patterned structure is fabricated through an imprinting process, and the reliability of fabrication of the three-dimensional patterned structure can be improved because the height of the residual photoresist layer is changed linearly depending on the imprint process time.

As described above, although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

【CLAIMS】

【Claim 1】

A method of fabricating a three-dimensional patterned structure using imprint lithography and photolithography, comprising:

(a) depositing a photoresist on a substrate through spin coating;

(b) imprinting the deposited photoresist using a mold having a predetermined pattern at a predetermined temperature and pressure to fabricate a structure; and

(c) providing a photo mask having a predetermined pattern on the fabricated structure and then exposing and developing the structure to form a three-dimensional patterned structure having a specific pattern.

【Claim 2】

The method according to claim 1, wherein, in (b), the imprinting of the deposited photoresist, a thickness of a residual photoresist layer is controlled by an imprint process time, and the imprint process time is set within a range from 1 to 60 seconds.

【Claim 3】

The method according to claim 1, wherein the imprinting temperature ranges from 80℃ to 100℃.

【Claim 4】

The method according to claim 1, wherein the imprinting pressure ranges from 5 bar to 10 bar.

【Claim 5】

The method according to claim 1, wherein the mold has a three-dimensional intaglio structure, in which gold (Au) is deposited on a silicon substrate using chromium (Cr) as an adhesion layer.

【Claim 6】

The method according to claim 1, wherein the mold has a length of 8 cm, an upper width of 60 μm, a lower width of 50 μm, a section height of 60 μm and a gradient of 5° between the upper width and lower width.

【Claim 7】

The method according to claim 1, wherein the substrate is made of silicon.

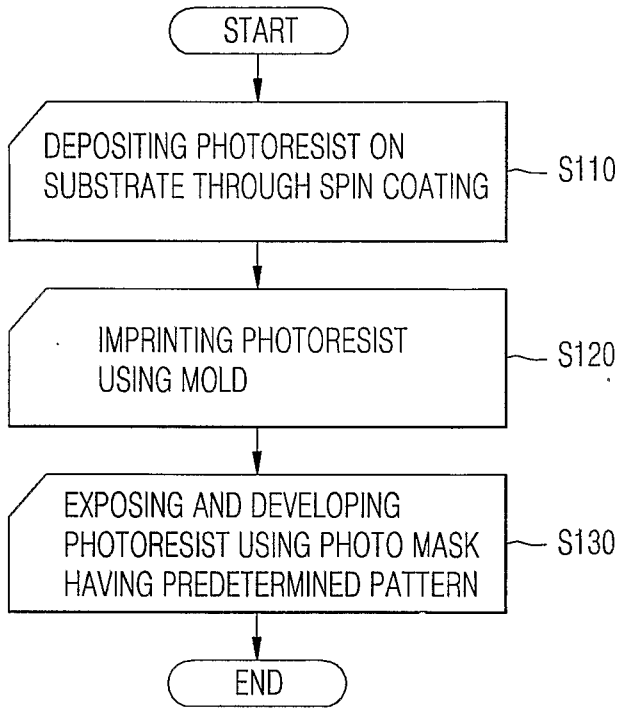

START
DEPOSITING PHOTORESIST ON SUBSTRATE THROUGH SPIN COATING
S110
IMPRINTING PHOTORESIST USING MOLD
S120
EXPOSING AND DEVELOPING PHOTORESIST USING PHOTO MASK HAVING PREDETERMINED PATTERN
S130
END

FIG. 1

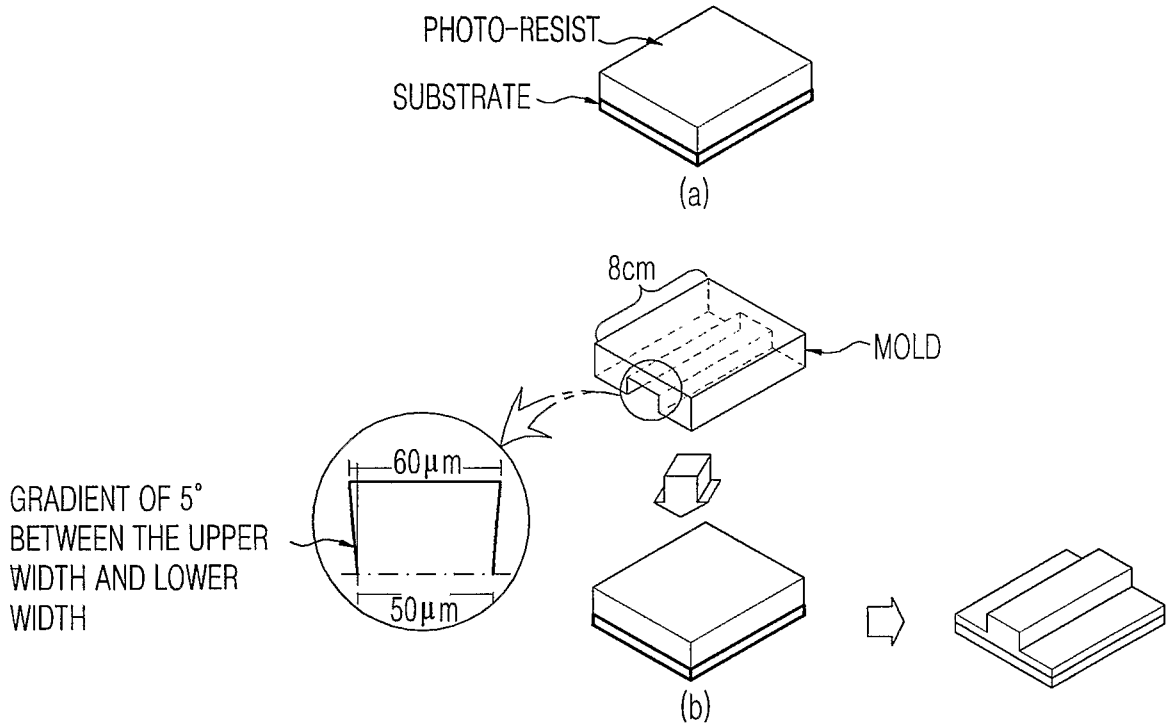
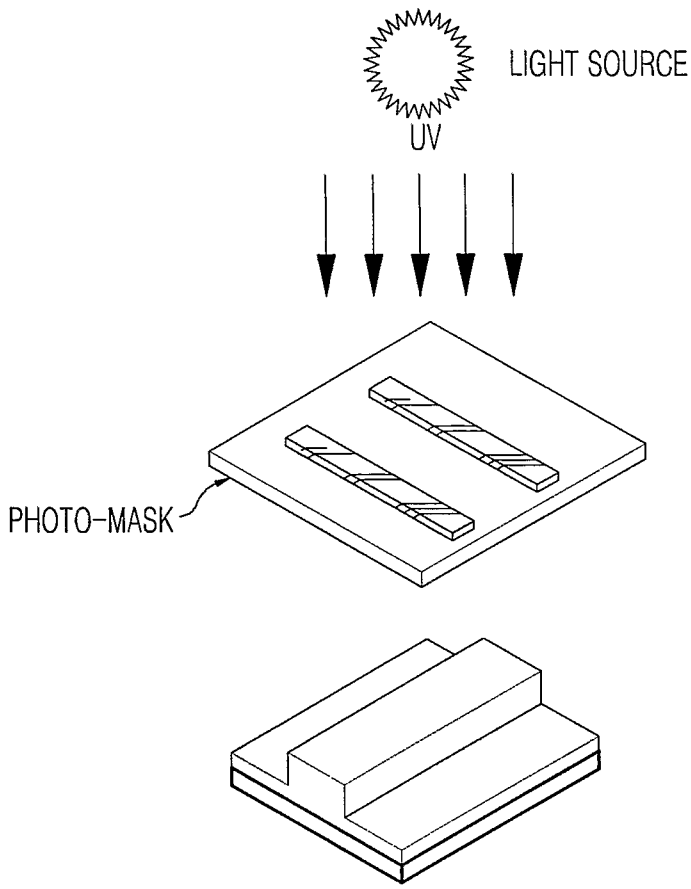
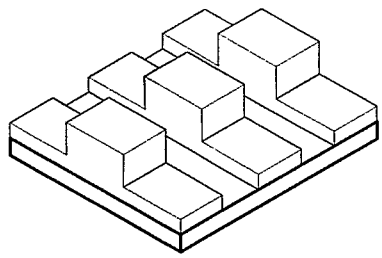


PHOTO-RESIST
SUBSTRATE
(a)
8cm
MOLD
60μm
50μm
GRADIENT OF 5°
BETWEEN THE UPPER
WIDTH AND LOWER
WIDTH
(b)

FIG. 2A

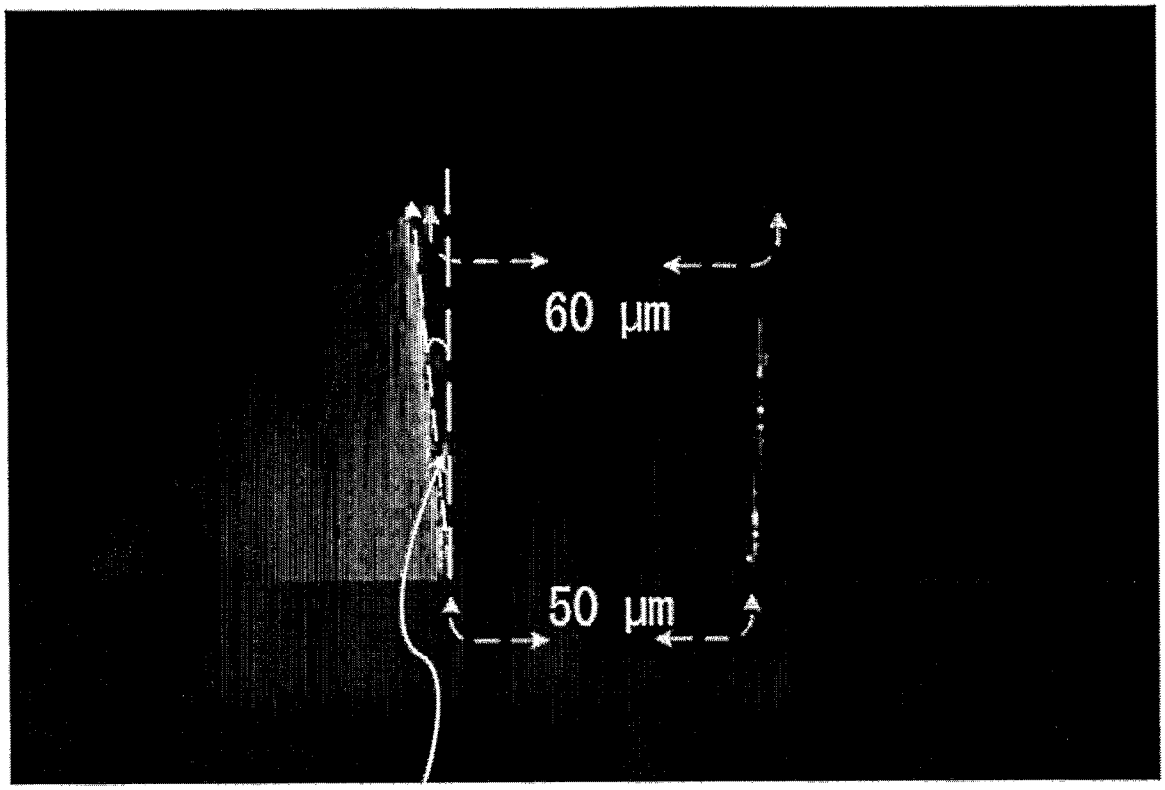


(c)



(d)

FIG. 2B



GRADIENT OF 5°
BETWEEN THE UPPER
WIDTH AND LOWER WIDTH

FIG. 3

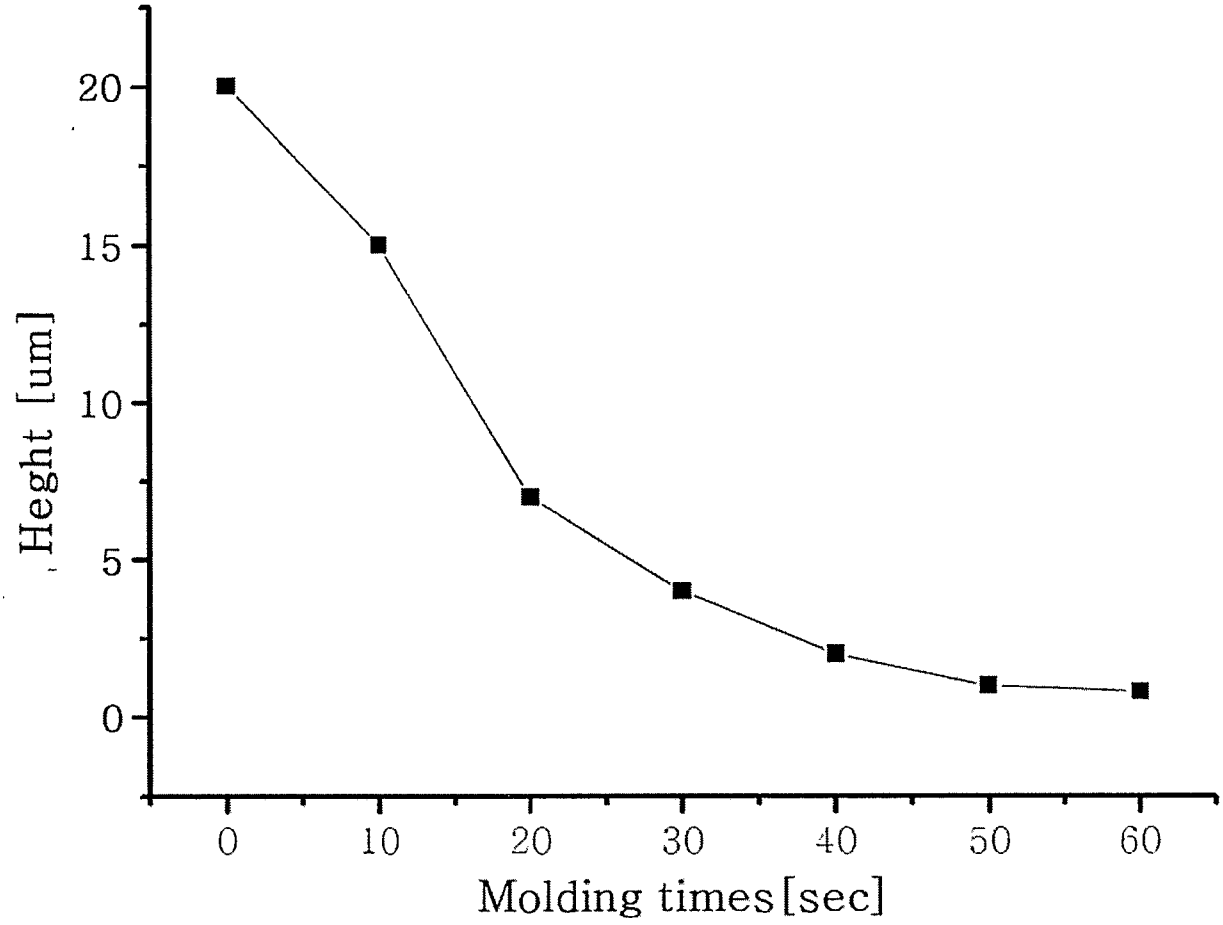


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2008/001138

A. CLASSIFICATION OF SUBJECT MATTER

H01L 21/00(2006.01)i, H01L 21/027(2006.01)i

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)
IPC 8 H01L 21/00, 21/027

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
KOREAN UTILITY MODELS AND APPLICATIONS FOR UTILITY MODELS SINCE 1975
JAPANESE UTILITY MODELS AND APPLICATIONS FOR UTILITY MODELS SINCE 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS(KIPO internal) & keyword : imprint, photolithography, and pattern

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2005/057634 A1 (TOKYO UNIVERSITY OF AGRICULTURE AND TECHNOLOGY TLO CO., LTD.) 23 June 2005 See the abstract; Paragraph [0028]-[0030]; claim 8; and FIG. 3	1-7
A	KR 10-2005-0075066 A (SAMSUNG ELECTRONICS CO., LTD.) 20 July 2005 See the abstract; claim 10; and FIG. 4a-4e	1-7
A	KR 10-2007-0066428 A (MAGNACHIP SEMICONDUCTOR, LTD.) 27 June 2007 See the abstract; claim 1; and FIG. 2a-2c	1-7

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 AUGUST 2008 (27.08.2008)	**27 AUGUST 2008 (27.08.2008)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer
KIM, Kap Byung
Telephone No. 82-42-481-8498

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2008/001138

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2005-057634 A1	23.06.2005	KR 10-2006-0128886 A	14.12.2006
		EP 1696471 A1	30.08.2006
		US 2007-0117389 A1	24.05.2007
KR 10-2005-0075066 A	20.07.2005	US 2005-158637 A1	21.07.2005
KR 10-2007-0066428 A	27.06.2007	None	