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(71) Applicant *(for all designated States except US)*: **MIMOS BERHAD** [MY/MY]; Technology Park Malaysia, Kuala Lumpur, 57000 (MY).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **LEE, Hing Wah** [MY/MY]; Mimos Berhad, Technology Park Malaysia, Kuala Lumpur, 57000 (MY). **BIEN, Chia Sheng Daniel** [MY/MY]; Mimos Berhad, Technology Park Malaysia, Kuala Lumpur, 57000 (MY).

(74) Agent: **NANJAPPAN, Puvaneswari**; Kass International Berhad, 8-7-2 Menara Mutiara Bangsar, Jalan Liku, Off Jalan Riong, Bangsar, Kuala Lumpur, 59100 (MY).

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(54) **Title**: AN APPARATUS FOR MIXING FLUIDS, A METHOD OF MIXING THE FLUIDS USING THE APPARATUS AND A METHOD OF FABRICATING THE APPARATUS

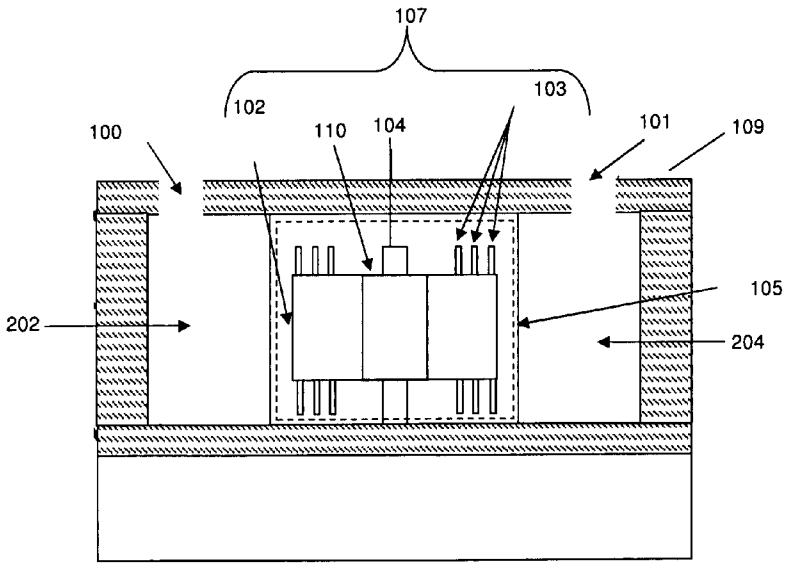

Figure 2

(57) **Abstract**: The present invention is an apparatus (109) for mixing fluids, methods for performing fluids mixing and also methods of fabricating the apparatus (109) for mixing fluids. The apparatus (109) breaks the streamlines and increase the diffusion rate of fluids during the mixing process to achieve improved mixing of fluids.

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AN APPARATUS FOR MIXING FLUIDS, A METHOD OF MIXING THE FLUIDS USING THE APPARATUS AND A METHOD OF FABRICATING THE APPARATUS

FIELD OF THE INVENTION

The present invention relates generally to an apparatus for mixing fluids, method for performing mixing of fluids and method of fabricating the apparatus.

BACKGROUND OF THE INVENTION

In most biological/chemical microanalyser systems, samples or reagents are generally in the form of fluid. In order to ensure successful completion or effectiveness of the biological/chemical reaction for a particular analyser system, a mixing device is essential. Most of the fluid flow is in the state of laminar which are steady and cannot mix naturally when comes into contact. Mixing of small volume of fluid flowing through narrow channels can be achieved by using a micromixer.

Micromixer is a necessary apparatus in a microfluidic system used in most biochemistry analysis, drug delivery, agriculture, environmental monitoring and sequencing or synthesis of nucleic acids. Generally, there are two types of micromixers, which are passive and active micromixers. Passive micromixers do not require external energy wherein the mixing process relies entirely on diffusion or chaotic advection. On the other hand, active micromixers use an external field for the mixing process. The structure of the active micromixer is more complicated due to the necessity of external power and the cost for building the mixer is also higher than building a passive micromixer.

There are continuous advances in the micromixer technology. However, there is still a need for efficient and reliable micromixer capable of enhancing the diffusion rate between the fluids for mixing purposes.

SUMMARY OF THE INVENTION

It is disclosed herein, an apparatus for mixing at least two fluids substantially homogenously, the apparatus includes:

1.1. a fluid entry point;

1.2. a mixing chamber housing a rotary gear wherein the rotary gear includes:

1.2.1. a shaft wherein the shaft rotates about a longitudinal centerline axis of the shaft;

1.2.2. a rotor attached to the shaft;

1.2.3. plurality of teeth attached to the rotor;

1.2.4. plurality of pillar attached to the plurality of teeth;

1.3. a fluid exit point;

wherein the at least two fluids flow simultaneously through the fluid entry point to the rotary gear provided in the mixing chamber;

wherein a force provided by the at least two moving fluids rotates the rotary gear;

wherein the plurality of pillar attached to the plurality of teeth breaks the streamlines of the at least two fluids and enhances the diffusion rate of the at least two fluids thus mixing the at least two fluids;

wherein a mixed fluid exits through the fluid exit point.

It is also disclosed herein, a method of mixing at least two fluids substantially homogenously by the apparatus mentioned above, the method including the steps of:

1.1. flowing of at least two fluids to the mixing chamber through the fluid entry point;

1.2. flowing of at least two fluids to the rotary gear;

1.3. rotating the plurality of teeth and the plurality of pillar attached to the plurality of teeth in circular motion by the force provided by the at least two moving fluids;

1.4. rotating the shaft and the rotor provided in the rotary gear in circular motion;

1.5. breaking the streamlines and enhancing the diffusion rate of the at least two fluids by the plurality of pillar attached to the plurality of teeth;

1.6. flowing of a substantially homogenously mixed fluid through the fluid exit point.

Also disclosed herein is a method of fabricating the apparatus as mentioned, the method including the steps of:

1.1. depositing a first insulating layer onto top side of a substrate;

1.2. depositing a first sacrificial oxide layer onto top of the insulating layer and patterning the sacrificial oxide layer;

1.3. depositing a second insulating layer and performing back etching;

1.4. depositing a second sacrificial oxide layer onto top of the first sacrificial oxide layer and patterning the second sacrificial oxide layer;

1.5. depositing and patterning a third insulating layer;

1.6. depositing and patterning a third sacrificial oxide layer;

1.7. depositing and patterning a fourth insulating layer;

1.8. depositing and patterning fourth sacrificial oxide layer;

1.9. depositing and patterning a fifth insulating layer;

1.10. performing sacrificial release of the first, second, third and fourth sacrificial oxide layers.

Also disclosed herein, an apparatus for mixing at least two fluids substantially homogenously, the apparatus includes:

1.1. at least one fluid entry point;

1.2. at least one mixing chamber wherein the at least one mixing chamber houses a rotary gear wherein the rotary gear includes:

1.2.1. a shaft wherein the shaft rotates about a longitudinal centerline axis of the shaft;

1.2.2. a rotor attached to the shaft;

1.2.3. plurality of teeth attached to the rotor;

1.2.4. plurality of pillar attached to the plurality of teeth;

1.3. at least one fluid exit point;

wherein at least two fluids flow through the designated fluid entry point to the designated mixing chamber and flows to the rotary gear included in the designated mixing chamber;

wherein a force provided by the at least two moving fluids rotates the rotary gear;

wherein the plurality of pillar attached to the plurality of teeth breaks the streamlines of the at least two fluids and enhances the diffusion rate of the at least two fluids thus mixing the at least two fluids;

wherein a substantially homogenously mixed fluid exits through the designated fluid exit point.

It is also disclosed herein, a method of mixing at least two fluids substantially homogenously by the apparatus mentioned above, the method including the steps of:

1.1. flowing of at least two fluids to the designated mixing chamber through the fluid entry point;

1.2. flowing of at least two fluids to the rotary gear provided in the designated mixing chamber;

1.3. rotating plurality of teeth and plurality of pillar attached to the plurality of teeth in circular motion by the force provided by the at least two moving fluids;

1.4. rotating the shaft and the rotor provided in the rotary gear in circular motion;

1.5. breaking the streamlines and enhancing the diffusion rate of the at least two fluids by the plurality of pillar attached to the plurality of teeth;

1.6. flowing of a substantially homogenously mixed fluid through the designated fluid exit point.

Also disclosed herein is a method of fabricating the apparatus as mentioned above, the method including the steps of:

1.1. depositing a first insulating layer onto top side of a substrate;

1.2. depositing a first sacrificial oxide layer onto top of the insulating layer and patterning the sacrificial oxide layer;

1.3. depositing a second insulating layer and performing back etching;

1.4. depositing a second sacrificial oxide layer onto top of the first sacrificial oxide layer and patterning the second sacrificial oxide layer;

1.5. depositing and patterning a third insulating layer;

1.6. depositing and patterning a third sacrificial oxide layer;

1.7. depositing and patterning a fourth insulating layer;

1.8. depositing and patterning fourth sacrificial oxide layer;

1.9. depositing and patterning a fifth insulating layer;

1.10. performing sacrificial release of the first, second, third and fourth sacrificial oxide layers.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates the top view of a preferred embodiment of the invention.

Figure 2 illustrates the A-A cross sectional view of a preferred embodiment of the invention.

Figure 3 (a) through (j) show stages in fabrication process of a preferred embodiment of the invention.

Figure 4 (a) through (d) illustrates different configurations of plurality of teeth of a rotary gear.

DETAILED DESCRIPTION OF THE INVENTION

The invention and its various embodiments are better understood by reading the description along with the accompanying drawings which appear herein for purpose of illustration only and do not limit the invention in any way.

Figure 1 illustrates the top view of an embodiment of the invention. The invention includes a fluid entry point (100) wherein at least two fluids flow to a rotary gear (107). Rotary gear (107) is inclusive of a shaft (104) which is capable of rotating about a longitudinally extending, centerline axis of the shaft (104). The rotary gear (107) also includes a rotor (110) that is fixedly connected and aligned to the shaft (104). When the shaft (104) rotates about its centreline axis, the rotor (110) also rotates about the shaft's (104) centreline axis. The rotary gear (107) also includes plurality of teeth (102) attached to the rotor (110) and plurality of pillar (103) attached to the plurality of teeth (102). The rotary gear (107) is placed in mixing chamber (105) wherein mixing process is performed. Fluid exits through the fluid exit point (101) after mixing process is done at the mixing chamber (105).

Figure 2 illustrates the A-A cross sectional view of a preferred embodiment of the invention. At least two fluids flow simultaneously through the fluid entry point (100). The at least two fluids flow to the mixing chamber (105) through a microfluidic channel (202). The mixing chamber (105) houses the rotary gear (107). Rotary gear (107) is inclusive of the shaft (104), a rotor (110), plurality of teeth (102) and plurality of pillar (103) attached

to the teeth (102). The at least two fluids comes in contact with the rotary gear (107) and the force provided by the at least two moving fluids causes the rotary gear (107) to move in a rotating motion. The movement creates a swirling force thus disturbing the flow of the at least two fluids. The swirling force may be clockwise or counter clockwise in direction. A chaotic and high turbulence stream of fluid flow is generated and the mixing of the at least two fluids is performed through diffusion. The plurality of pillar (103) attached to the teeth (102) breaks the streamlines of the at least two fluids and also enhances the diffusion rate of the at least two fluids during the mixing process. Once the mixing process is completed, a mixed fluid will flow through a microfluidic channel (204) and exits the microfluidic channel (204) through fluid exit point (101).

Referring to Figure 3 (a) through (j), there is shown stages in the fabrication process of a preferred embodiment of the invention, including the steps of:

a) depositing a first insulating layer (700) onto top side of a substrate (40);
b) depositing a first sacrificial oxide layer (701) onto top of the insulating layer (700) and patterning the sacrificial oxide layer (701);
c) depositing a second insulating layer (703) and performing back etching; Back etching is performed to planarize the layer;
d) depositing a second sacrificial oxide layer (704) onto top of the first sacrificial oxide layer (701) and patterning the second sacrificial oxide layer (704);
e) depositing and patterning a third insulating layer (705);
f) depositing and patterning a third sacrificial oxide layer (706);
g) depositing and patterning a fourth insulating layer (707);
h) depositing and patterning fourth sacrificial oxide layer (708);
i) depositing and patterning a fifth insulating layer (709);
j) performing sacrificial release of the first, second, third and fourth sacrificial oxide layers (701, 704, 706, 708).

The insulating layers (700, 703, 705, 707, 709) are made of silicon nitride (Si_3Ni_4) or polymide. The insulating layers (700, 703, 705, 707, 709) can also be made of other alternative compounds that are of insulator material and able to withstand or etches very slowly in hydrofluoric acid.

The substrate (40) is a silicon or glass or quartz substrate. The sacrificial oxide layers (701, 704, 706, 708) are made of phosphosilicate glass (PSG). These sacrificial oxide layers (701, 704, 706, 708) can also be made of silicon dioxide, spin on glass (SOG) and Tetraethly-orthosilicate (TEOS).

Figure 4 (a)-(d) illustrates different configuration of the plurality of teeth (102) of the rotary gear (107) with different arrangements of the plurality of pillar (103) attached to the teeth (102). Figure 4 (a) illustrates serpentine configuration of the teeth (102). Figure 4 (a) illustrates zig-zag configuration of the teeth (102). Curved zig-zag configuration of the teeth (102) is illustrated in Figure 4 (c) and Figure 4 (d) illustrates slanted configuration of the teeth (102).

While several particularly preferred embodiments of the present invention have been described and illustrated, it should now be apparent to those skilled in the art that various changes and modifications can be made without departing from the spirit and scope of the invention. Accordingly, the following claims are intended to embrace such changes, modifications, and areas of application that are within the spirit and scope of this invention.

CLAIMS

1. An apparatus (109) for mixing at least two fluids substantially homogenously, the apparatus (109) includes:
   1.1. a fluid entry point (100);
   1.2. a mixing chamber (105) housing a rotary gear (107) wherein the rotary gear (107) includes:
      1.2.1. a shaft (104) wherein the shaft (104) rotates about a longitudinal centerline axis of the shaft (104);
      1.2.2. a rotor (110) attached to the shaft (104);
      1.2.3. plurality of teeth (102) attached to the rotor (110);
      1.2.4. plurality of pillar (103) attached to the plurality of teeth (102);
   1.3. a fluid exit point (101);

wherein the at least two fluids flow simultaneously through the fluid entry point (100) to the rotary gear (107) provided in the mixing chamber (105);
wherein a force provided by the at least two moving fluids rotates the rotary gear (107);
wherein the plurality of pillar (103) attached to the plurality of teeth (102) breaks the streamlines of the at least two fluids and enhances the diffusion rate of the at least two fluids thus mixing the at least two fluids;
wherein a mixed fluid exits through the fluid exit point (101).

2. A method of mixing at least two fluids substantially homogenously by the apparatus (109) as claimed in claim 1, the method including the steps of:
   2.1. flowing of at least two fluids to the mixing chamber (105) through the fluid entry point (100);
   2.2. flowing of at least two fluids to the rotary gear (107);
   2.3. rotating the plurality of teeth (102) and the plurality of pillar (103) attached to the plurality of teeth (102) in circular motion by the force provided by the at least two moving fluids;
   2.4. rotating the shaft (104) and the rotor (110) provided in the rotary gear (107) in circular motion;
   2.5. breaking the streamlines and enhancing the diffusion rate of the at least two fluids by the plurality of pillar (103) attached to the plurality of teeth (102);

2.6. flowing of a substantially homogenously mixed fluid through the fluid exit point (101).

3. A method of fabricating an apparatus (109) as claimed in claim 1, the method including the steps of:
   3.1. depositing a first insulating layer (700) onto top side of a substrate (40);
   3.2. depositing a first sacrificial oxide layer (701) onto top of the insulating layer (700) and patterning the sacrificial oxide layer (701);
   3.3. depositing a second insulating layer (703) and performing back etching;
   3.4. depositing a second sacrificial oxide layer (704) onto top of the first sacrificial oxide layer (701) and patterning the second sacrificial oxide layer (704);
   3.5. depositing and patterning a third insulating layer (705);
   3.6. depositing and patterning a third sacrificial oxide layer (706);
   3.7. depositing and patterning a fourth insulating layer (707);
   3.8. depositing and patterning fourth sacrificial oxide layer (708);
   3.9. depositing and patterning a fifth insulating layer (709);
   3.10. performing sacrificial release of the first, second, third and fourth sacrificial oxide layers (701, 704, 706, 708).

4. An apparatus (109) for mixing at least two fluids substantially homogenously, the apparatus (109) includes:
   4.1. at least one fluid entry point (100);
   4.2. at least one mixing chamber (105) wherein the at least one mixing chamber (105) houses a rotary gear (107) wherein the rotary gear (107) includes:
      4.2.1. a shaft (104) wherein the shaft (104) rotates about a longitudinal centerline axis of the shaft (104);
      4.2.2. a rotor (110) attached to the shaft (104);
      4.2.3. plurality of teeth (102) attached to the rotor (110);
      4.2.4. plurality of pillar (103) attached to the plurality of teeth (102);
   4.3. at least one fluid exit point (101);

wherein at least two fluids flow through the designated fluid entry point (100) to the designated mixing chamber (105) and flows to the rotary gear (107) included in the designated mixing chamber (105);

wherein a force provided by the at least two moving fluids rotates the rotary gear (107);
wherein the plurality of pillar (103) attached to the plurality of teeth (102) breaks the streamlines of the at least two fluids and enhances the diffusion rate of the at least two fluids thus mixing the at least two fluids;
wherein a substantially homogenously mixed fluid exits through the designated fluid exit point (101).

5. A method of mixing at least two fluids substantially homogenously by the apparatus (109) as claimed in claim 4, the method including the steps of:
5.1. flowing of at least two fluids to the designated mixing chamber (105) through the fluid entry point (100);
5.2. flowing of at least two fluids to the rotary gear (107) provided in the designated mixing chamber (105);
5.3. rotating plurality of teeth (102) and plurality of pillar (103) attached to the plurality of teeth (102) in circular motion by the force provided by the at least two moving fluids;
5.4. rotating the shaft (104) and the rotor (110) provided in the rotary gear (107) in circular motion;
5.5. breaking the streamlines and enhancing the diffusion rate of the at least two fluids by the plurality of pillar (103) attached to the plurality of teeth (102);
5.6. flowing of a substantially homogenously mixed fluid through the designated fluid exit point (101).

6. A method of fabricating an apparatus as claimed in claim 5, the method including the steps of:
6.1. depositing a first insulating layer (700) onto top side of a substrate (40);
6.2. depositing a first sacrificial oxide layer (701) onto top of the insulating layer (700) and patterning the sacrificial oxide layer (701);
6.3. depositing a second insulating layer (703) and performing back etching;
6.4. depositing a second sacrificial oxide layer (704) onto top of the first sacrificial oxide layer (701) and patterning the second sacrificial oxide layer (704);
6.5. depositing and patterning a third insulating layer (705);
6.6. depositing and patterning a third sacrificial oxide layer (706);
6.7. depositing and patterning a fourth insulating layer (707);

6.8. depositing and patterning fourth sacrificial oxide layer (708);

6.9. depositing and patterning a fifth insulating layer (709);

6.10. performing sacrificial release of the first, second, third and fourth sacrificial oxide layers (701, 704, 706, 708).

7. The method as claimed in claim 3 and claim 6 wherein the substrate (40) is a silicon or glass or quartz substrate.

8. The method as claimed in claim 3 and claim 6 wherein the first, second, third, fourth and fifth insulation layers (700, 703, 705, 707, 709) are silicon nitride (Si_3Ni_4) or polymide layers.

9. The method as claimed in claim 3 and claim 6 wherein the first, second, third and fourth sacrificial oxide layers (701, 704, 706, 708) are phosphosilicate glass (PSG) layers or silicon dioxide or spin on glass (SOG) or Tetraethly-orthosilicate (TEOS) layers.

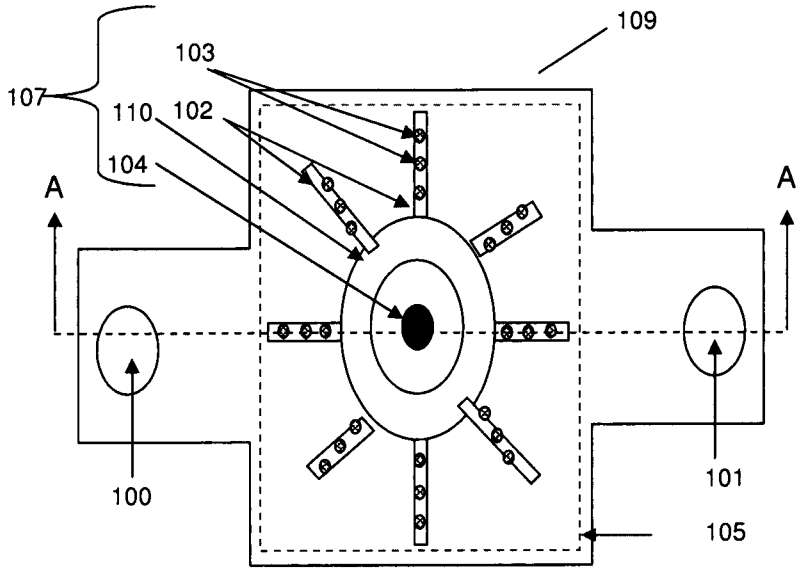


Figure 1

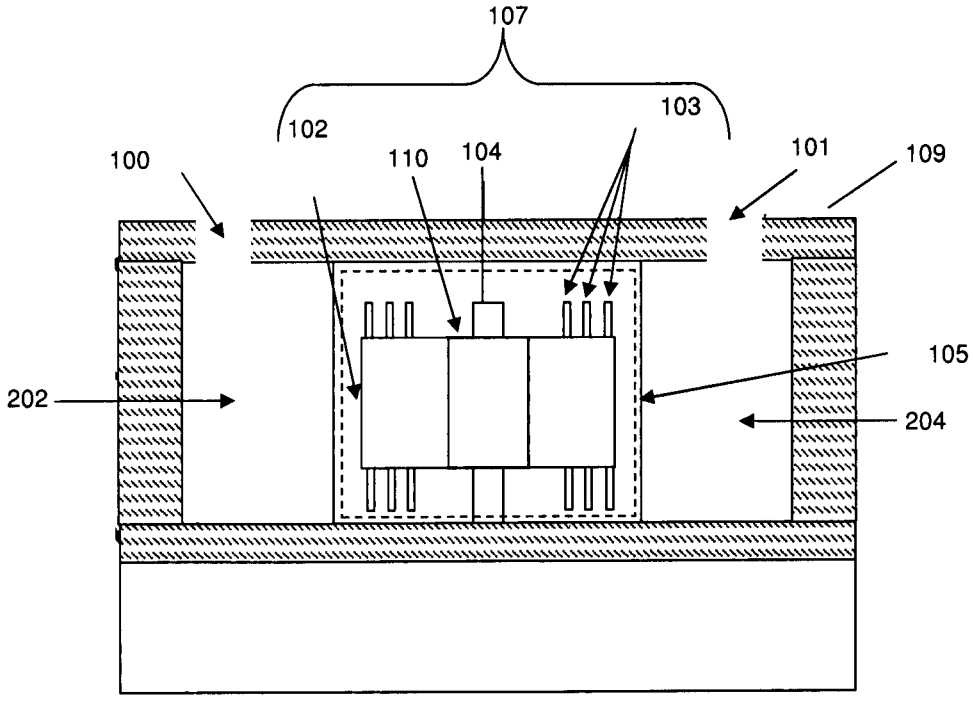
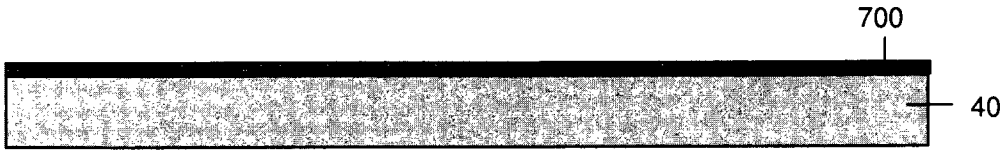
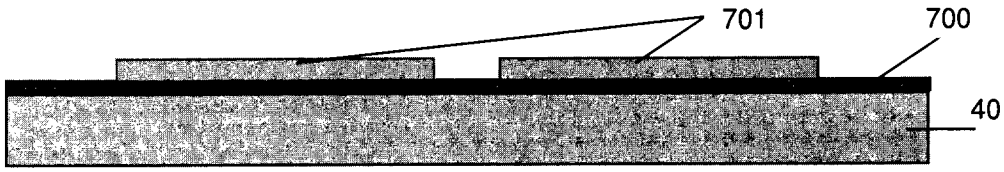


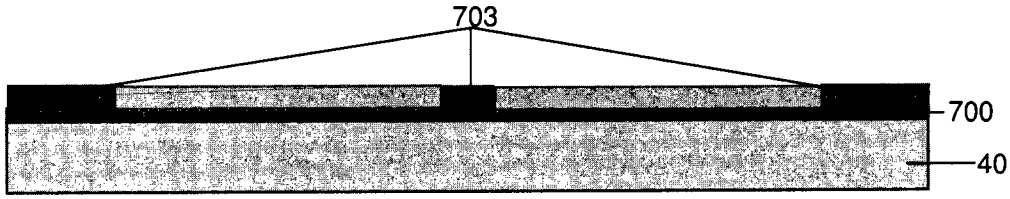
Figure 2


700
40

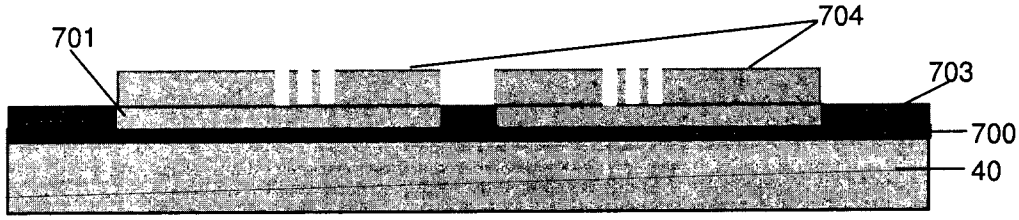
a)


701
700
40

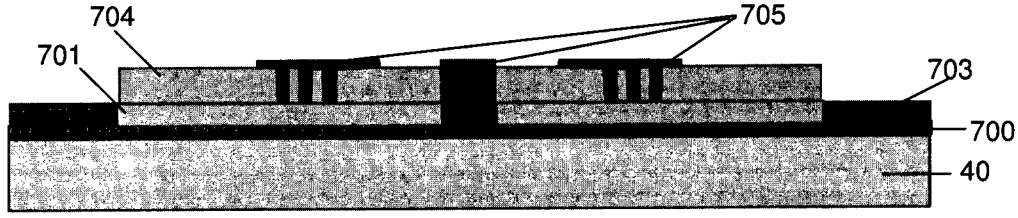
b)


703
700
40

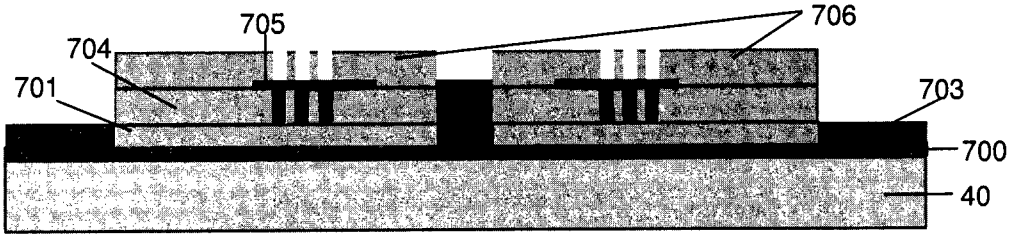
c)


704
701
703
700
40

d)


704
705
701
703
700
40

e)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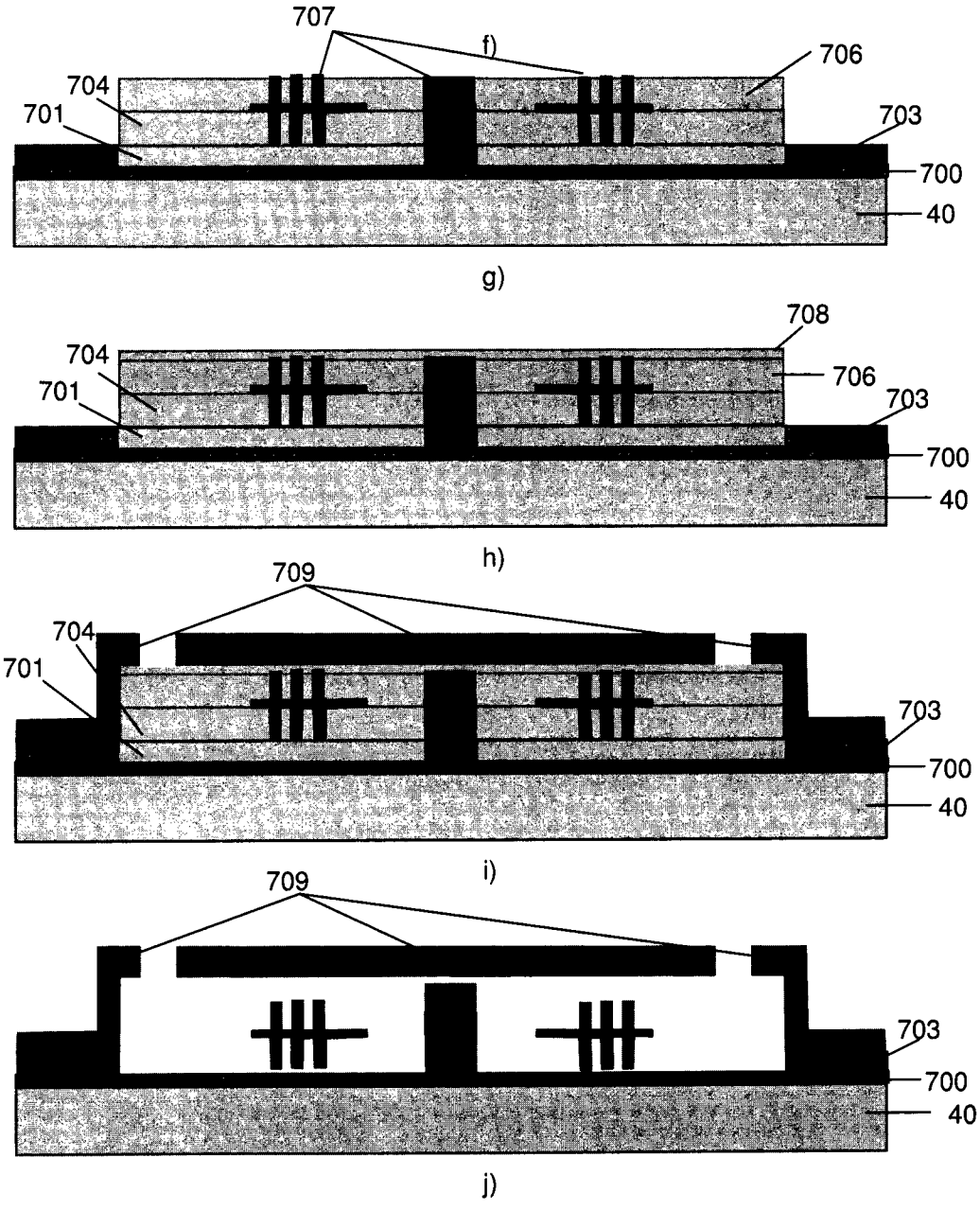
707
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i)
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703
700
40
j)

Figure 3

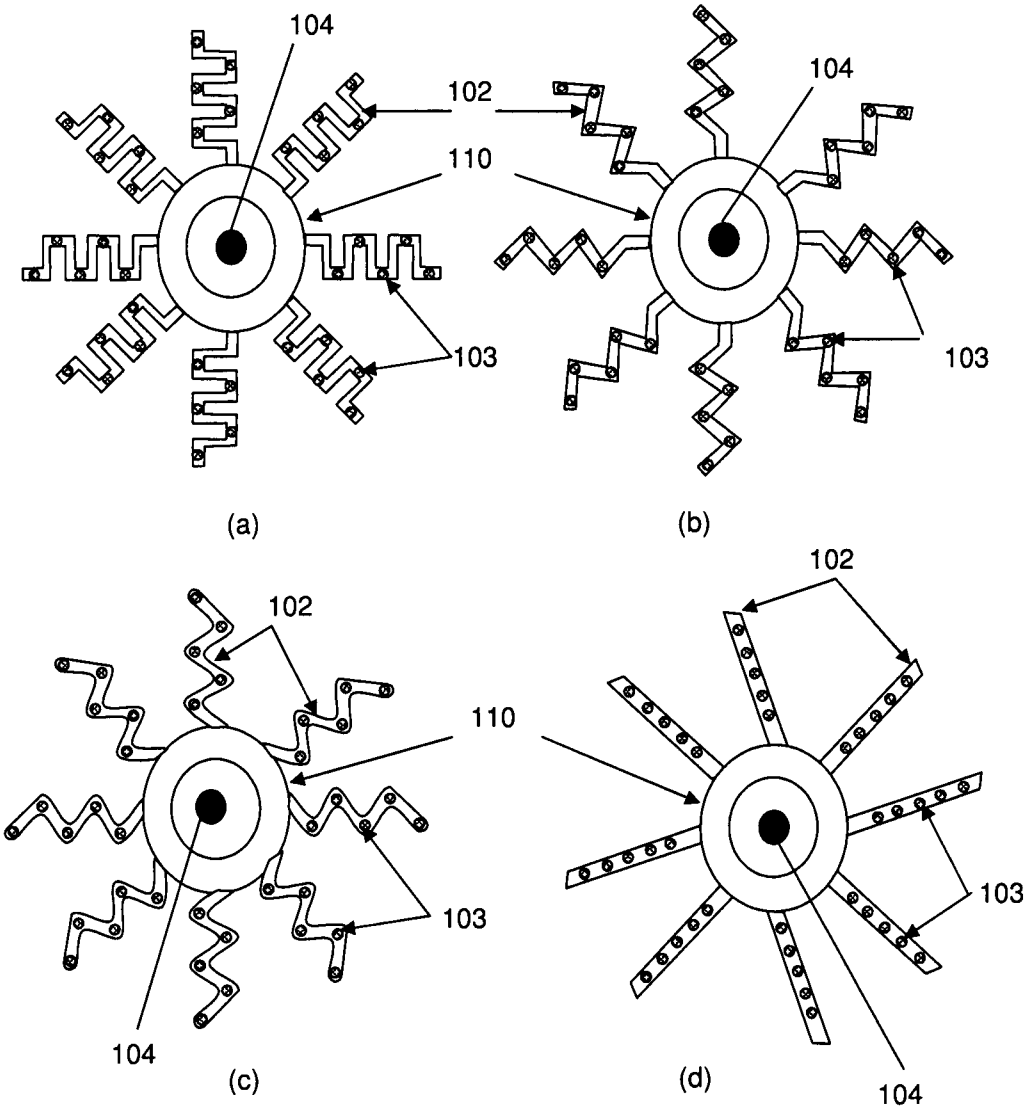

Figure 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2012/000029

A. CLASSIFICATION OF SUBJECT MATTER

B01F 3/08 (OCT 2005) B01F 7/20 (OCT 2005)

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)

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)
Databases-
WPI, EPODOC: IPC Marks- B01F3/LOW, B01F7/LOW with Key Words- TEETH, TOOTH+, GEAR?, COG?, +WHEEL?, PILLAR?, COLUMN?, PROTRU+, STEM+, STUD+, BREAK+, BROKE+, DISPERSE+, DIFFUS+, ROTAT+, ROTAR+, REVOLV+, GYRATOR+
GOOGLE PATENTS: Word Search 1- fluid, mixing, apparatus, gear, pillar; Word Search 2- micromixer, microfluid, rotor

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

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Date of the actual completion of the international search	Date of mailing of the international search report
25 June 2012	27 June 2012

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PO BOX 200, WODEN ACT 2606, AUSTRALIA
Email address: pct@ipaustralia.gov.au
Facsimile No.: +61 2 6283 7999

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AUSTRALIAN PATENT OFFICE
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Telephone No. 0262837948

INTERNATIONAL SEARCH REPORT

International application No.
PCT/MY2012/000029

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1, 2, 4, 5

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	**PCT/MY2012/000029**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/0237854 A1 (NAVARRO et al.) 27 October 2005 Abstract; figs 1-5	1, 2, 4, 5
A	US 4814376 A (TANAKA et al.) 21 March 1989 Abstract; figs 1-3	1, 2, 4, 5
A	US 2004/0124296 A (LIU et al.) 01 July 2004 Abstract; figs 1, 2	1, 2, 4, 5
A	US 6105822 A (LARSEN et al.) 22 August 2000 Abstract; fig 1	1, 2, 4, 5

Supplemental Box

Continuation of: **Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1, 2, 4, 5 are directed an apparatus and a method for mixing at least two fluids substantially homogenously, the apparatus including: a fluid entry point; a mixing chamber housing a rotary gear, said rotary gear including a shaft that rotates about a longitudinal centerline axis; a rotor attached to the shaft; a plurality of teeth attached to the rotor; a plurality of pillars attached to the plurality of teeth and a fluid exit point. It is considered that the plurality of pillars attached to the plurality of teeth comprises a first distinguishing feature.

- Claims 3, 6-9 are directed to a method of fabricating a mixing apparatus by depositing and patterning multiple alternate layers of insulating and sacrificial oxide layers onto a top side of a substrate. It is considered that the method including the steps of depositing a first insulating layer onto top side of a substrate; depositing a first sacrificial oxide layer onto top of the insulating layer and patterning the sacrificial oxide layer; depositing a second insulating layer and performing back etching; depositing a second sacrificial oxide layer onto top of the first sacrificial oxide layer and patterning the second sacrificial oxide layer; depositing and patterning a third insulating layer; depositing and patterning a third sacrificial oxide layer; depositing and patterning a fourth insulating layer; depositing and patterning fourth sacrificial oxide layer; depositing and patterning a fifth insulating layer; performing sacrificial release of the first, second, third and the fourth sacrificial oxide layers comprises a second distinguishing feature.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.□

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims 1, 2, 4, 5 and claims 3, 6-9 the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied a *priori*.

INTERNATIONAL SEARCH REPORT	International application No. PCT/MY2012/000029

Supplemental Box

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/MY2012/000029**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 2005/0237854 A1	27 Oct 2005	AU 2003260568 A1	22 Dec 2003
		CA 2489088 A1	18 Dec 2003
		CN 1658958 A	24 Aug 2005
		EP 1513605 A1	16 Mar 2005
		FR 2840546 A1	12 Dec 2003
		FR 2840546 B1	25 Feb 2005
		JP 2005528978 A	29 Sep 2005
		US 2005237854 A1	27 Oct 2005
		US 7287899 B2	30 Oct 2007
		WO 03103818 A1	18 Dec 2003
US 4814376 A	21 Mar 1989	JP 63125530 A	28 May 1988
		JP 5082851 B	22 Nov 1993
		KR 940000201 B1	12 Jan 1994
		US 4814376 A	21 Mar 1989
US 2004/0124296 A	01 Jul 2004	None	
US 6105822 A	22 Aug 2000	AU 3611600 A	10 Apr 2001
		EP 1210291 A1	05 Jun 2002
		US 6105822 A	22 Aug 2000
		WO 0117894 A1	15 Mar 2001

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.