

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY



(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference UWOTL129683	<b>FOR FURTHER ACTION</b>	See Form PCT/IPEA/416
International application No. <b>PCT/US2007/072038</b>	International filing date( <i>day/month/year</i> ) <b>25 MAY 2007 (25.05.2007)</b>	Priority date ( <i>day/month/year</i> ) 23 JUNE 2006 (23.06.2006)
International Patent Classification (IPC) or national classification and IPC  <b>H05K 1/18(2006.01)i, H05K 3/30(2006.01)i</b>		
Applicant  <b>UNIVERSITY OF WASHINGTON et al</b>		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
- a.  (sent to the applicant and to the International Bureau) a total of 4 sheets, as follows:
- sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
- sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
- b.  (*sent to the International Bureau only*) a total of (indicate type and number of electronic carrier(s)) \_\_\_\_\_ containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:
- Box No. I Basis of the report
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application

Date of submission of the demand  <b>21 APRIL 2008 (21.04.2008)</b>	Date of completion of this report  29 AUGUST 2008 (29.08.2008)
Name and mailing address of the IPEA/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, Jong Hee  Telephone No. 82-42-481-8500 

**Box No. I Basis of the report**

1. With regard to the **language**, this report is based on:

- the international application in the language in which it was filed.
- a translation of the international application into \_\_\_\_\_ which is the language of a translation furnished for the purposes of:
- international search (under Rules 12.3(a) and 23.1(b)).
- publication of the international application (under Rule 12.4(a)).
- international preliminary examination (under Rules 55.2(a) and/or 55.3(a)).

2. With regard to the **elements** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

- the international application as originally filed/furnished
- the description:  
 pages 1-14 \_\_\_\_\_ as originally filed/furnished  
 pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_  
 pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_
- the claims:  
 pages \_\_\_\_\_ as originally filed/furnished  
 pages\* \_\_\_\_\_ as amended (together with any statement) under Article 19  
 pages\* 15-18 \_\_\_\_\_ received by this Authority on 21/04/2008  
 pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_
- the drawings:  
 pages 1/5-5/5 \_\_\_\_\_ as originally filed/furnished  
 pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_  
 pages\* \_\_\_\_\_ received by this Authority on \_\_\_\_\_
- the sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3.  The amendments have resulted in the cancellation of:

- the description, pages \_\_\_\_\_
- the claims, Nos. \_\_\_\_\_
- the drawings, sheets \_\_\_\_\_
- the sequence listing (*specify*): \_\_\_\_\_
- any table(s) related to sequence listing (*specify*): \_\_\_\_\_

4.  This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- the description, pages \_\_\_\_\_
- the claims, Nos. \_\_\_\_\_
- the drawings, sheets \_\_\_\_\_
- the sequence listing (*specify*): \_\_\_\_\_
- any table(s) related to sequence listing (*specify*): \_\_\_\_\_

5.  This report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 70.2(e)).

\* If item 4 applies, some or all of those sheets may be marked "superseded."

**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

## 1. Statement

Novelty (N)	Claims	<u>1-31</u>	YES
	Claims	<u>None</u>	NO
Inventive step (IS)	Claims	<u>1-31</u>	YES
	Claims	<u>None</u>	NO
Industrial applicability (IA)	Claims	<u>1-31</u>	YES
	Claims	<u>None</u>	NO

## 2. Citations and explanations (Rule 70.7)

**1. PRIOR ARTS**

Reference is made to the following documents:

D1: US 5,824,186 A (John Stephen Smith et al.) 20 October 1998

D2: US 7,007,370 B2 (David H. Gracias et al.) 07 March 2006

D1 relates to a method and apparatus for assembling microstructures onto a substrate through fluid transport.

D2 relates to a technique for self assembly of macro-scale objects, optionally defining electrical circuitry as well as articles formed by self assembly.

**2. Novelty and Inventive Step****2.1 Novelty**

Amended claims 1-20 provide a method for assembling a plurality of microcomponents onto a template. The method comprises the steps of: fabricating a template, immersing the template in a heated liquid, placing at least some of the plurality of microcomponents into the heated liquid, and cooling an alloy, which are not described in documents D1 and D2.

Amended claims 21-31 provide a method of assembling a plurality of micro-components onto a template. The method comprises the steps of: fabricating a template, immersing the template in liquid, placing the first micro-components into the liquid, heating the liquid, and cooling the template. However, these steps are not described in documents D1 and D2.

Therefore, the subject matter of amended claims 1-31 is considered to be novel under PCT Article 33(2).

**2.2 Inventive Step**

Claims 1 and 21 involve the template having an interconnect network interconnecting a plurality of binding sites. However, neither of the documents nor any combination of documents teaches or fairly suggests the interconnect network. Furthermore, the technical feature of the above interconnect network is not obvious to a person skilled in the art. Therefore, amended claims 1 and 21 are considered to involve an inventive step under PCT Article 33(3).

(Continued on the Supplemental Box)

**Supplemental Box**

In case the space in any of the preceding boxes is not sufficient.

Continuation of:

**Box No. V**

Amended claims 2-20 and 22-31 are dependent on amended claims 1 and 21, respectively, and are also considered to involve an inventive step.

Therefore, the amended claims 1-31 can be regarded as involving an inventive step under PCT Article 33(3).

**C. Industrial Applicability**

The invention including the amended claims 1-31 is considered to be industrial applicable under PCT Article 33(4).

## CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method for assembling a plurality of microcomponents onto a template, the method comprising the steps of:

fabricating a plurality of microcomponents of more than one type, wherein each type of microcomponent has a distinct shape, and further wherein each of the microcomponents have metal pads;

fabricating a template having a plurality of recessed binding sites wherein each binding site is shaped to correspond to one of the types of microcomponents, the template having an embedded interconnect network interconnecting the plurality of binding sites, and wherein each of the binding sites includes an alloy having a low melting temperature;

immersing the template in a heated liquid that is hotter than the alloy melting temperature;

placing at least some of the plurality of microcomponents into the heated liquid such that at least some of the microcomponents are received into the plurality of recessed binding sites with their metal pads engaging the alloy; and

cooling the alloy thereby connecting the received microcomponents to the embedded interconnect network.

2. The method of Claim 1, wherein the plurality of microcomponents include transistors.

3. The method of Claim 2, wherein the transistors are fabricated with silicon nitride used both as a diffusion mask and as a gate dielectric layer.

4. The method of Claim 1, wherein the distinct shapes of the microcomponents include one or more shapes from the group comprising circular, square, rectangular, triangular, and cruciform.

5. The method of Claim 1, wherein the metal pads are formed on only one side of the microcomponents.

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6. The method of Claim 1, wherein the microcomponents are formed on a silicon-on-insulator wafer and released from the wafer using an acid bath to produce freestanding microcomponents.
7. The method of Claim 1, wherein the template includes a substrate formed from a material selected from the group polyester and polyethylene terephthalate.
8. The method of Claim 7, wherein binding sites are formed on the substrate with an epoxy-based clear negative photoresist.
9. The method of Claim 7, wherein the alloy melting temperature is less than about 80°C.
10. The method of Claim 7, wherein the alloy is applied to the template using a dip-coating technique.
11. The method of Claim 1, wherein the heated liquid comprises a liquid selected from the group ethylene glycol and glycerol.
12. The method of Claim 11, wherein the liquid is heated to about 70°C.
13. The method of Claim 1, further comprising the steps of cleaning the microcomponents with a short piranha etch and rinsing the microcomponents with de-ionized water prior to placing the microcomponents in the heated liquid.
14. The method of Claim 1, wherein the step of immersing the template in the heated liquid includes orienting the template at an angle of approximately 20 to 60 degrees with respect to horizontal.
15. The method of Claim 1, further comprising the step of fluid-dynamically urging the microcomponents to flow past the binding sites.
16. The method of Claim 15, further comprising the step of recirculating a portion of the microcomponents after they have flowed past the binding sites.
17. The method of Claim 1, further comprising the step of agitating the heated liquid.

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18. The method of Claim 1, further comprising the step of lowering the heated liquid temperature to solidify the alloy.

19. The method of Claim 1, wherein the step of placing at least some of the plurality of microcomponents into the heated liquid is accomplished in several steps wherein a first type of the plurality of microcomponents is first placed into the heated liquid and then a second type of the plurality of microcomponents is subsequently placed into the heated liquid.

20. The method of Claim 1, wherein the plurality of microcomponents comprise one or more of electronic microcomponents, optoelectronic microcomponents, and micromechanical microcomponents.

21. A method of assembling a plurality of microcomponents onto a template comprising the steps of:

fabricating a plurality of first microcomponents having a first shape and a metal pad interconnect;

fabricating a template with a plurality of recessed binding sites shaped to receive the first microcomponents, the binding sites being electrically connected with an embedded interconnect network, and further comprising a low melting temperature alloy;

immersing the template in a liquid;

placing the first microcomponents into the liquid such that at least some of the first microcomponents are received into at least some of the recessed binding sites such that the received microcomponent metal pad interconnects engage the low melting temperature alloy;

heating the liquid to a temperature greater than the melting temperature of the low melting temperature alloy; and

cooling the template such that the low melting temperature alloy solidifies.

22. The method of Claim 21, wherein the step of heating the liquid occurs after the first microcomponents have been received into the recessed binding sites.

23. The method of Claim 21, wherein the distinct shapes of the microcomponents include one or more shapes from the group comprising circular, square, rectangular, triangular, and cruciform.

24. The method of Claim 21, wherein the metal pad interconnects are formed on only one side of the first microcomponents.

25. The method of Claim 21, further comprising the steps of:  
fabricating a plurality of second microcomponents having a second shape and a metal pad interconnect;

fabricating the template to also include a plurality of recessed binding sites shaped to receive the second microcomponents, the binding sites being electrically connected with an interconnect network, and further comprising a low melting temperature alloy;  
and

placing the second microcomponents into the liquid such that at least some of the second microcomponents are received into at least some of the recessed binding sites such that the received second microcomponent metal pad interconnects engage the low melting temperature alloy.

26. The method of Claim 21, wherein the template includes a substrate formed from one of polyester and polyethylene terephthalate, and an epoxy-based clear negative photoresist.

27. The method of Claim 21, wherein the heated liquid is selected from the group ethylene glycol and glycerol.

28. The method of Claim 27, wherein the ethylene liquid is heated to about 70°C.

29. The method of Claim 21, further comprising the steps of cleaning the microcomponents with a short piranha etch and rinsing the microcomponents with de-ionized water prior to placing the microcomponents in the liquid.

30. The method of Claim 21, further comprising the step of recirculating a portion of the first microcomponents.

31. The method of Claim 21, further comprising the step of agitating the heated liquid.

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