

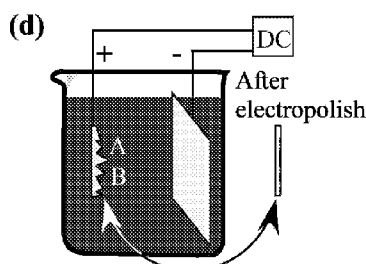
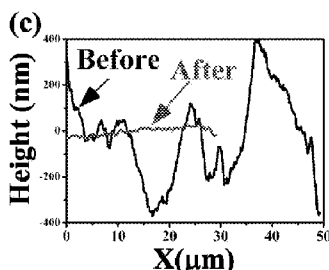
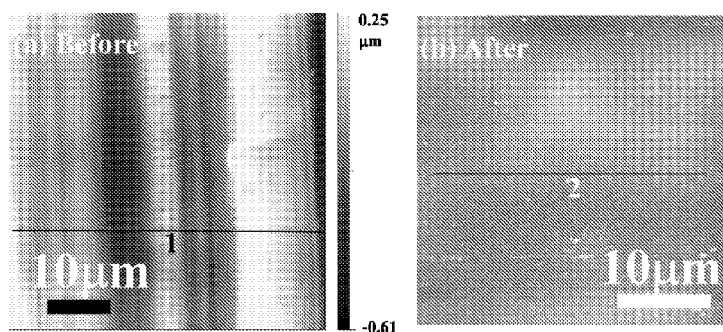


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[Continued on next page]

(54) Title: LARGE-SCALE GRAPHENE SHEET: ARTICLES, COMPOSITIONS, METHODS AND DEVICES INCORPORATING SAME

(57) Abstract: Provided are methods for growing large-size, uniform graphene layers on planarized substrates using Chemical Vapor Deposition (CVD) at atmospheric pressure; graphene produced according to these methods may have a single layer content exceeding 95%. Field effect transistors fabricated by the inventive process have room temperature hole mobilities that are a factor of 2-5 larger than those measured for samples grown on commercially-available copper foil substrates.



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9 August 2012

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(8) - C01B 31/00 (2012.01) USPC - 428/689; 423/445R According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC(8)- C01B 31/00 (2012.01); USPC- 428/689; 423/445R Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Patents and NPL (classification, keyword; search terms below) Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PubWest (US Pat, PgPub, EPO, JPO), GoogleScholar (PL, NPL), FreePatentsOnline (US Pat, PgPub, EPO, JPO, WIPO, NPL); search terms: graphene, grow, deposit, sheet, layer, film, planarize, substrate, surface, structure, layer, mechanical, chemical, polish, electropolish, copper, Cu		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/0051897 A1 (CHEN et al.) 04 March 2010 (04.03.2010), Figs. 1C, 1D; para [0007], [0018], [0019], [0021], [0023], [0024], [0026], [0032], [0036]	1, 2, 5, 22-24, 27
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Y		3, 4, 6-21, 25, 26
Y	US 2010/0021708 A1 (KONG et al.) 28 January 2010 (28.01.2010), para [0023], [0031], [0032], [0048]	3, 4, 6-21, 25, 26
Y, P	US 2010/0224851 A1 (COLOMBO et al.) 09 September 2010 (09.04.2010), para [0007]-[0010], [0017]-[0040]	3, 4, 6-21, 25, 26
Y	US 2010/0127312 A1 (GREBEL et al.) 27 May 2010 (27.05.2010), para [0023]-[0083]	3, 4, 6-21, 25, 26
Y	US 2009/0140801 A1 (OZYILMAZ et al.) 04 June 2009 (04.06.2009), para [0074]-[0110]	3, 4, 6-21, 25, 26
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/>		
* Special categories of cited documents:		
"A"	document defining the general state of the art which is not considered to be of particular relevance	"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
"E"	earlier application or patent but published on or after the international filing date	"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
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"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
"O"	document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed	
Date of the actual completion of the international search 01 February 2012 (01.02.2012)		Date of mailing of the international search report <b>23 FEB 2012</b>
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201		Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

**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:

-- Please see Extra Sheet --

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.:

1-27

**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.

Box No. III, Observations where unity of invention is lacking:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: claims 1-27 directed to a method of fabricating graphenic material, comprising:  
growing a sheet of graphene atop a planarized metallic substrate.

Group II: claims 28-42 directed to a composition, comprising:  
a graphene sheet comprising at least about 80% single-layer graphene.

Group III: claims 43-60 directed to a substrate-supported graphene layer, comprising:  
graphene comprising at least about 80% single-layer graphene, wherein the graphene layer is disposed directly adjacent to a substrate.

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because under PCT Rule 13.2 they lack the same or corresponding technical features for the following reasons:

Group I does not include the single-layer graphene of groups II and III.

Group II does not include the substrate of groups I and III.

Group II and III do not include the metal substrate of group I.

The common feature of groups I and III of graphene on a substrate is taught by US 2010/0021708 A1 to Kong et al. (para [0041]).  
The common feature of a graphene comprising at least 80% single-layer graphene of groups II and III is taught by US 2009/0140801 A1 to Ozyilmaz et al. (Abstract; para [0009]; [0019]; [0028]; 'substantially single layer graphene layer'); therefore the common feature is not an improvement over the prior art.

None of these technical features are common to the other groups, nor do they correspond to a special technical feature in the other groups. Therefore, unity of invention is lacking.