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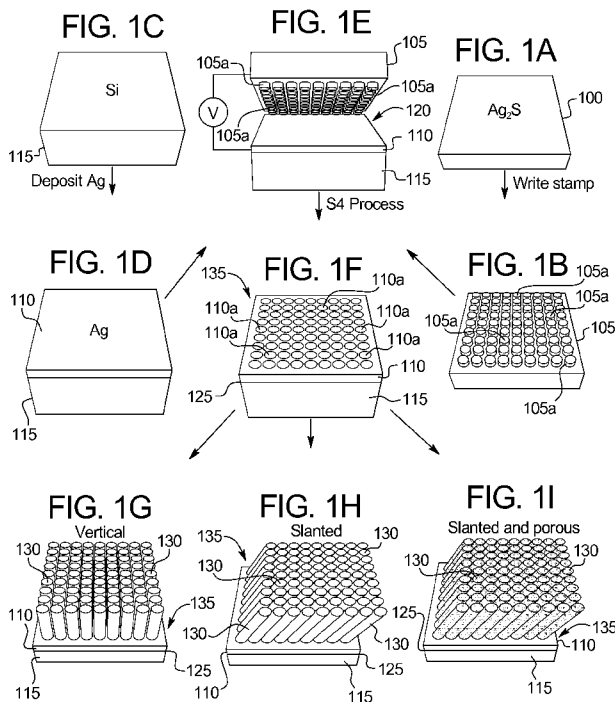
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[Continued on next page]

(54) Title: METHOD OF FORMING AN ARRAY OF HIGH ASPECT RATIO SEMICONDUCTOR NANOSTRUCTURES



(57) Abstract: A new method for forming an array of high aspect ratio semiconductor nanostructures entails positioning a surface of a stamp comprising a solid electrolyte in opposition to a conductive film disposed on a semiconductor substrate. The surface of the stamp includes a pattern of relief features in contact with the conductive film so as to define a film-stamp interface. A flux of metal ions is generated across the film-stamp interface, and a pattern of recessed features complementary to the pattern of relief features is created in the conductive film. The recessed features extend through an entire thickness of the conductive film to expose the underlying semiconductor substrate and define a conductive pattern on the substrate. The stamp is removed, and material immediately below the conductive pattern is selectively removed from the substrate. Features are formed in the semiconductor substrate having a length-to-width aspect ratio of at least about 5: 1.

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LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,  
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## INTERNATIONAL SEARCH REPORT

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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)

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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

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) &amp; Keywords: high aspect ratio, semiconductor, nanostructure, nanowire, stamp, electrochemical stamping process, metal-assisted chemical etching process, etchant

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005-0191419 A1 (JAMES HELT) 01 September 2005 See abstract and [0062]-[0081]	1-20
A	US 2006-0009003 A1 (ROMANO et al.) 12 January 2006 See [0064]-[0073]	1-20
A	KR 10-2007-0093461 A (PRESIDENT & FELLOWS OF HARVARD COLLEGE) 18 September 2007 See [0066], [0092]-[0118], and [0240]-[0251]	1-20
A	WO 2006-078281 A2 (NANOSYS, INC. et al.) 27 July 2006 See [00074]-[00080]	1-20
A	US 6790785 B1 (LI; XIULING et al.) 14 September 2004 See abstract and claims 1-21	1-20

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

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Date of the actual completion of the international search

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005-0191419 A1	01.09.2005	None	
US 2006-0009003 A1	12.01.2006	US 7344961 B2	18.03.2008
KR 10-2007-0093461 A	18.09.2007	EP 1736760 A2	27.12.2006
		EP 1736760 A3	18.06.2008
		JP 2004-507104 A	04.03.2004
		JP 2004-515782 A	27.05.2004
		JP 2004-535066 A	18.11.2004
		JP 2008-249705 A	16.10.2008
		JP 2008-300848 A	11.12.2008
		JP 2009-042232 A	26.02.2009
		JP 4583710 B2	10.09.2010
		KR 10-0791732 B1	04.01.2008
		KR 10-0984585 B1	30.09.2010
		KR 10-0995457 B1	18.11.2010
		KR 10-2009-0049095 A	15.05.2009
		US 2002-0130311 A1	19.09.2002
		US 2003-0089899 A1	15.05.2003
		US 2005-0164432 A1	28.07.2005
		US 2006-0175601 A1	10.08.2006
		US 2007-0026645 A1	01.02.2007
		US 2007-0032023 A1	08.02.2007
		US 2007-0032051 A1	08.02.2007
		US 2007-0032052 A1	08.02.2007
		US 7211464 B2	01.05.2007
		US 7301199 B2	27.11.2007
		US 7476596 B2	13.01.2009
		US 7595260 B2	29.09.2009
		US 7666708 B2	23.02.2010
		WO 02-17362 A2	28.02.2002
		WO 03-005450 A2	16.01.2003
		WO 2004-038767 A2	06.05.2004
		WO 2004-038767 A3	06.05.2004
WO 2006-078281 A2	27.07.2006	AU 2005-325265 A1	27.07.2006
		CA 2572798 A1	27.07.2006
		CN 101124659 A0	13.02.2008
		EP 1769530 A2	04.04.2007
		JP 2008-506254 A	28.02.2008
		KR 10-2007-0032360 A	21.03.2007
		WO 2006-016914 A3	16.02.2006
		WO 2006-078281 A3	27.07.2006
US 6790785 B1	14.09.2004	AU 2001-89109 A1	26.03.2002
		WO 02-23607 A1	21.03.2002