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Tricard

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(54) **PHOTO-MASKS FOR LITHOGRAPHY**

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G03F 1/48	(2012.01)
G03F 1/46	(2012.01)
G03F 1/76	(2012.01)
H05G 2/00	(2006.01)
G21K 1/06	(2006.01)

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CPC .. ***G03F 1/22*** (2013.01); ***G03F 1/46*** (2013.01); ***G03F 1/48*** (2013.01); ***G03F 1/76*** (2013.01); ***G21K 1/062*** (2013.01); ***H05G 2/001*** (2013.01); *G21K 2201/067* (2013.01)

(58) **Field of Classification Search**

CPC B82Y 10/00; B82Y 40/00; G03F 1/24; G03F 1/60; G03F 1/46; G03F 1/76; G02B 5/10

USPC 250/492.22; 430/5; 359/359, 361, 838; 427/160

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,670,205	A	6/1987	Montierth	
6,300,018	B1 *	10/2001	Dilley	G03F 1/42 430/22
6,375,551	B1	4/2002	Darcangelo et al.	
7,064,808	B1 *	6/2006	Gilissen	G03F 7/70716 355/72
7,129,010	B2 *	10/2006	Alkemper	B82Y 10/00 428/428
8,242,039	B2	8/2012	Sugawara	
8,736,810	B2 *	5/2014	Wilklow	B82Y 10/00 355/53
8,870,396	B2 *	10/2014	Kaller	G02B 5/08 359/838
9,126,191	B2 *	9/2015	Yin	B01J 23/42
2003/0043370	A1 *	3/2003	Goldberg	G03F 1/84 356/237.5
2004/0009410	A1	1/2004	Lercel et al.	
2004/0063004	A1 *	4/2004	Alkemper	B82Y 10/00 430/5

(Continued)

FOREIGN PATENT DOCUMENTS

KR	10-0805360	2/2008	H01L 21/027
WO	WO 00/75727	12/2000	G03F 1/14
WO	WO 2010/020337	2/2010	G03F 1/14

OTHER PUBLICATIONS

International Search Report and Written Opinion of the International Searching Authority for International Application No. PCT/US2015/023899 Dated Jul. 24, 2015 (12 pages).

(Continued)

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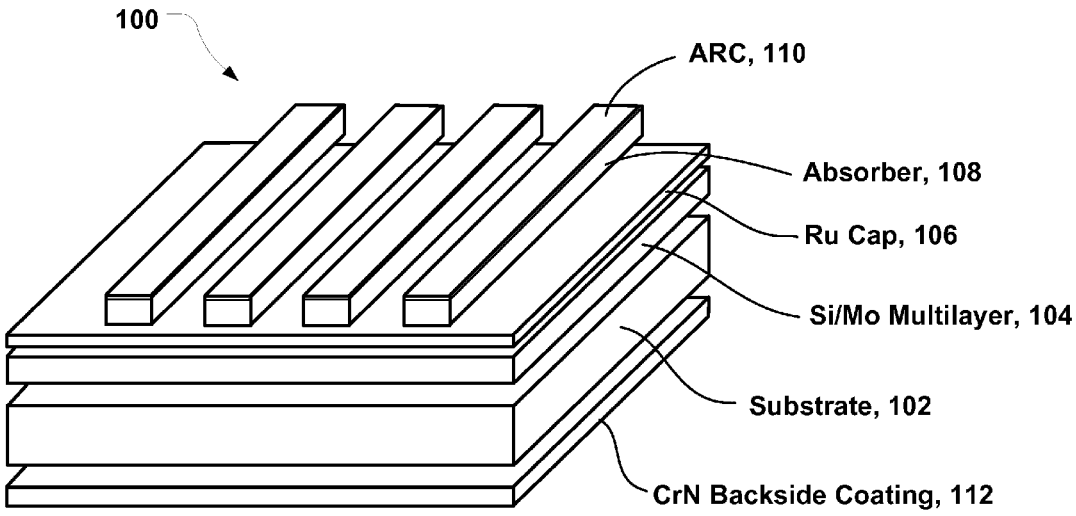
(57) **ABSTRACT**

A photo-mask for use in extreme ultraviolet (EUV) lithography, in which the photo-mask has low coefficient of thermal expansion and high specific stiffness.

19 Claims, 3 Drawing Sheets