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(54) **WRITER POLE FORMATION**

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(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,568,335	A	10/1996	Fontana et al.	
7,999,401	B2 *	8/2011	Murai	H01L 23/5389 257/690
8,191,238	B2	6/2012	Demtchouk et al.	
8,259,411	B2	9/2012	Yang et al.	
8,381,392	B2	2/2013	Zou et al.	
8,721,902	B1	5/2014	Wang et al.	
8,790,523	B2	7/2014	Watanabe et al.	
2007/0210394	A1 *	9/2007	Kanakasabapathy	H01L 23/544 257/421
2007/0230046	A1 *	10/2007	Le	G11B 5/1278 360/125.04
2008/0151437	A1 *	6/2008	Chen	G11B 5/1278 360/319
2010/0187120	A1	7/2010	Seets et al.	
2012/0236437	A1	9/2012	Kautzky	
2013/0010387	A1	1/2013	Yang et al.	

* cited by examiner

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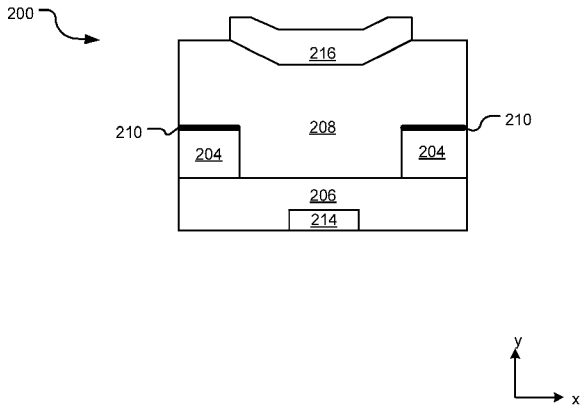
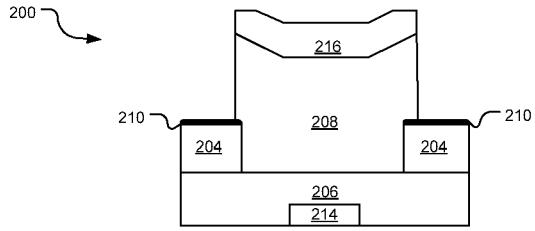
(57) **ABSTRACT**

Implementations disclosed herein provide a method of reducing the topography at the alignment and overlay marks area during the writer pole photolithography process in order to reduce the wafer scale variation and reduce the writer pole photolithography process rework rate. In one implementation, an intermediate stage of a wafer for writer pole formation is generated by removing a part of at least one metallic writer pole layer on top of an intermediate stage writer pole wafer to form a recovery trench, depositing an optically transparent material on top of the wafer, wherein the thickness of the optically transparent material is higher than a target recovery trench topography, forming a photoresist pattern on top of the optically transparent material over the recovery trench, etching the optically transparent material, and removing the photoresist pattern and at least part of the remaining optically transparent material.

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