US009094593B2

(12) **United States Patent**
Rudmann et al.

(10) **Patent No.: US 9,094,593 B2**
(45) **Date of Patent: Jul. 28, 2015**

(54) **OPTOELECTRONIC MODULES THAT HAVE SHIELDING TO REDUCE LIGHT LEAKAGE OR STRAY LIGHT, AND FABRICATION METHODS FOR SUCH MODULES**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/339,623**

(22) Filed: **Jul. 24, 2014**

(65) **Prior Publication Data**

US 2015/0036046 A1 Feb. 5, 2015

Related U.S. Application Data

(60) Provisional application No. 61/859,820, filed on Jul. 30, 2013.

(51) **Int. Cl.**

H01L 21/00	(2006.01)
H04N 5/225	(2006.01)
H01L 25/00	(2006.01)

(52) **U.S. Cl.**
CPC ***H04N 5/2252*** (2013.01); ***H01L 25/50*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,400,072	A	3/1995	Izumi et al.	
2007/0126912	A1	6/2007	De Bruin et al.	
2009/0130791	A1	5/2009	Kwon et al.	
2009/0256931	A1*	10/2009	Lee et al.	348/231.99
2010/0045845	A1	2/2010	Yoneyama	
2010/0073533	A1*	3/2010	Yano et al.	348/294
2010/0073534	A1*	3/2010	Yano et al.	348/294
2011/0050979	A1	3/2011	Rudmann	
2011/0051390	A1	3/2011	Lin et al.	
2012/0146170	A1	6/2012	Vigier-Blanc et al.	
2012/0307139	A1*	12/2012	Cheng et al.	348/374
2013/0019461	A1	1/2013	Rudmann et al.	
2014/0183585	A1	7/2014	Gubser et al.	

* cited by examiner

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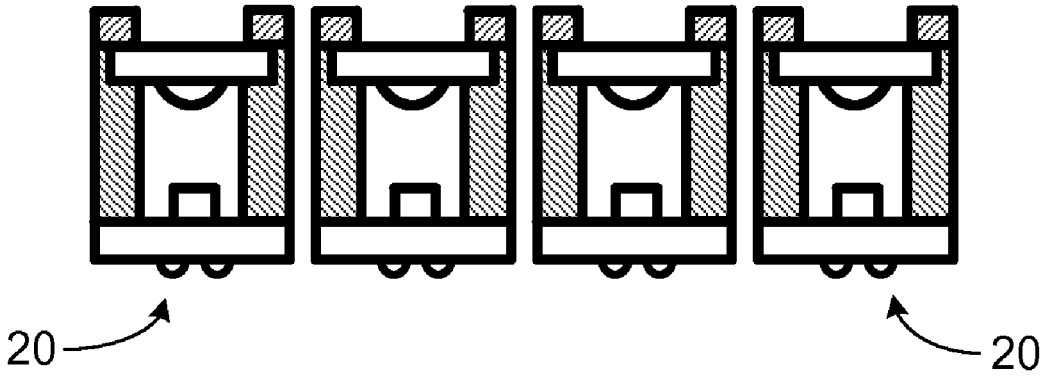
(57) **ABSTRACT**

Optoelectronic modules include an optoelectronic device and a transparent cover. A non-transparent material is provided on the sidewalls of the transparent cover, which can help reduce light leakage from the sides of the transparent cover or can help reduce stray light from entering the module. The modules can be fabricated, for example, in wafer-level processes. In some implementations, openings such as trenches are formed in a transparent wafer. The trenches then can be filled with a non-transparent material using, for example, a vacuum injection tool. When a wafer-stack including the trench-filled transparent wafer subsequently is separated into individual modules, the result is that each module can include a transparent cover having sidewalls that are covered by the non-transparent material.

18 Claims, 25 Drawing Sheets