

(12) **United States Patent**
Tauke-Pedretti et al.

(10) **Patent No.:** **US 9,029,239 B2**
(45) **Date of Patent:** **May 12, 2015**

(54) **SEPARATING SEMICONDUCTOR DEVICES FROM SUBSTRATE BY ETCHING GRADED COMPOSITION RELEASE LAYER DISPOSED BETWEEN SEMICONDUCTOR DEVICES AND SUBSTRATE INCLUDING FORMING PROTUBERANCES THAT REDUCE STICTION**

(52) **U.S. Cl.**
CPC **H01L 31/18** (2013.01); **H01L 31/0735** (2013.01); **H01L 31/1852** (2013.01); **H01L 31/1892** (2013.01); **Y02E 10/52** (2013.01); **Y02E 10/544** (2013.01)

(58) **Field of Classification Search**
USPC 257/E21.513
See application file for complete search history.

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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.

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(21) Appl. No.: **14/067,433**

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(22) Filed: **Oct. 30, 2013**

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(65) **Prior Publication Data**

US 2014/0048123 A1 Feb. 20, 2014

Related U.S. Application Data

(60) Continuation-in-part of application No. 13/707,875, filed on Dec. 7, 2012, now Pat. No. 8,592,249, which is a division of application No. 12/957,082, filed on Nov. 30, 2010, now Pat. No. 8,329,503, which is a continuation-in-part of application No. 11/933,458, filed on Nov. 1, 2007.

(57) **ABSTRACT**

A method includes etching a release layer that is coupled between a plurality of semiconductor devices and a substrate with an etch. The etching includes etching the release layer between the semiconductor devices and the substrate until the semiconductor devices are at least substantially released from the substrate. The etching also includes etching a protuberance in the release layer between each of the semiconductor devices and the substrate. The etch is stopped while the protuberances remain between each of the semiconductor devices and the substrate. The method also includes separating the semiconductor devices from the substrate. Other methods and apparatus are also disclosed.

(51) **Int. Cl.**

H01L 21/46 (2006.01)
H01L 31/0735 (2012.01)
H01L 31/18 (2006.01)

16 Claims, 16 Drawing Sheets

