

## (19) United States

# (12) Patent Application Publication (10) Pub. No.: US 2022/0360246 A1

Zhang et al.

Nov. 10, 2022 (43) **Pub. Date:** 

(54) TRANSVERSELY-EXCITED FILM BULK ACOUSTIC RESONATOR FABRICATION USING A PIEZOELECTRIC PLATE, SILICON SUBSTRATE AND HANDLE WAFER **SANDWICH** 

(71) Applicant: Resonant Inc., Austin, TX (US)

Inventors: **Kuan Zhang**, Goleta, CA (US); Andrew Kay, Provo, UT (US); Albert Cardona, Santa Barbara, CA (US); Chris O'Brien, San Diego, CA (US)

(21) Appl. No.: 17/565,271

(22) Filed: Dec. 29, 2021

### Related U.S. Application Data

- Continuation of application No. 17/565,123, filed on Dec. 29, 2021.
- (60) Provisional application No. 63/185,465, filed on May 7, 2021.

#### **Publication Classification**

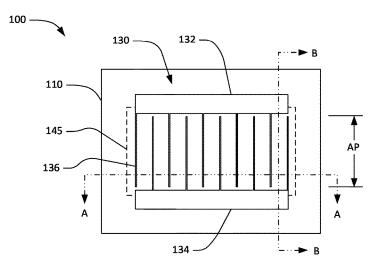
(51) Int. Cl. H03H 9/02 (2006.01)H03H 3/04 (2006.01) H03H 9/13 (2006.01)(2006.01)H03H 9/17

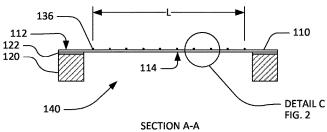
U.S. Cl.

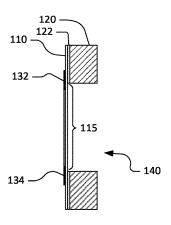
CPC ............ *H03H 9/02228* (2013.01); *H03H 3/04* (2013.01); H03H 9/02102 (2013.01); H03H 9/02133 (2013.01); H03H 9/13 (2013.01); H03H 9/174 (2013.01); H03H 2003/023 (2013.01)

#### (57)ABSTRACT

An acoustic resonator device is formed that reduces a thermal coefficient of expansion mismatch between a piezoelectric plate and a silicon substrate by bonding the front surface of the silicon substrate having a filled and planarized sacrificial tub to a piezoelectric substrate and thinning the silicon substrate by removing material from a back surface. That back surface is then bonded to a handle wafer having a thermal coefficient of expansion (TCE) closer to a TCE of the piezoelectric substrate than a TCE of the silicon substrate and thinning the piezoelectric substrate to a target piezoelectric membrane thickness to form a piezoelectric plate. A conductor pattern is formed on the thinned piezoelectric plate and the sacrificial tub is removed to form a cavity and release a membrane of the piezoelectric plate using an etchant introduced through holes in the piezoelectric plate.







SECTION B-B