

課題番号 : F-18-KT-0030
 利用形態 : 機器利用
 利用課題名(日本語) : (100)単結晶シリコンを用いた同調型振動リングジャイロ스코ープにおける形状補償
 Program Title(English) : Geometrical compensation of (100) single-crystal silicon mode-matched vibratory ring gyroscope
 利用者名(日本語) : シュウ ユンインー, 土屋智由
 Username(English) : Shu Yunyi, T. Tsuchiya
 所属名(日本語) : 京都大学大学院工学研究科
 Affiliation(English) : Department of Micro Engineering, Kyoto Univ.
 キーワード/Keyword : リソグラフィ・露光・描画装置、直接描画、ドライエッチング、ジャイロ스코ープ

1. 概要(Summary)

When the resonant frequencies of drive and sense modes are matched, the mechanical output of a MEMS vibratory ring gyroscope is maximal, so the high performance is possible to achieve. But for (100) single crystal silicon (SCS) vibratory ring gyroscope (VRG), the anisotropic in-plane Young's modulus causes frequency splits (Δf) between the drive and sense modes [1]. Here, non-uniform radial width design of VRG to compensate the elastic anisotropy of (100) single crystal silicon was introduced and characterized by FEA (有限要素法) simulation and experiments.

2. 実験(Experimental)

【利用した主な装置】

- [A3] Laser pattern generator
- [B8] Reactive ion deep silicone etcher

【実験方法】

Ring gyros were fabricated using SOI wafer. An aluminum layer for electrodes was deposited on the (100) silicon wafer surface by PECVD (Fig. 1). Then vibratory ring gyroscope and electrodes structures were patterned by laser direct writing on photoresist. Deep reactive-ion etching (DRIE) was applied to etch out the ring and spring beams. At last, sacrificial layer was etched and vibratory ring gyroscope was released through vapor hydrofluoric acid (VHF).

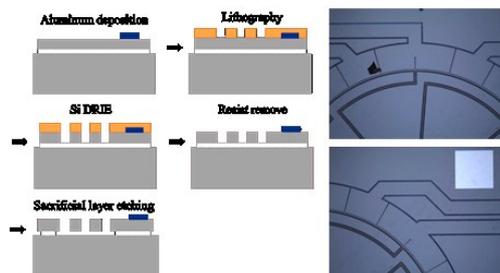


Fig. 1 Sample fabrication.

3. 結果と考察(Results and Discussion)

Fig. 2 shows frequency split changes with increased tuning voltage of VRGs w/ and w/o width compensation. It's observed that frequency split first decreased and then increased with tuning voltages. And for VRG w/ width compensation, the minimum frequency split is about 30 Hz at 12 V, while the minimum split of VRG w/o width compensation is as large as 160 Hz at 9 V. The anisotropic stiffness of uncompensated VRG fabricated in (100) SCS is not able to be completely compensated by electrostatic tuning, which proves the necessity of geometrical compensation design.

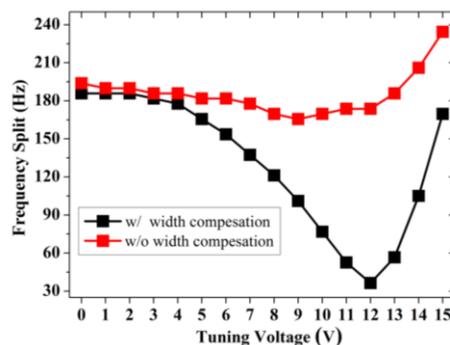


Fig. 2 Frequency split changes with increased tuning voltage.

4. その他・特記事項(Others)

・参考文献 Reference

[1] Hopcroft M A, Nix W D, Kenny T W. J. microelectromech. Syst. 2010, 19(2): 229-238.

・関連文献

S. Yunyi, Y. Hirai, T. Tsuchiya, O. Tabata, The 5th IEEE International Symposium on Inertial Sensors and Systems, Lake Como, Italy, 2018.

5. 論文・学会発表(Publication/Presentation) なし

6. 関連特許(Patent) なし。