MODELING OF HIGH-SENSITIVITY SAW MAGNETIC FIELD SENSORS WITH AU-SiO_2 PHONONIC CRYSTALS

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In this study, we aim to improve the sensitivity of surface acoustic wave (SAW) magnetic field sensors by integrating precisely designed phononic crystals (PnCs). Our focus is on amplifying the interaction between the SAW and the magnetostrictive material within the PnC structure to enhance the magnetoelastic effect. This is achieved by coupling the resonant modes of the PnC to the Rayleigh wave generated by the interdigital transducers (IDTs).

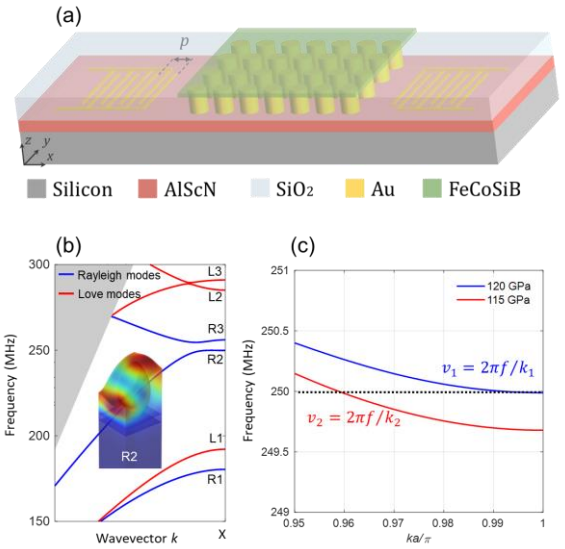

Fig. 1 (a) Schematic illustration of the SAW magnetic field sensor with embedded Au-SiO_2 PnC. (b) Band diagram of the PnC and displacement profile within a unit cell for the second Rayleigh mode (R2). (c) SAW phase velocity variations resulting from changes in the Young's modulus of the magnetostrictive layer.

Our previous study [1] modeled a square array of FeCoSiB pillars on a silicon substrate covered by an AlScN piezoelectric layer and a SiO_2 guiding layer, revealing an increase in the sensor's sensitivity caused by the resonance effects in the PnC structure. To avoid material loss from patterning the magnetostrictive layer, our current study employs a continuous magnetostrictive layer over a solid-solid PnC structure composed of Au pillars embedded within the SiO_2 guiding layer. Our approach significantly enhances the interaction between the SAW and the magnetostrictive material, improving the sensor's sensitivity to external magnetic fields by more than 40 times compared to a similar device without the PnC structure.

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References

1. M. Samadi, J. Schmalz, J. M. Meyer, F. Lofink, M. Gerken, *Micromachines*, 2023, 14(11), 2130.