

SAWtrain Research Highlight 6: “Zero-group-velocity acoustic waveguides for high-frequency resonators”

The propagation of Lamb-like modes along a silicon-on-insulator (SOI)/AlN thin supported structure was simulated in order to exploit the intrinsic zero group velocity (ZGV) features to design electroacoustic resonators that do not require metal strip gratings or suspended edges to confine the acoustic energy.

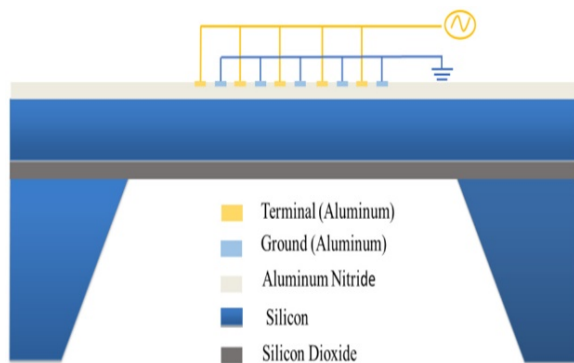


Figure 1: Schematic of the Lamb mode resonator on AlN/Si/SiO₂ suspended membrane with a thick Si rigid frame.

The behaviour of the ZGV resonators operating as gas sensors was studied under the hypothesis that the surface of the device is covered with a thin polyisobutylene (PIB) film able to selectively adsorb dichloromethane (CH₂Cl₂), trichloromethane (CHCl₃), carbon tetrachloride (CCl₄), tetrachloroethylene (C₂Cl₄), and trichloroethylene (C₂HCl₃) at atmospheric pressure and room temperature. The sensor sensitivity to gas concentration in air was simulated for the first four ZGV points of the inhomogeneous plate. The feasibility of high-frequency, low TCF electroacoustic micro-resonator based on SOI and piezoelectric thin film technology was demonstrated by the present simulation study

Publication:

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In this work, the author studied the ZGV resonant conditions in the SOI/AlN composite plate, i.e. the frequencies where the mode group velocity vanishes while the phase velocity remains finite were investigated in the frequency range from a few hundreds of MHz up to 1900 MHz. Some ZGV points were found that show up mostly in low-order modes. The thermal behaviour of these points was studied in the -30 to 220 °C temperature range and the temperature coefficients of the ZGV resonant frequencies (TCF) were estimated.

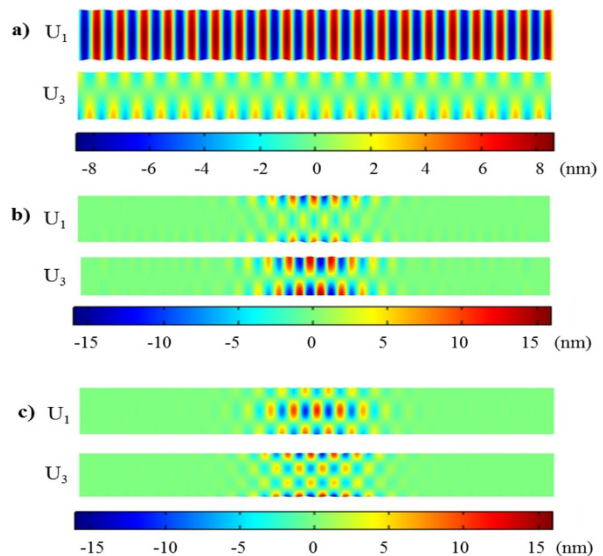


Figure 2: The field profile of (a) a propagating mode, the qSO mode, at frequency 155 MHz and $\lambda = 50 \mu\text{m}$; (b) non-propagating ZGV3 mode for $\lambda = 50 \mu\text{m}$, (c) non-propagating ZGV5 mode for $\lambda = 30 \mu\text{m}$