

Ultrasound velocity enhancement using gold nanoparticles and its multifunctional sensor application

Teguh Firmansyah Talam^{1,2}, Gunawan Wibisono², Eko Tjipto Rahardjo², Jun Kondoh¹
Shizuoka University¹, Universitas Indonesia²
E-mail: teguh.firmansyah81@ui.ac.id

1. Introduction

Shear-horizontal surface acoustic wave (SH-SAW) device has excellent characteristics for sensor, due to large electromechanical coupling (K_s^2)[1]-[2]. The K_s^2 value is highly correlated with the ultrasound velocity. SH-SAW sensor was usually fabricated on a 36XY-LiTaO₃ substrate using a developed input/output interdigital transducers (I/O IDTs). We propose deposition gold nanoparticles (AuNPs) on the SH-SAW propagation surface between I/O IDTs to enhance ultrasound velocity. The verification of ultrasound velocity enhancement was conducted by frequency-domain and time-domain measurement. Figure 1(a), (b), (c), and (d) show the SH-SAW device structures without or with AuNPs, magnitude/phase of the transmission coefficient, and delay comparison, respectively.

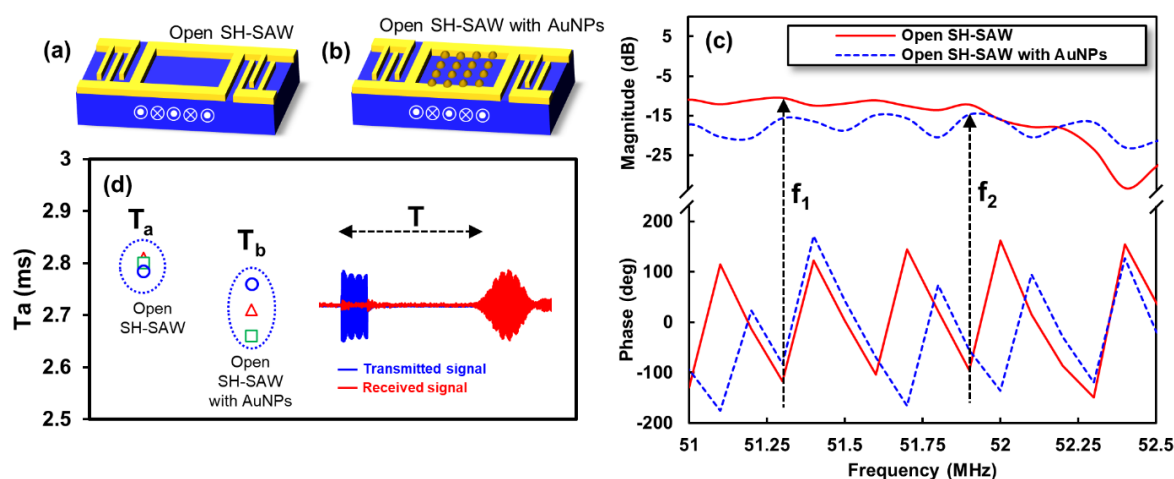


Figure 1. (a) Open SH-SAW, (b) open SH-SAW with AuNPs, (c) magnitude/ phase of transmission coefficient, and (d) delay comparison.

2. Experimental Procedures and Result

In brief, the SH-SAW was fabricated on a 36YX-LiTaO₃ substrate and followed by deposited AuNPs on the propagation surface. Then, the device was annealed temperature of 500 °C and quenched. The vector network analyzer (VNA) was used for frequency-domain evaluation. It can be seen from Figure 1(c) that the value of the phase of open SH-SAW with AuNPs was higher than SH-SAW at the highest value of transmission coefficient magnitude. A higher phase has meant a larger frequency or larger velocity. Moreover, a signal generator with a sensitive oscilloscope was used for time-domain evaluation. The delay of amplitude shift keying (ASK) signal was used to evaluate. It can be obtained from Figure 1.d. that the average \bar{T}_a for SH-SAW is 2.798 ms and the average \bar{T}_b for SH-SAW with AuNPs is 2.710 ms. An identical supporting measurement system was used, and a lower value of \bar{T} implies a higher value of V or K_s^2 value. These results were also in-line with the proposed by [3][4]. In general, the SH-SAW with the AuNPs sensor has higher V and K_s^2 with the possibility of a multifunctional sensor.

Acknowledgment

This research was subsidized by JKA through its promotion found from KEIRIN RACE.

Acknowledgment

- [1] S. Kobayashi, et al., Sensor 20, pp. 1-12 (2020).
- [2] J. Kondoh, et al., Jpn. J. Appl. Phys. 40, 3713-3717. (2001).
- [3] C. Wang., et al., ACS Sensors. 5 (2), 362–369. (2020)
- [4] K. Toma., et al. Sensors Actuators, B Chem. 249, 685–690. (2017).