Design of FIDT for 3D Analysis of MEMS Based Gas Sensor Using SAW Technology

V. S. P. Rajesh
St. Mary's Group of Institutions, Hyderabad, India

Introduction: This paper presents MEMS based SAW gas sensor with the multi-segmented, focused interdigital transducer (FIDT) structure for effective operation, reliable working, ease of fabrication & with more energy optimization.

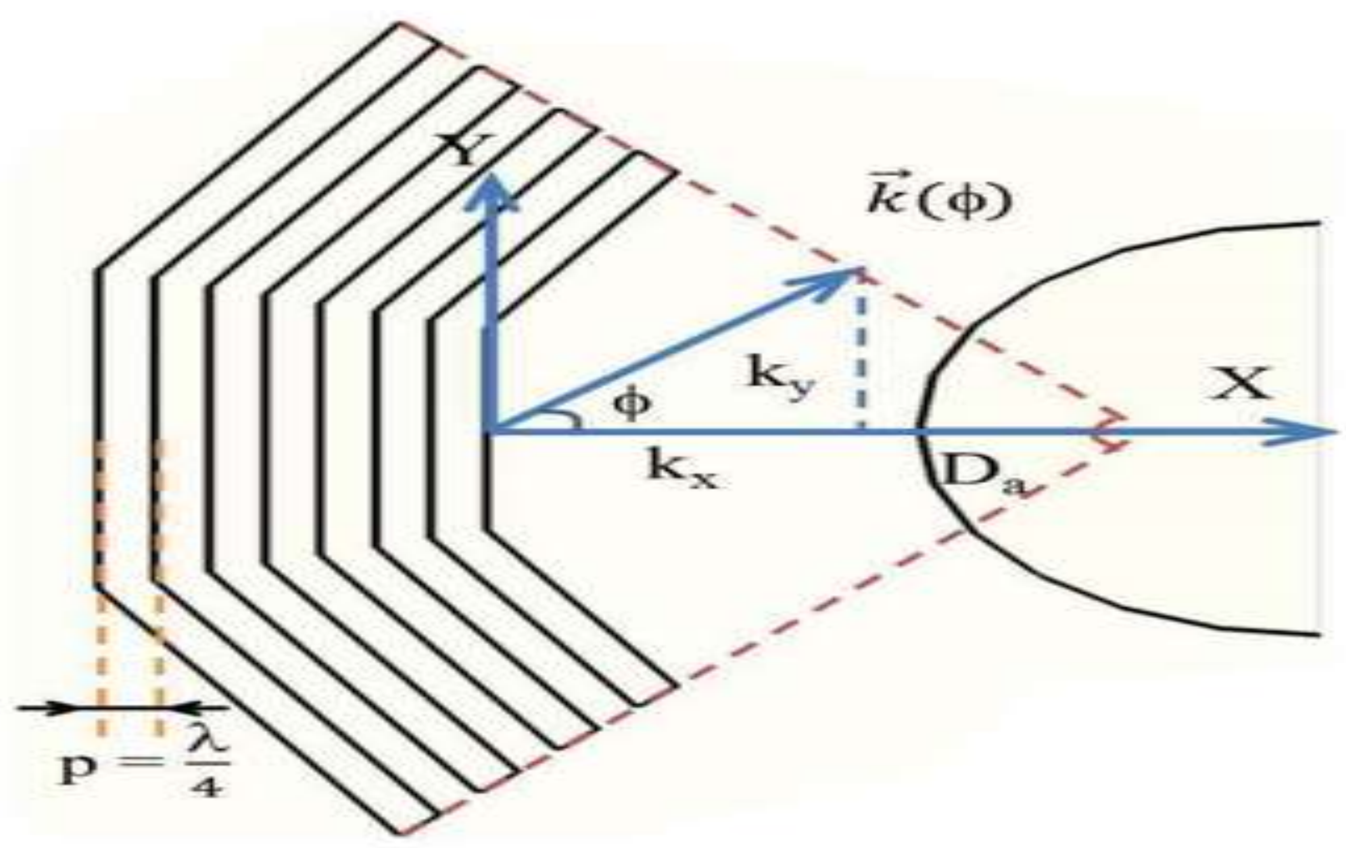

Figure 1. Focused IDT model with three straight segments.

Computational Methods: For analysis of surface X- Y plane the total surface displacement u(x, y) is represented in scalar component. According to the angular spectrum of plane wave theory, the total displacement distribution of both conventional & concentric IDT is given by the following equation

$$\psi(x,y)=\sum_{i=1}^{N}\frac{1}{2\pi}\int_{-\infty}^{\infty}\bar{\Psi}(k_y)\exp[-j\{xk_x(k_y)+yk_y\}]dk_y$$

Two-segmented FIDT with solid blocks of 1μmx0.25μmx0.5μm are made of aluminum that are positioned on the corner of base Lithium Niobate piezoelectric material of 4μmx6μmx1μm, having 1μm radius & 0.5 μm height circular PIB film as sensing medium.

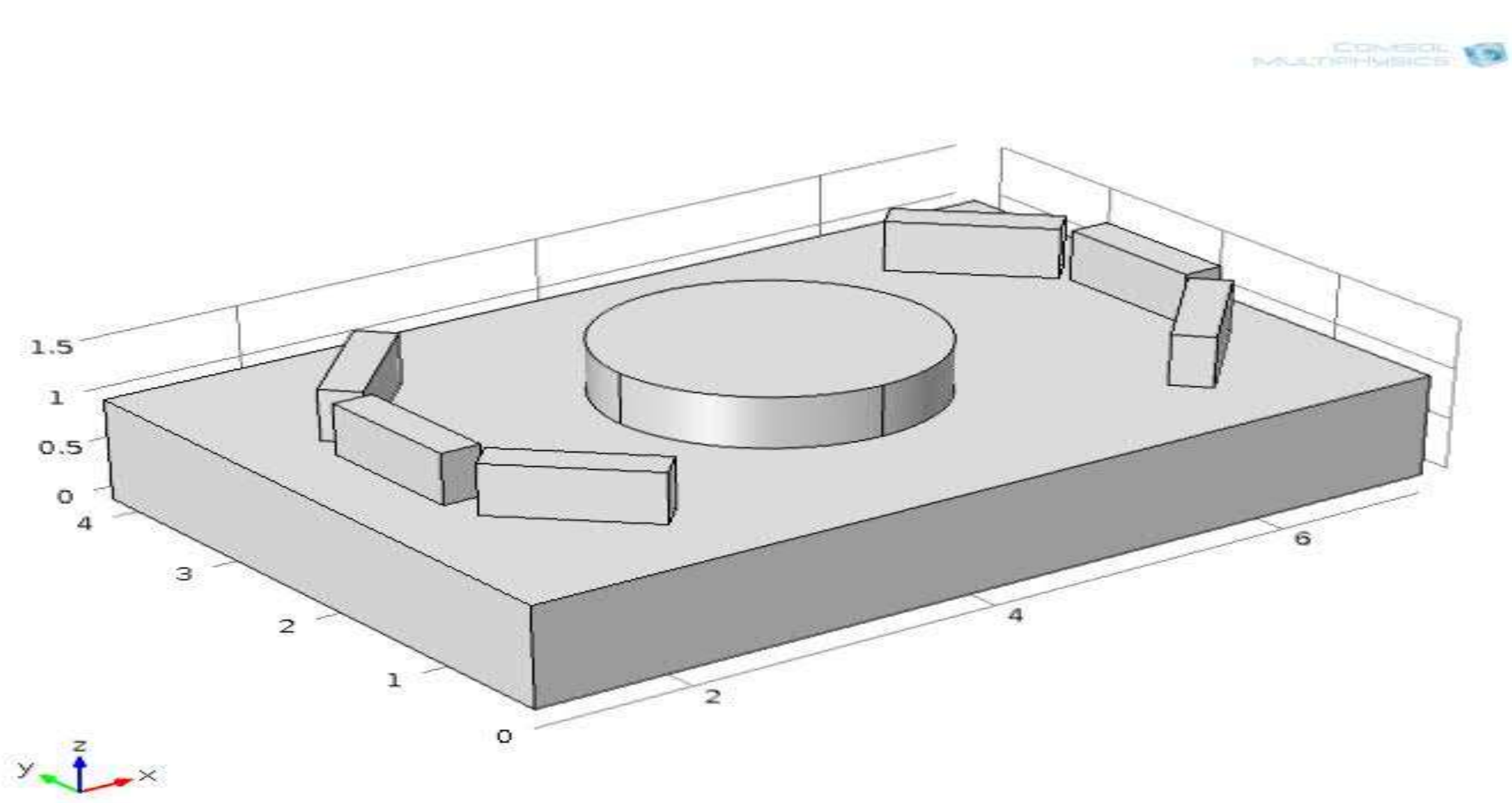

Figure 2. Focused Inter Digital Transducer model of SAW sensor

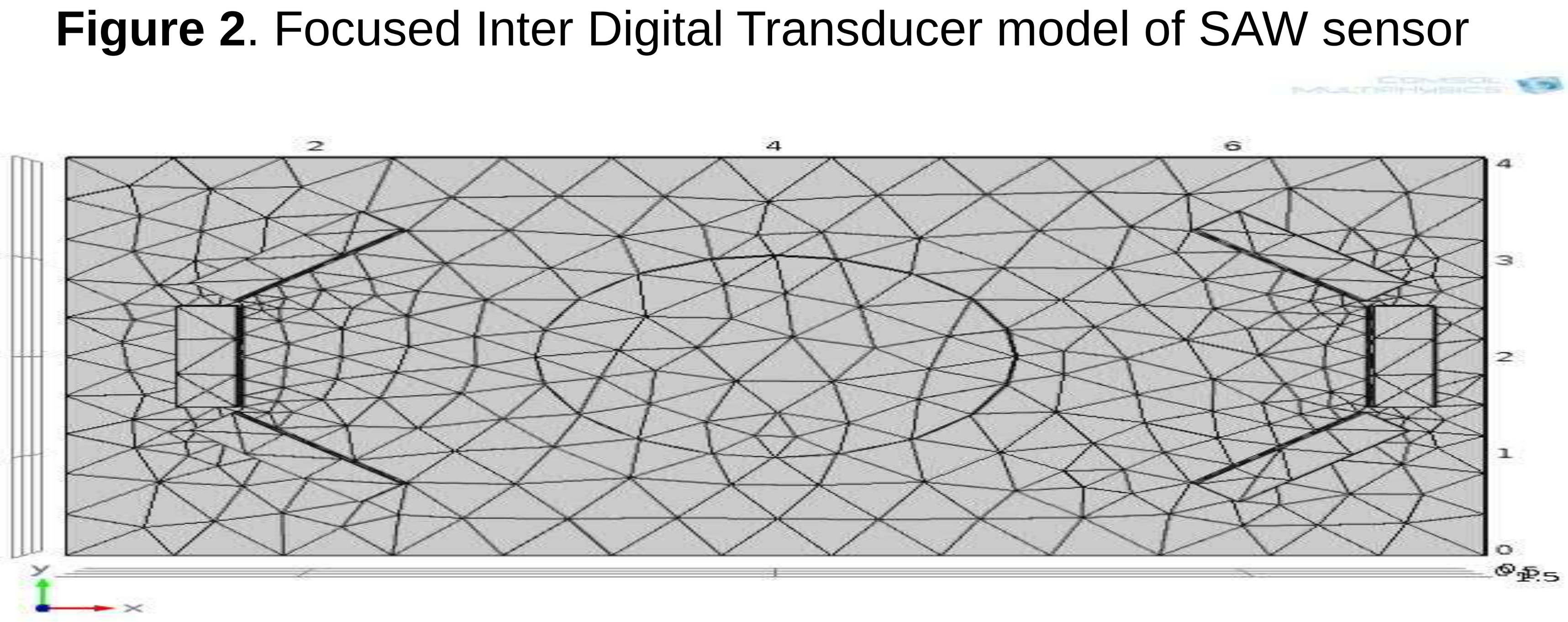

Figure 3. Physics controlled fine element size meshing of FIDT model

Results: Simulation methodology suggests that two-segmented FIDT structure is better as it consumes similar amount of energy & dissipates lower energy around the medium than that of the conventional IDT.

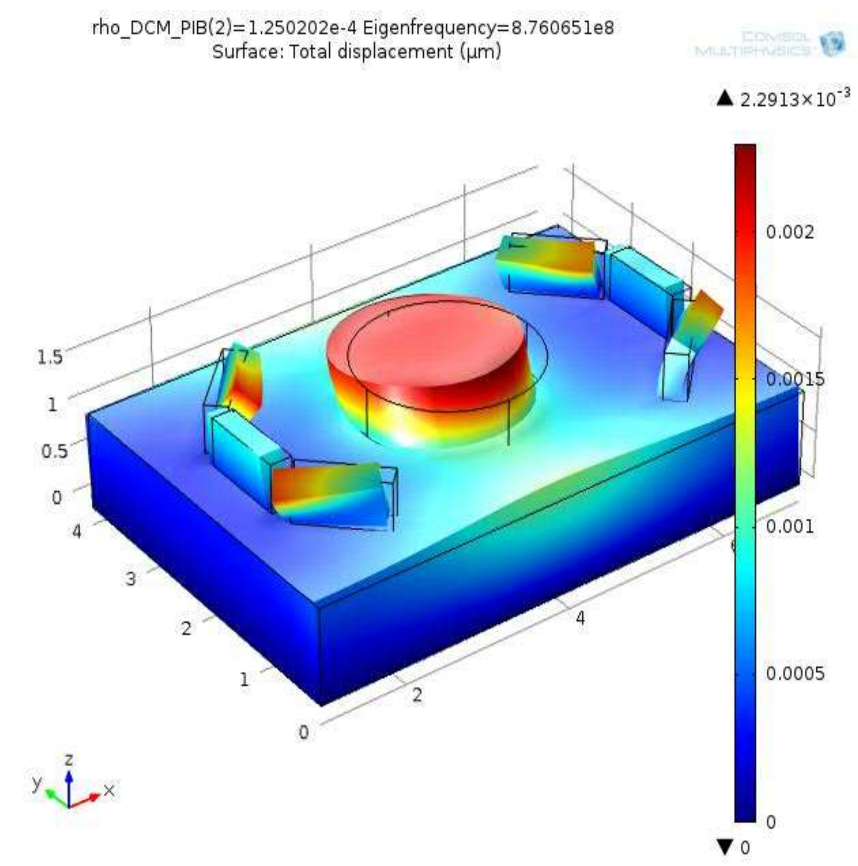

Figure 4. Surface displacement at resonance frequency.

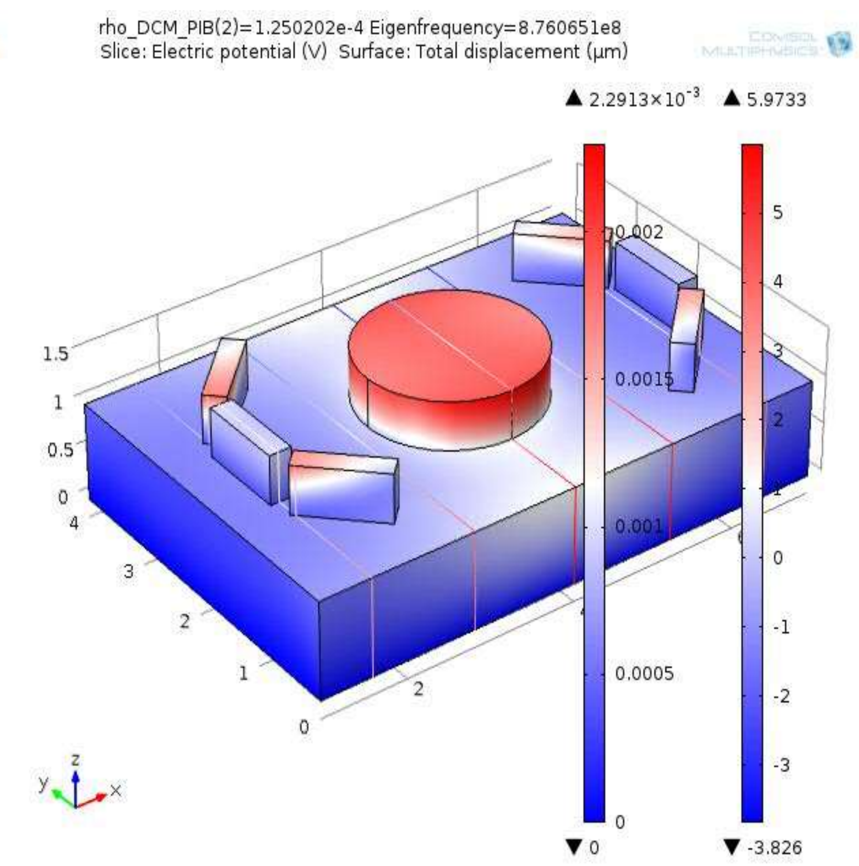

Figure 5. Electrical potential at resonance frequency.

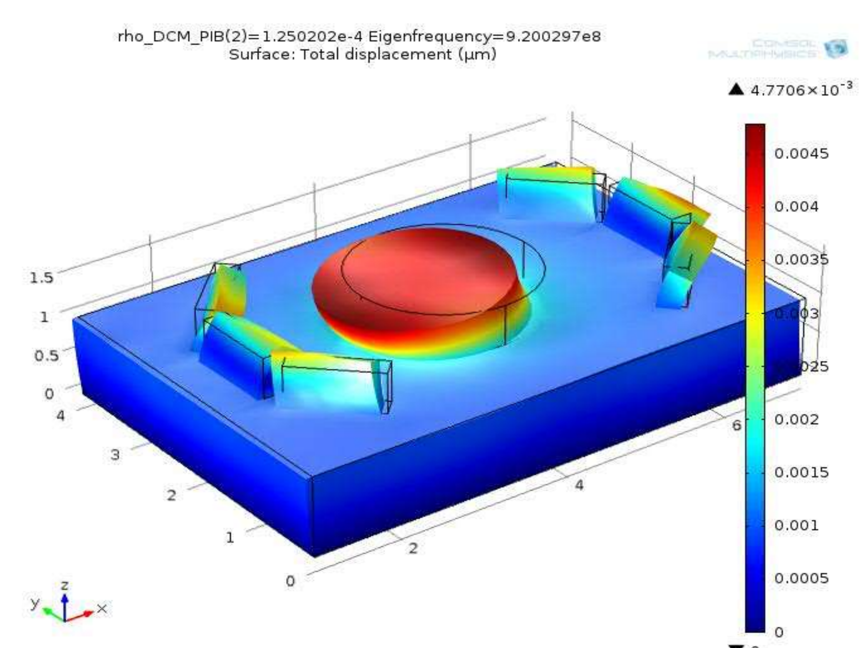

Figure 6. Surface displacement at anti-resonance frequency.

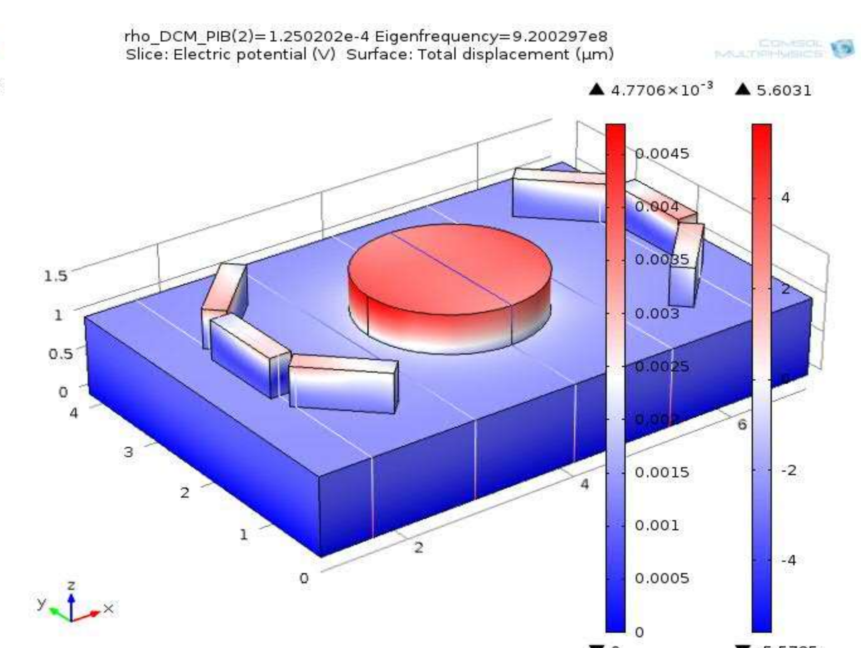

Figure 5. Electrical potential at anti-resonance frequency.

Parameter	Focused IDT Model	Conventional Model
Surface Displacement at Resonance	2.2193 X 10^{-3}	1.855 X 10^{-3}
Surface Displacement at Anti - Resonance	4.7706 X 10^{-3}	2.487 X 10^{-3}
Electrical Potential at Resonance	5.9733	5.9748
Electrical Potential at Anti - Resonance	5.6031	5.3614

Table 1. Comparison between F-IDT & Conventional IDT.

Conclusions: FIDT based design helps in concentration of more acoustic energy on to the sensing medium, which resulted in enhancement of surface displacement amplitude values when compared to conventionally available design values, reflecting its increased utility as a industrial gas sensor for sensing DCM, CO etc., gases.

References:

1. Thu Hang Bui, Tung Bui Duc, and Trinh Chu Duc, Microfluidic Injector Simulation With FSAW Sensor for 3-D Integration, IEEE Transactions on Instrumentation and Measurement, Vol. 64, No. 4, April (2015).