FEM Simulation of Interdigitated Electrode Device

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INTRODUCTION:

- Micro/Nano technology has facilitated miniaturization of devices for many applications such as biosensing [1].
- Interdigitated electrodes (IDEs) are widely reported in many applications due to its rapid response and high sensitivity [2].
- Geometrical parameters such as width(w), gap(g), length(L) and non-dimensional parameter such as metallization ratio (η) these parameters are crucial to ensure high sensitivity.

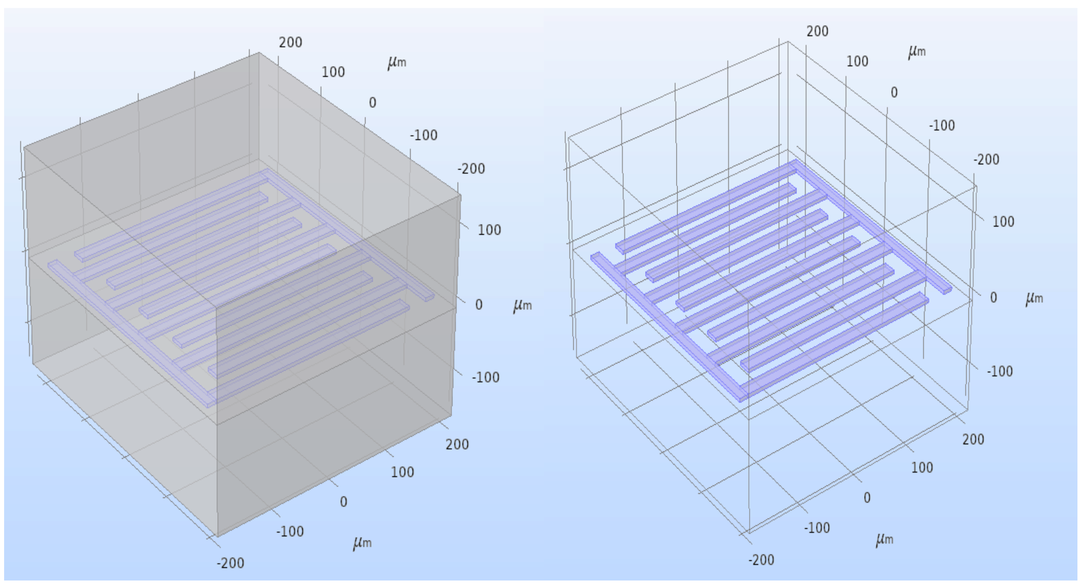

Figure 1. Modelling of IDEs device using COMSOL®
With W=10µm,G=10µm,and L=300µm

COMPUTATIONAL METHODS:

- The FEM modelling was carried out by COMSOL Multiphysics® 5.4.
- Electrical characterization was carried out using Electrostatics interface of the AC/DC Module.
- Simulations were performed using normal mesh as well as adaptive mesh refinement (AMR).
- The analytical expression as shown in equation 1 is used to evaluate capacitance of IDEs device [3].

$$C = (\mathrm{N} - 3)\frac{C_i}{2} + 2\frac{C_i C_e}{C_i - C_e} \qquad (1)$$

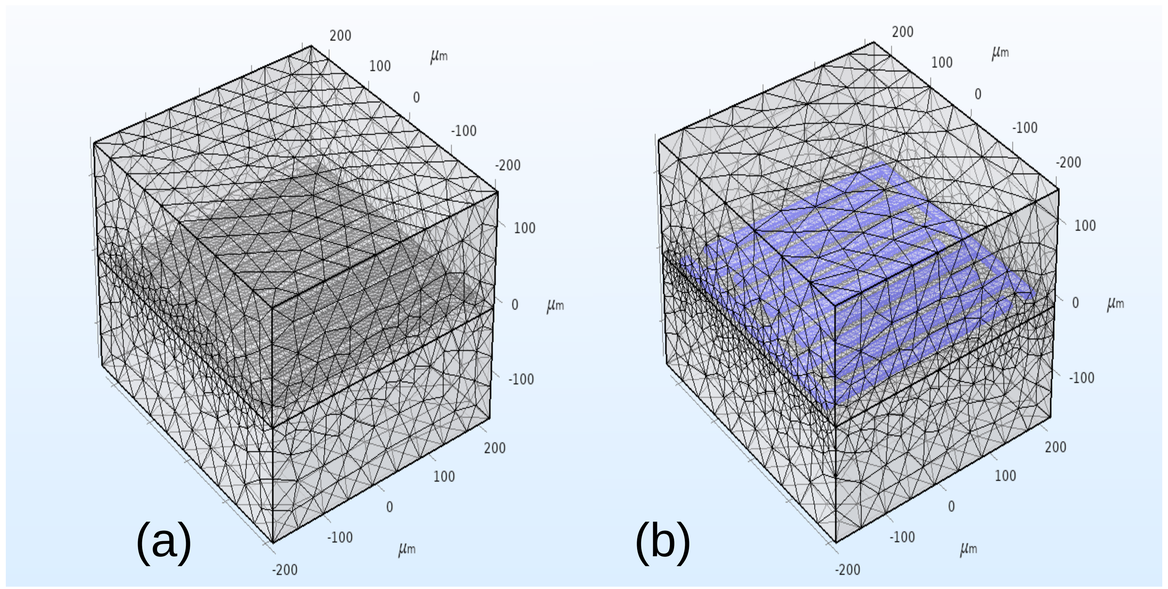

Figure 2. Meshing sequence for IDEs device a. Normal mesh
b. Adaptive mesh

RESULTS:

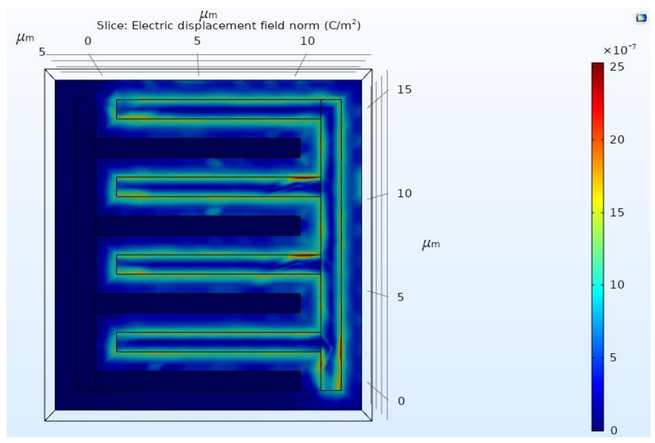

Figure 3. Electric field displacement of IDEs device

Metallization Ratio	Normal Mesh (Capacitance in pF)	Adaptive Mesh (Capacitance in pF)
0.3	2.4797	2.4550
0.5	3.4146	2.9962
0.6	4.7435	3.9313
0.7	6.4641	4.9159

Table 1. DC capacitance of IDEs device with normal and adaptive mesh for variation in metallization ratio

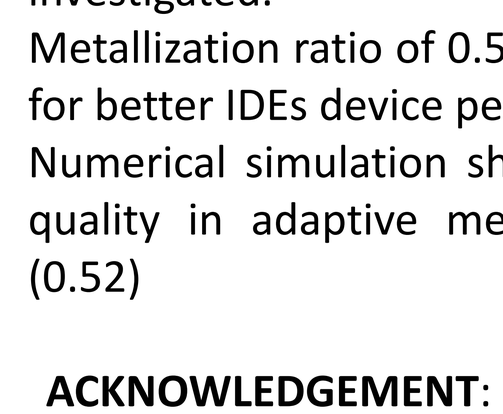

Figure 4. The effect of metallization ratio on Penetration depth of IDEs device with variation in electrode fingers

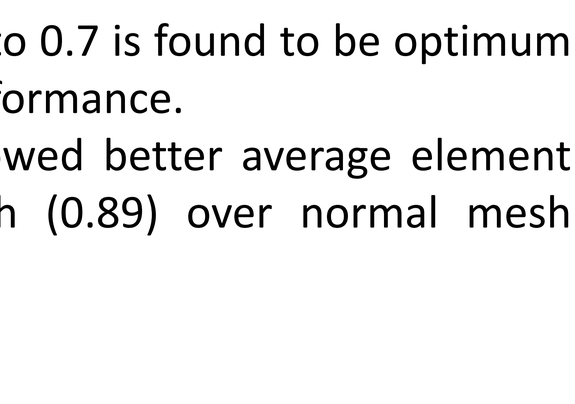

Figure 5. The effect of metallization ratio on IDEs device performance

CONCLUSIONS:

- Numerical Simulation of IDEs for different number of electrode fingers and metallization ratio were investigated.
- Metallization ratio of 0.5 to 0.7 is found to be optimum for better IDEs device performance.
- Numerical simulation showed better average element quality in adaptive mesh (0.89) over normal mesh (0.52)

ACKNOWLEDGEMENT:

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REFERENCES:

1. M. Bäcker et al., *Planar and 3D interdigitated electrodes for biosensing applications: The impact of a dielectric barrier on the sensor properties*, Phys. Status Solidi Appl. Mater. Sci., vol. 211, no. 6, pp. 1357-1363,2014
2. A. Rivadeneyra, J. Fernández-Salmern, J. Banqueri, J. A. López Villanueva, L. F. Capitan-Vallvey, and A. J. Palma, *A novel electrode structure compared with interdigitated electrodes as capacitive sensor*, Sens. Actuators B Chem., vol. 204, pp. 552-560, 2014
3. R. Igreja and C. J. Dias. *Analytical evaluation of the interdigital electrodes capacitance for a multi-layered structure*, Sens. Actuators A Phys., 112, no. 2-3, pp. 291-301, 2004