Simulation and Optimization of Interdigitated Electrodes (IDE) for Detection of Bisphenol A in Drinking Water

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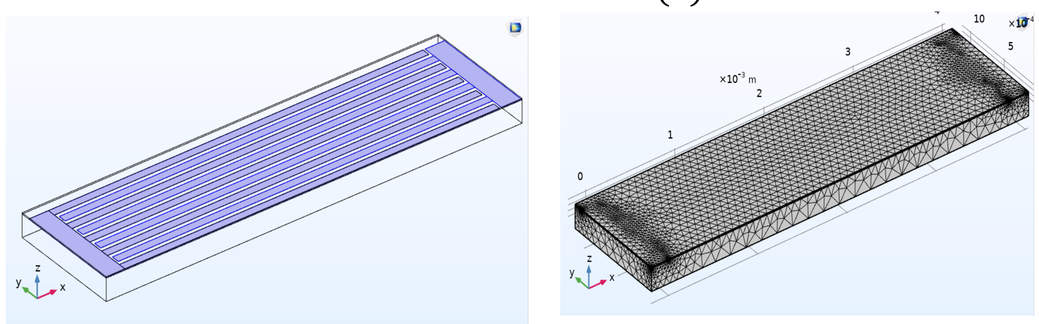
Rationale

- Bisphenol A (BPA) is used predominantly as a monomer in the production of plastics
- Easily migrate out of plastic and contaminate drinks and foods
- Thus, propose a technique for continuously monitor presence of BPA in drinking water using impedance spectroscopy (IS)
- Using IS, impedance profiles of a transformer oil with different quality levels were obtained to monitor the health of a transformer
- The IS uses an IDE to create a complex impedance which varies with the relative permittivity of the medium present around the IDE
- Geometrical parameters such as width (w), space (S), length (L) number of fingers (n) are important to enhance the sensitivity of IDE

Methodology

- Complete system simulation by COMSOL Multiphysics 5.5 is used for IDE sensitivity optimization
- Parameter characterization is carried out using Electrostatics interface of the AC/DC Module
- The analytical expression as expressed in Eqn. 1 is used to evaluate the electric field of IDE device

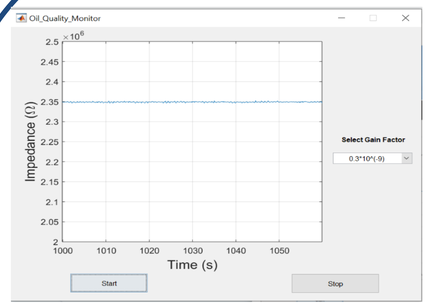
$$E = -\nabla V \qquad (1)$$



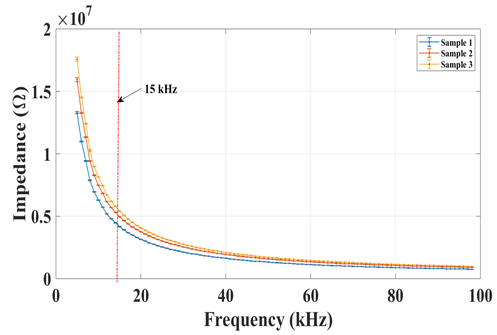
(a) (b)

Fig. 1. (a) Modeling of IDEs device using COMSOL, L= 3810 µm , S= 40 µm and w= 80 µm, (b) Meshing of IDE

Results



(a)



(b)

Fig. 2. (a) Real-time monitoring of transformer oil impedance, (b) Impedance spectra of the oil with different concentration of fault gases

(a)

W (µm)	Avg. EF (V/m)
40	5516.2
60	5601.0
80	5624.6

(b)

L (mm)	Avg. EF (V/m)
1	5665.4
2	5820.4
3	5893.8

(c)

S (µm)	Avg. EF (V/m)
20	5596.9
40	5634.6
60	5526.4
80	5329.8

Table 1. Average electric field in x-direction by sweeping the (a) width of the IDE fingers, when l= 1380 µm, s= 40 µm and n= 5. (b) length of the IDE fingers, when w= 80 µm, S= 40 µm and n= 5. (c) spacing of the IDE fingers, when L= 1380 µm, w= 80 µm and n= 5. Where, Avg. EF is average Electric Field in x-direction

Conclusion

- Simulation of IDEs for different width, spacing length and number of electrode fingers are investigated
- As n, w and l increase, the electric field in x-direction increases
- S of 40 µm is found to be optimum for enhance sensitivity of IDE device
- By analyzing the impedance spectrum, it can be surmised that the impedance value of a sample (water) varies with the concentration of BPA