

Design and Simulation of PDMS-Based Dry Electrode with Impurities

Yashus G., Roopa J., K. S. Geetha, B. S. Satya Narayana, Shivanand P., Yogeesh C. K., Arjun K., Dhvani Patel., Brinda A., Chitra S.

R. V. College of Engineering, Department of Electronics and Communication, Mysore Road, Bengaluru.

Introduction: This paper proposes the simulation of electrodes for measuring Bio-medical potentials using more flexible Poly Dimethyl Siloxane (PDMS) electrodes over conventional Ag/AgCl wet electrodes and PVDF based dry electrodes. Comsol Multiphysics is used to simulate the electrode. The piezoelectric device physics is used to evaluate the displacement created and the potential generated by PDMS.

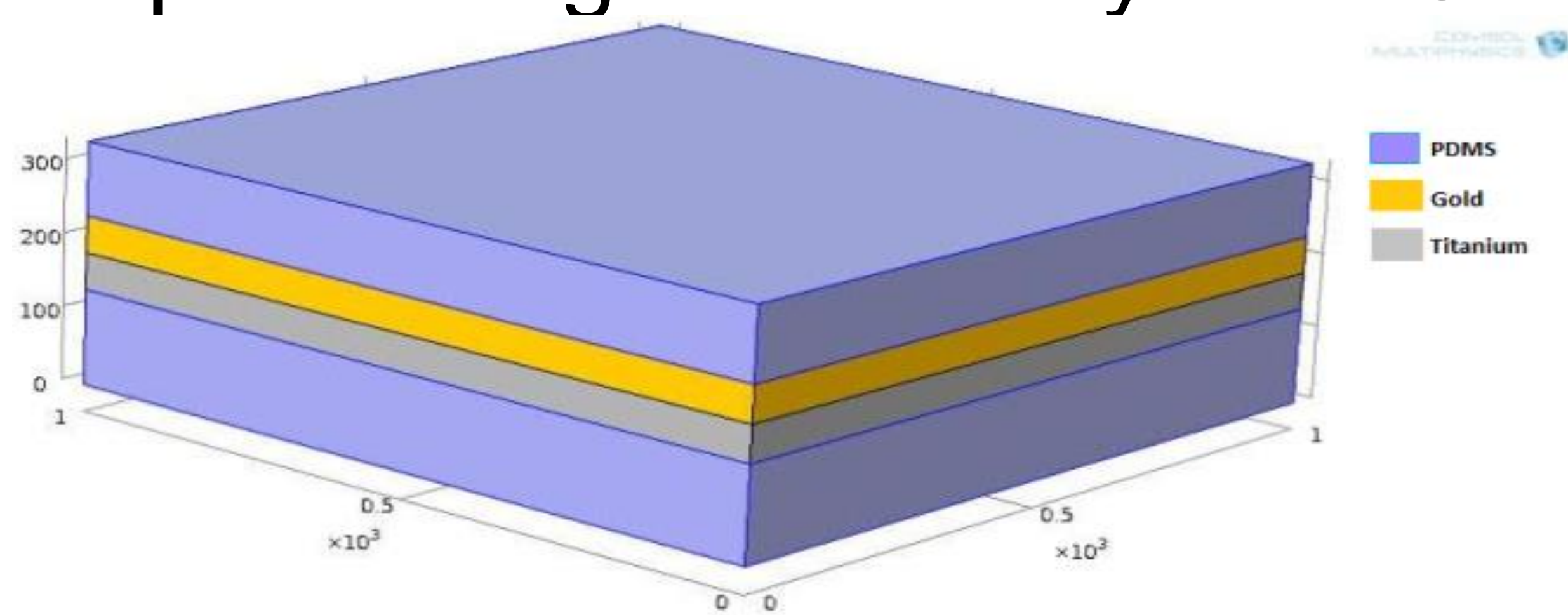


Figure 1. Structure of the dry electrode

Computational Methods: The electrode consists of 4 layers. The first layer is PDMS, 130 μm thick. Second layer is 40 μm thick titanium metal deposited using Physical Vapor Deposition (PVD). Third layer is gold -50 μm thick. Fourth layer is higher conductive PDMS -100 μm thick.

The Linear Elastic Material Model node in the Materials Browser is used to set the Mechanical Properties of PDMS. Using the Comsol Model Builder, we virtually set the deformation levels and observe the corresponding voltage changes, which is pre-amplified and filtered for diagnosis.

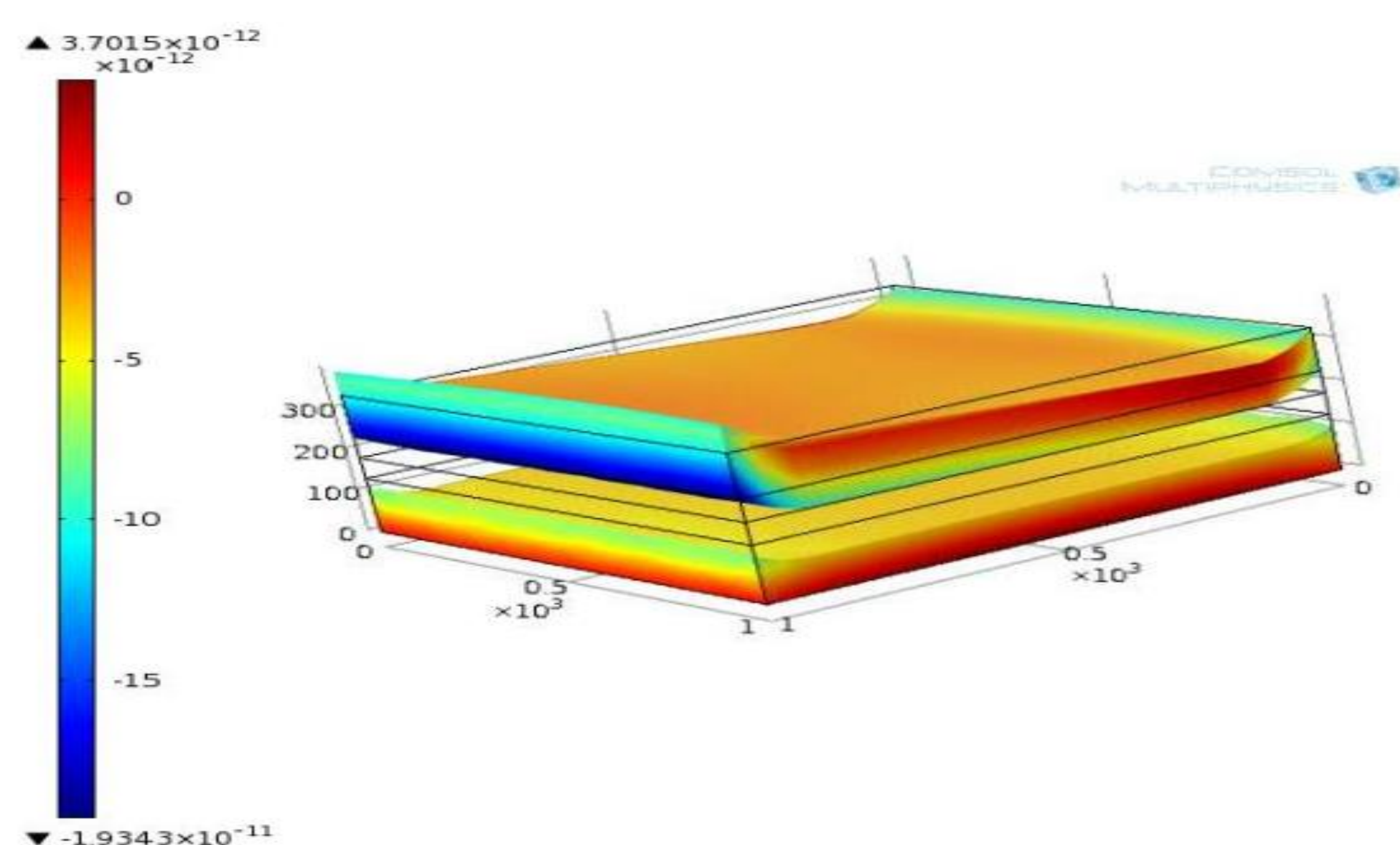


Figure 2. Deformation Vs Potential for 5μm displacement

Results: The material was synthesized and simulated using Comsol Multiphysics tool. The variation of electric field inside the bulk of the electrode has been simulated and values listed below in table 1.

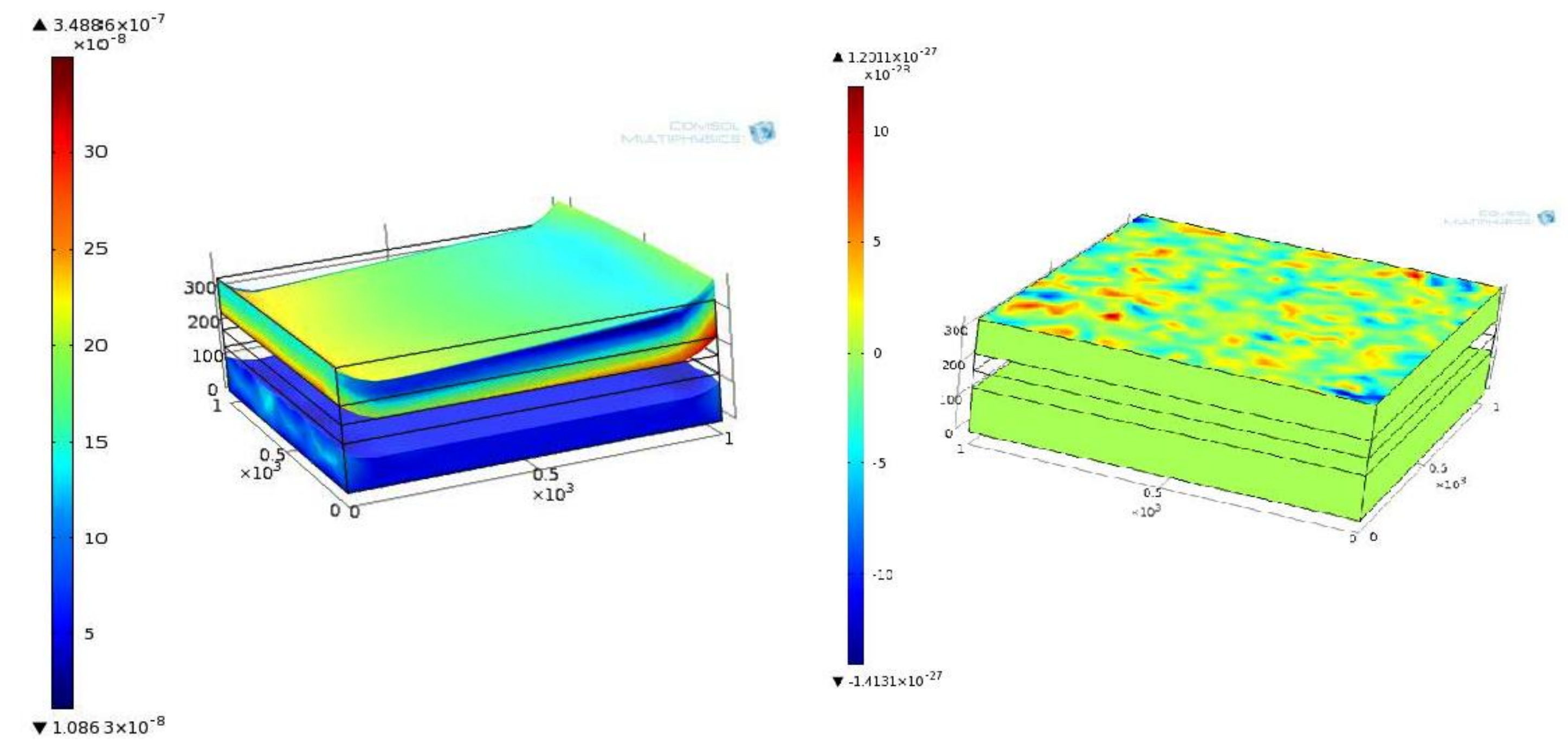


Figure 3. Deformation (μm) vs Electric field (V/m). Figure 4. Charge generated on PDMS surface

Parameter	Maximum Value for 5μm deformation
Potential	20pV
Electric field	300nV/m
Surface charge density	$1.2011 \times 10^{-27} \text{C/m}^2$

Table 1 Parameters and their simulated values

Conclusions: PDMS gives approximately the same results as that given by PVDF electrodes. PDMS is found to be more flexible and cost effective. Thus this provides an alternative means to measure essential bio-potentials and also overcomes the inherent limitations of conventional wet electrodes and PVDF.

References:

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