Design and Simulation of PDMS-Based Dry Electrode with Impurities

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Abstract

Bio-potentials refer to the voltage produced by a tissue of the body, particularly muscle tissue during a contraction, these signals are used to analyze various ailments in the medical field like ECG, EEG, EOG, etc. For a single EEG test, at least 20 electrodes are required and costs range between 100$ to 500$, hence there is a need to cut down on costs per electrode to bring down the cost of the test as a whole. The conventional electrodes that are used for the measurement of the bio-signals are those of Ag/AgCl wet electrodes. This type of electrodes presents challenges such as non-flexibility, irritation to skin and deteriorating signal quality over a longer period of usage.

The simulation on electrode material has been carried out in COMSOL Multiphysics software. The piezoelectric device physics was used to evaluate the displacement created and the potential generated due to piezoelectricity of PDMS. The potential created due to the flow of bio-signals between neurons results in the deformation of the first PDMS layer due to anti-piezoelectric effect which results in potential being conducted by the subsequent metal layers of gold and titanium, which also provides the electrical contact for the external circuit. The outer PDMS layer serves the role of covering this setup and also acts as the substrate for fabrication process.

The library for the PDMS material that has four layers for illustrating piezoelectric property was created using COMSOL Multiphysics. The electrode consists of 4 layers. The first layer is made of PDMS layer of thickness 130µm. The second layer is of titanium metal which is deposited using Physical Vapour Deposition (PVD) to a thickness of 40µm, this layer improves the adhesion of gold layer which is the third layer, the thickness of which is 50µm. The fourth layer is made of higher conductive PDMS and is of 100µm in thickness. The structure of the electrode used for the purpose of simulation in COMSOL Multiphysics. The fourth layer is the one that is in contact with the skin while the first layer is the exterior one and acts as a cover and a substrate for the process of PVD. It is the layer from which electrical contact originates for the subsequent connection to the signal conditioning circuit and the oscilloscope for viewing the obtained waveforms.

Further work can be taken through fabrication process for different analysis performed on it such as potential variation, electric field variation and the charge density created due to piezoelectric property of the PDMS for material properties that can be used in biomedical application that was simulated in COMSOL Multiphysics.

Reference

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Figures used in the abstract

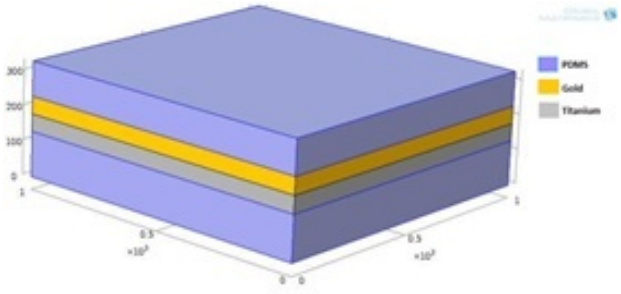

Figure 1: Simulation Model.

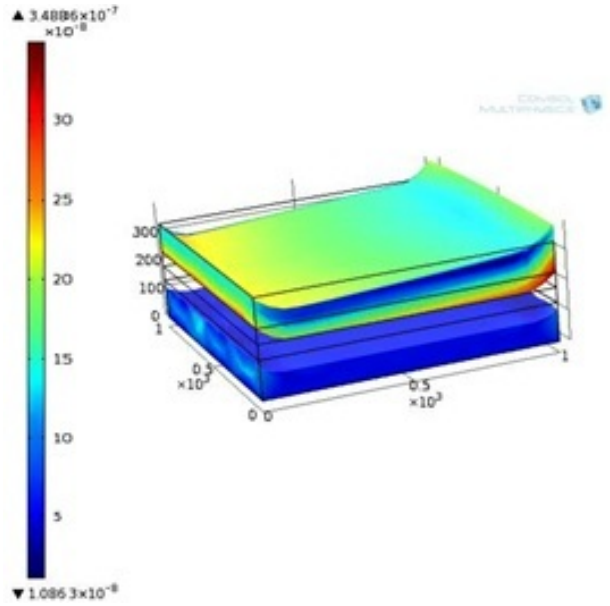

Figure 2: Multi Layer.

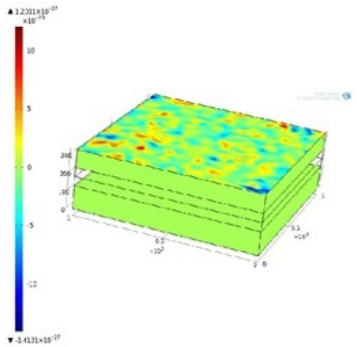

Figure 3: Layers.