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Abstract

Wireless Bipolar Nanopore Electrode (WNE) as a new type of nanoelectrode offers a novel and generally accessible tool for analyzing single molecules/ions, discriminating single particles and probing single cells. The WNE fabricates by a metal coated quartz nanopore, which owns a gold nanostructure at the tip. As exposed to an external electric field in a solution, the conductive nanotip of WNE exhibits a certain polarization potential difference at its two terminals due to the bipolar electrochemistry. The ionic current as the most basic principle for the detection of translocated analytes can be easily influenced by the interactions between the electrolyte and the surface charge on nanopore walls, particularly for the metal-coated nanopores. Despite the behavior of ion transport in nanopores have been modeled widely, description of the polarization metal is still a challenge for WNEs. In this study, the COMSOL Multiphysics○R software is used to study the ion transport in WNEs. Poisson-Nernst−Planck (PNP) and Navier−Stokes (NS) equations have been used to simulate steady-state solutions for ionic current and potential distribution at room temperature of 298 K in a 2D axial symmetric geometry model. For solving the ununiform distribution of charge in the nanopore wall, we have used optimum junction location in the polarization metal and the ununiform charge distribution could be successfully described. The simulation results have successfully explained the ionic current blockade, ion current rectification, ununiform potential distribution and the fluid motion in the tip of the nanopore electrodes.

Figures used in the abstract

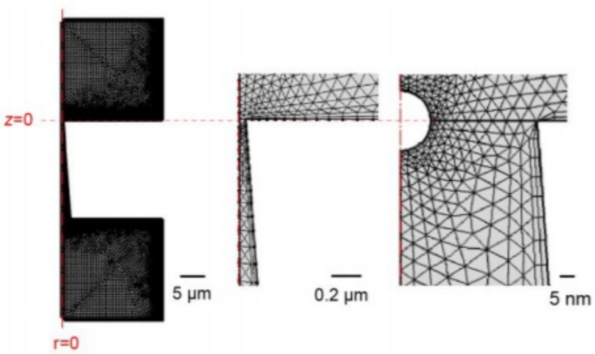

Figure 1: Mesh for the finite element simulation of the ANE with radius of 45 nm by using 2D axisymmetric geometry