Applying an electrical field gradient to living cells via ferroelectric boundaries

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In recent years, an increased interest has emerged in the possibility of using ferroelectric materials as virtual electrodes to investigate biological specimens. Recently, ferroelectric materials have been used to study the electromechanical properties of the cell and nucleus membranes, demonstrating that the surface-screened charges of ferroelectric materials affect the mechanical properties of cells. In this work, we aim to establish a new method for investigating the mechanical properties of living cells with an AFM nanoneedle for cells grown on field gradients that occur between opposite polarization domains and study the electromechanical properties of living cells. Our results suggest that the field gradient created at the interface of opposite ferroelectric domains affects the mechanical properties of the cell and nucleus membranes. We have observed a decrease in the elastic properties of the cell membrane for cells grown on a Periodically Poled Lithium Niobate crystal compared to cells grown on a Lithium Niobate ferroelectric crystal. The penetration of the cell membrane is more straightforward as almost no force is needed to penetrate its cell membrane. These results open new possibilities for understanding, studying, and modulating the inner part of cells under a field gradient at the interface of 180° ferroelectric domain walls.