Uniform electric field generation in circular multi-well cell culture plate/dish using polymeric inserts

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Uniform *in vitro* electrical field (EF) stimulation to cells has been achieved in rectangular shaped cultureware. Creation of a uniform EF from two electric potentials is difficult due to different electrical resistances originated from the length differences between the diameter of the circle and the length of any parallel chord of the bottom circular chamber. To address this challenge, we developed a three-dimensional computer-aided designed polymeric insert to modulate the electrical resistance in circular shaped multi-well culture plates and create uniform EF. A uniform EF with a coefficient of variation (CV) of 1.2 % in the 6-well plate can be generated with an effective stimulation area percentage of 69.5%. In particular NIH/3T3 mouse embryonic fibroblast cells are used to validate the performance of the 3D designed Poly(methyl methacrylate) (PMMA) inserts in a circular-shaped 6-well plate. The CAD based inserts can be easily scaled up (i.e., 100 mm dishes) to further increase effective stimulation area percentages, and also be implemented in commercially available cultureware for a wide variety of EF-related research such as EF-cell interaction and tissue regeneration studies.

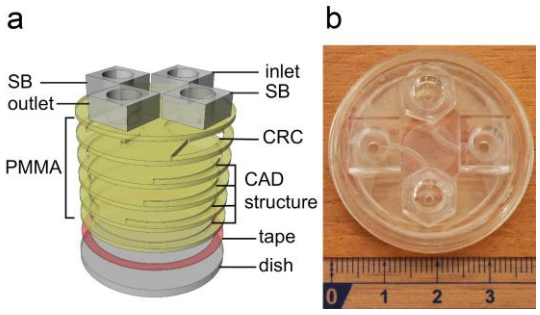

Figure 1. (a) The structure of the polymeric insert (b) A photo picture of the insert adhered to a 35 mm dish.

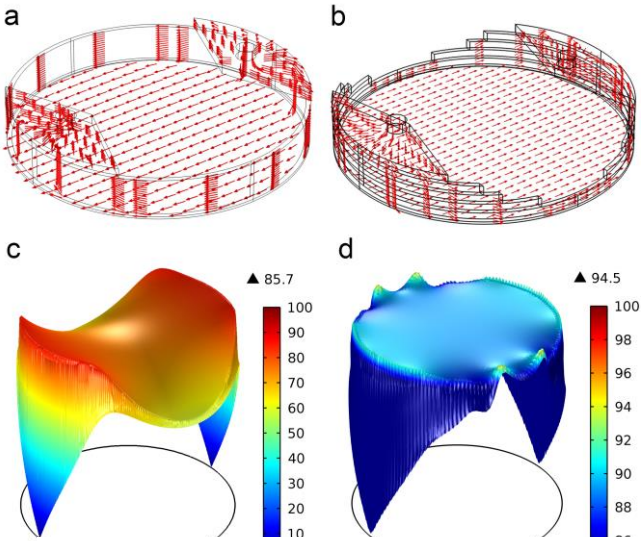

Figure 2. The simulation of the EF in the inserts using COMSOL Multiphysics (a) the current distribution in an insert without the designed structure (b) the current distribution in an insert with the designed structure. (c) The non-uniform EF in the insert without designed structure (d) The rectified uniform EF created using the polymeric insert in this study.