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Electroporation dynamics of giant lipid vesicles

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ABSTRACT

Electroporation is an efficient method for intracellular delivery. Although popular, the molecular details of this process are not well understood. Studying of various aspects of membrane electroporation using cells is difficult due to their inherent complexity. The use of membrane models such as giant unilamellar vesicles (GUVs) offers the advantage of well-controlled conditions and direct visualization with optical microscopy. Electric fields induce deformation and poration of GUVs. The electrodeformation induced depend on the conductivity ratio between the inner and outer vesicle solutions, and can be either into a prolate or an oblate shape. For strong enough pulses, visible macropores open. After the end of the pulse, the vesicle shape relaxes back to its original shape and pores usually reseal, restoring membrane integrity. The dynamics of these processes are governed by the material and mechanical properties of the lipid bilayer. Here, we study the electrodeformation/poration dynamics of GUVs of different composition and in different media. The mechanical response of GUVs to electric pulses is assessed through the vesicle relaxation time after electrodeformation, *t* relax, and pore closure time, *T* pore. From the one side, the effect of residual agarose encapsulated in GUVs grown from hybrid films of agarose and lipids is investigated. From the other side, the presence of the negatively charged phospholipid POPG in the membrane is studied in the presence/absence of salt. The presence of residual agarose in the GUVs alters the mechanical response of GUVs: Both *t* relax and *T* pore show a much broader distribution of values towards slower dynamics. In addition, unusual behavior after pulse application is often observed, including very long-lived pores, increased membrane permeability, and expulsion of a polymer network through the macropore. Pores induced in GUVs containing POPG may open indefinitely and the vesicles burst. This bursting was observed much more frequently for GUVs with higher POPG fraction and in the presence of salt.

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