Ion Channels Reconstituted in Synthetic Block Copolymers

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Abstract:

Exploiting the nanoscale engineering principles of biological systems outside of living organisms has the potential to revolutionize technologies such as energy generation, sensors, environmental remediation, drug delivery, nanoscale synthesis, robotics, and material science. Unfortunately, biological molecules and the macromolecular assemblies in such devices are prone to mechanical instability and chemical degradation. These shortcoming are managed in organisms by the constant metabolic turnover of such molecules; a process that is engineered to remove and replace labile molecules and one that is (so far) difficult to mimic in artificial constructs. One approach to overcoming the fragility of these components has been to utilize engineered block copolymers in the place of lipids and synthetic macromolecules as membrane channels.

We present methods for forming, characterizing, and incorporating natural ion channels in to biomimetic planar membranes composed of amphiphilic block copolymers. Synthetic membranes were formed of diblocks and triblocks composed of hydrophilic poly(2-methyl-2-oxazoline) (PMOXA) and hydrophobic poly(dimethylsiloxane) (PDMS). The lipid diphytanoyl phosphocholine (DPhPC) served as a control. Phase-contrast microscopy was used to study membrane evolution over time after their formation. Electrical measurements were performed to characterize the thickness of the membrane and demonstrate functional reconstitution of the natural and artificial ion channels.

The capacitance measurements yielded 0.28 μF/cm^2 with a corresponding thickness of 8.5 nm for $PMOXA_6$ -$PDMS_{35}$-$PMOXA_6$ formed from a solution of ethanol-decane, 0.55 μF/cm^2 and 4.4 nm in chloroform-toluene and 0.46 μF/cm^2 and 5.4 nm for the diblock $PMOXA_6$ -$PDMS_{17}$ in ethanol-decane. This ion channels alamethicin and gramicidin reconstituted in the block copolymers show slower channel forming kinetics with somewhat higher conductance values than found in DPhPC.

<u>Biography of Presenter</u>

Michael Martin currently works as a research associate for Dr. Joel Fried in the Chemical Engineering Dept. at the University of Louisville. He also works as a research associate for Noveratech, LLC, a start-up company in Louisville developing nano-drug delivery solutions for intracellular adenosine triphosphate designed to

accelerate wound healing in various contexts. Finally, he is pursuing a PhD, part time, in physics at the University of Louisville.