Tuning the isoelectric point of polymeric nanochannel surfaces by atomic layer deposition of Al_2O_3, TiO_2, and SiO_2 to tailor selective ion transport

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Biological channels embedded in plasma membranes perform crucial metabolic functions and regulate the communication between each cell and its surroundings. These bio-channels exhibit highly selective ion transport, which can be investigated by various transport measurements. They inspire, at the same time, the biomimetic design of solid-state nanosensors that offer important advantages regarding durability, reproducibility, and stability. [1,2] In particular, polymer single nanochannel membranes are fabricated by combining swift heavy ion irradiation and chemical etching. Using this technique, we produce single nanochannels with high aspect-ratio, controlled dimension, and geometry. In addition, we apply atomic layer deposition (ALD) to conformally and homogeneously coat the single channel membranes with SiO_2, Al_2O_3, and TiO_2. The different isoelectric points of these oxides (Al_2O_3 ~pH 9, TiO_2 ~pH 5, SiO_2 ~pH 2 [3]) allow us to tailor the surface charge of the nanochannels. The resulting inorganic and well-defined nanochannels constitute excellent model systems to study ion-transport characteristics. We will present current-voltage measurements on single cylindrical and conical ALD coated nanochannels as a function of channel size, pH, and salt concentration. In all cases, ALD coating improved the stability of the channels exhibiting more reproducible ion conductivity than their uncoated counterparts, and enhanced long term stability. In the future ALD coated membranes will be combined with bio-channels to create a hybrid system for sensor applications.

References

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