

DC studies of Layer-by-layer nanopores electrical properties tuning on Polycarbonate Membranes

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Abstract (Arial 10)

Nanoporous membranes have numerous potential biological and medical applications that involve sorting, sensing, isolating, and releasing biological molecules^[1]. Recent advances in nanoscience are making possible to precisely control morphology as well as physical and chemical properties of the pores in nanoporous materials. Different researches showed that transport selectivity through solid-state nanopores can be effectively modulated by changing the size^[2], the charge^[3–5] and the polarity of the pores^[6–8] or by using tethered receptors that are capable of selective molecular recognition^[9]. Surface modification techniques are often used in order to achieve those results, as they can alter both physical and chemical properties.

We investigated how polyelectrolyte layer-by-layer (LBL) surface modification can be used to change the characteristics of nanoporous membranes. Studies were performed with a custom made three-dimensional multilayer microfluidic device able to fit membrane samples. The device allowed us to efficiently control LBL films deposition over blank low-cost commercially available polycarbonate track-etched (PCTE) membranes. We have demonstrated pore diameter reduction and deposition of the layers inside the pores through confocal and SEM images.

Posterior impedance studies served to study the effect of the LBL charges to the net inner nanopore surface charges. Measurements were performed using Phosphate Buffer Saline as conductive medium. DC results generally show dependence between the electrical resistance and the increasing number of layers. Adding layers on pore surface decreases the pore mean aperture, resulting in a diminution of ions flux and thus of electric current across the membrane. Measurements have also demonstrated contrasted behaviors depending on the number and parity of deposited opposite charge layers. PCTE membranes are originally negatively charged and results evidenced higher impedance increases for paired charges LBL depositions. Impedance decreased when an unpaired positive layer was added. Following Electrical Double Layer theory we hypothesize that charges in the buffer tend to redistribute in the solution, reorganizing near the pores surfaces and creating an opposing charges layer which alters local conductivity.

References

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Figures

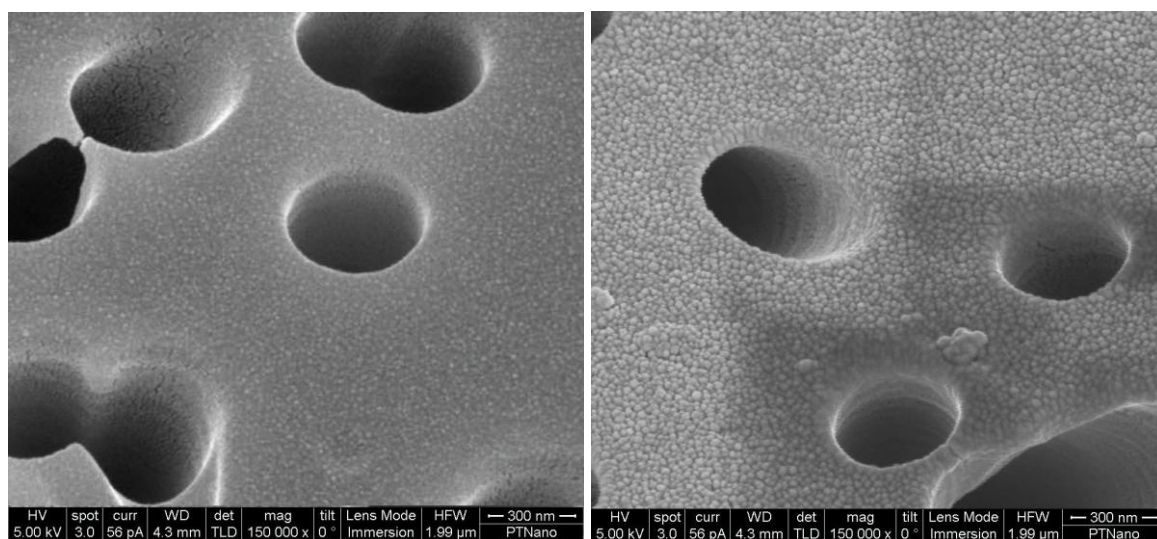


Figure 1. SEM images of polycarbonate membrane: on the left, not covered by polymers; on the right, covered by polymers.

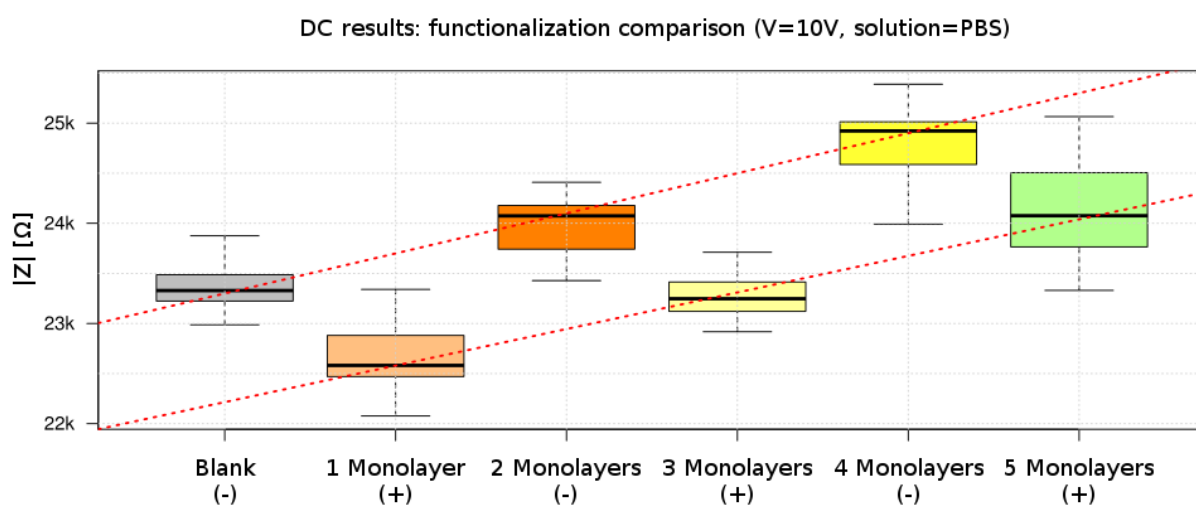


Figure 2. Measured resistance values comparison between different functionalizations of 200nm pore size membranes. Resistance tends to increase with the number of deposited layer, but measurements related to an odd number of deposited layers reveal a negative offset.