

Influence of ionic organization on current blockade induced by translocation of small macromolecule through a single nanopore

S. Cabello-Aguilar¹, F. Picaud², M. Bechelany¹, A. Abou-Chaaya¹, E. Balanzat³, P. Dejardin¹, C. Pochat-Bohatier¹, S. Balme¹

¹*Institut Européen des Membranes, UMR5635 CNRS-UM2-ENSCM, Place Eugène Bataillon, 34095 Montpellier Cedex 5, France*

²*Laboratoire de Nanomédecine, Imagerie et Thérapeutique, Université de Franche-Comté, Centre Hospitalier Universitaire de Besançon, 16 route de Gray, 25030 Besançon Cedex, France*

³*Centre de recherche sur les Ions, les MATériaux et la Photonique (CIMAP), UMR6252 CEA CNRS-ENSI CAEN, 6 Boulevard du Maréchal Juin, 14050 Caen Cedex 4, France*

Single macromolecule detection through a single nanopore is based on resistive pulse technique. Typically, the ionic current is recorded. However at the nanometer scale it cannot be considered bulk like. Our main goal will be to emphasize the importance of the ion structuration (i) around the macromolecule and (ii) inside the nanopore on the signal induced by macromolecule translocation.

Here, we will report the fabrication of a single nanopore with high aspect ratio, tailored by the track etching and atomic layer deposition techniques. The Polyethylene glycol-carboxylate (PEG- carboxylate) molecules (low molar mass 200 and 600 g.mol⁻¹) translocation through this nanopore has been studied. The current trace show that PEG-carboxylate molecules permeate through the nanopore, promote an unusual and unexpected blockade of ionic current. The latter is characterized by the presence of current spikes at the beginning and at the end of the blockade (Figure 1). This parameter was shown to be the most discriminative regarding to the PEG-carboxylate molar mass.

The question of unusual and unexpected blockade of ionic current has been investigated by Molecular Dynamics Simulation. The results show that the cation shell surrounding the PEG-carboxylate should induce the ionic current blockade which is at the origin of the experimental signal (Figure 2).

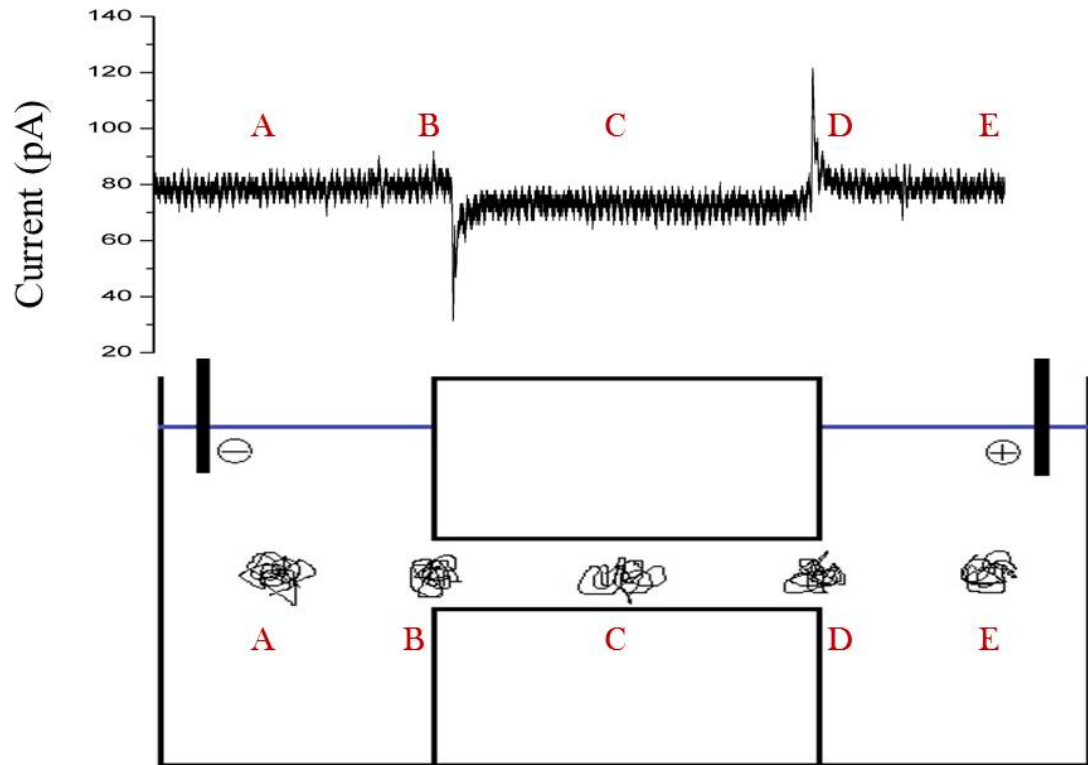


Figure 1 : detail of a current blockade

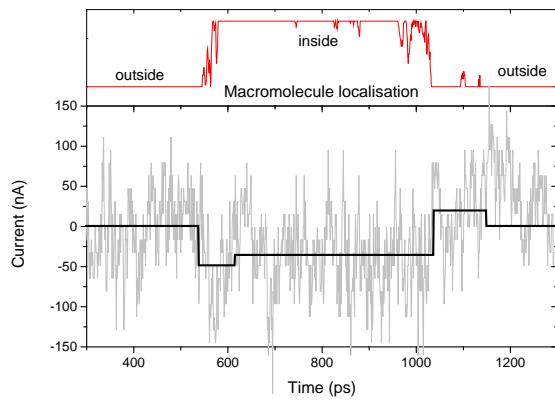


Figure 2 : Ionic current calculated by MD simulation (bottom) and macromolecule localization (top) for PEG200-carboxylate