Selective protein binding using a solid-state nanopore into a microfluidic device

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Solid-state nanopores are powerful tools to detect DNA configurations [1,2], protein size [3,4] and conformation [5,6,7], nanoparticles [8] and virus [9]. The nanometric diameter of solid-state nanopores can be tuned to fit the analyte size. Moreover, they present better chemical and mechanical stability than the biological ones [10]. However, the interactions between nanoparticles to be detected and the nanopore remain poorly controlled, while the membrane supporting the nanopore has a short lifetime attributed to a high surface energy [5]. To overcome these drawbacks, we have proposed a polymer functionalization to better control the pore size, to passivate the membrane. Hence avoiding nonspecific interactions of nanoparticles, by manipulating the chemical and physical surface properties [10]. Furthermore, to increase the specificity, a receptor can be immobilized on the nanopore surface to specifically capture the target molecules [9], leading to an active sensor. The nanopore chip was inserted into a microfluidic device to facilitate its handling and ease the possible change of buffers. The proof of concept was done using the streptavidin-biotin complex, where the streptavidin was captured by the grafted biotin inside the nanopore [11]. We plan to use this approach for virus detection.

Fig. 1 a) Microfluidic device with a nanopore chip placed on it. b) Current blockade when a streptavidin molecule transiently resides inside a functionalized nanopore. c) Streptavidin interactions with a nanopore grafted with short and biotinylated long polymer (PEG) chains.