# Development of biomimetic nanoporous membranes for the sensing and separation of proteins

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Recent advances in bio-sensing and bio-separations have focused on use of appropriate materials via 'bottom-up' approaches [1]. These developments are further accelerated by the ease of syntheses of nanosized materials and the possible chemical functionalization of these nanomaterials, which inspire varied sensor platform designs showing potentials of yielding high sensitivity, specificity and stability. In this report, we describe two recent works on developments of protein sensors using a membrane-based electrochemical biosensor. A nanoporous material based on nanoporous alumina with tunable pore sizes was coated onto an electrochemical sensing electrode for the attachment of immunoglobulin probes. The sensing mechanism of the selective and sensitive electrochemical protein sensor was described in Fig. 1. Using ferrocenemethanol as the redox probe, decrease in current was observed at the immunoglobulin-modified alumina electrode upon selective binding of the complementary protein antigen, giving an immunocomplex which effectively block the channels [2].

In a second work, we describe the use of a micrometer-thick platinum coated nanoporous membrane for the separation of proteins and nanoparticles of sizes larger than 10 nm. A high field strength of ca. 30kV $m^{-1}$ was applied using very low applied potentials of ca. 2 V between the platinum-coated membranes. In addition, we demonstrated that under a constant convective flow condition, the same membrane system was capable of resolving small quantities of two proteins, bovine serum albumin and lysozyme, chosen for their small molecular sizes [3]. We further explored the inclusion of electrochemically active materials within the nanometer-sized pores to facilitate the separation of analytes with dimensions less than 5 nm. The biomimetic designs of these works will be discussed.

**References:**

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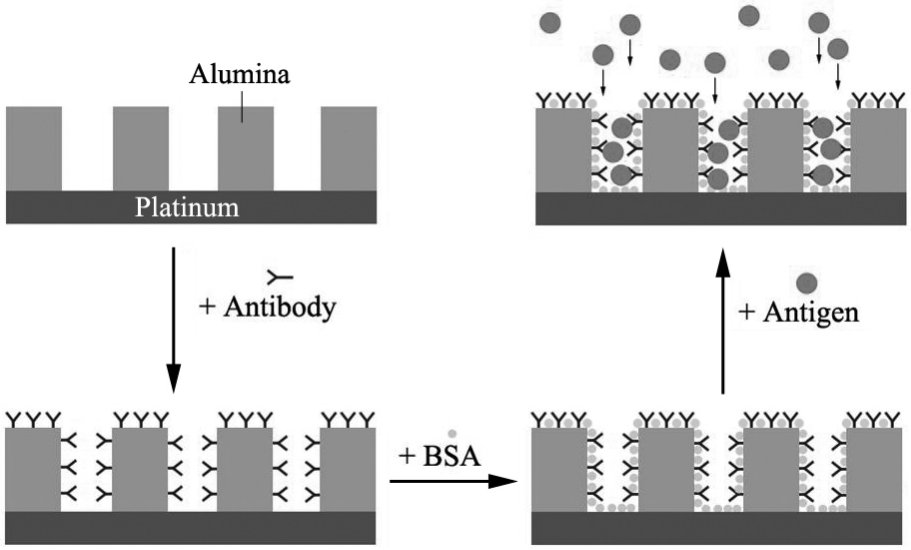


**Figure 1** Schematics of protein antigen detection using the membrane-based immunosensor. A monolayer or submonolayer of antibody was physically adsorbed onto the channel walls of the nanosized alumina pores, followed by blocking of non-specific adsorption sites with bovine serum albumin and finally the alumina modified electrode was used for protein antigen detection. Formation of the antibody-antigen complex resulted in the narrowing and blocking of the nanosized pores and the subsequent decrease in signal response towards a redox probe measured using differential pulse voltammetry.