4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

Engineering Polymer-Supported Membrane Proteins Bio-Inspired Ion Channels

E.A. Perpète[1*], C. Michaux[1], M. Pérez-Madrigal[2], L.J. del Valle[2], E. Armelin[2], and Carlos Alemán[2]

[1] *Unité de Chimie Physique Théorique et Structurale, University of Namur, Belgium*
[2] *Departament d'Enginyeria Química, ETSEIB, Universitat Politecnica de Catalunya, Barcelona, Spain*

Accepted for publication on 26th February 2015

Membrane proteins play a central role in many cellular and physiological processes, and are very important therapeutic targets, but they remain extremely difficult to isolate in a native form. On the other hand, biomedical platforms constructed by immobilizing membrane proteins in matrixes made of synthetic organic polymers is a challenge because the structure and function of these proteins are affected by environmental conditions.

In this work, we present the engineering of such a platform, starting from the production of a β-barrel membrane protein (Omp2a), including its renaturation by an original protocol combining specific cosolvent-detergent treatment, and eventually incorporating the resulting active biomolecule into a supporting matrix made of poly(N-methylpyrrole) (PNMPy).

The protein has been unequivocally identified in the composite, and its structure has been shown to remain unaltered. The PNMPy−Omp2a platform fulfills properties typically associated with functional bio-interfaces with biomedical applications (e.g., biocompatibility, biodegradability, and hydrophilicity).

The functionality of the immobilized protein has been examined by studying the passive ion transport response in the presence of Na+ and K+ electrolytic solutions. Although the behaviour of PNMPy and PNMPy−Omp2a is very similar for solutions with very low cationic concentration, the resistance of the latter decreases drastically when the concentration of ions increases to ca. 100 mM. This reduction reflects an enhanced ion exchange between the biocomposite and the electrolytic medium, which is not observed in PNMPy, evidencing that PNMPy−Omp2a is particularly well suited to prepare bio-inspired channels and smart biosensors.

Keywords: membrane protein, renaturation, polypyrrole, bio-inspired, channels

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John Smith[1*]，张三[2]，李四[3]

[1]*School of Engineering, University of Aberdeen, Aberdeen AB24 3UE, UK*
[2]*Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA*
[3] *中国 北京清华大学工程力学系，北京 100084*

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