Morphology and Permeability of Biomimetic Cellulose Triacetate-Impregnated Membranes: in situ Synchrotron Imaging and Experimental Studies

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Abstract : This study aimed to ascertain the controlled permeability of biomimetic cellulose triacetate (CTA) membranes by investigating the electrical oscillatory behavior across impregnated membranes (IM). The biomimetic CTA membranes were infused with a fatty acid to induce electrical oscillatory behavior and, hence, to ensure controlled permeability. In situ synchrotron radiation micro-computed tomography (SR-μCT) at the BioMedical Imaging and Therapy (BMIT) Beamline at the Canadian Light Source (CLS) was used to evaluate the main morphology of IMs compared to neat CTA membranes to ensure fatty acid impregnation inside the pores of the membrane matrices. A monochromatic beam at 20 keV was used for the visualization of the morphology of the membrane. The X-ray radiographs were recorded by means of a beam monitor AA-40 (500 μm LuAG scintillator, Hamamatsu, Japan) coupled with a high-resolution camera, providing a pixel size of 5.5 μm and a field of view (FOV) of 4.4 mm × 2.2 mm. Changes were evident in the phase transition temperatures of the impregnated CTA membrane at the melting temperature of the fatty acid. The pulsations of measured voltages were related to changes in the salt concentration of KCl in the vicinity of the electrode. Amplitudes and frequencies of voltage pulsations were dependent on the temperature and concentration of the KCl solution, which controlled the permeability of the biomimetic membranes. The presented smart biomimetic membrane successfully combined porous polymer support and impregnating liquid not only imitate the main barrier properties of the biological membranes but could be easily modified to achieve some new properties, such as facilitated and active transport, regulation by chemical, physical and pharmaceutical factors. These results open new frontiers for the facilitation and regulation of active transport and permeability through biomimetic smart membranes for a variety of biomedical and drug delivery applications.

Keywords : biomimetic, membrane, synchrotron, permeability, morphology
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