Study on the 3D Pore Morphology of Membrane and Its Connectivity by X-ray Microtomography

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Membrane filtration processes are currently used in a wide range of applications in chemical, environmental and biological industries due to its high-efficiency, energy-saving and a physical operation without phase change characteristics. However, fouling is often a key factor governing the performance of these separation processes. Several studies have shown that the membrane pore morphology and its connectivity can have a strong effect on fouling. How to grasp the structural characteristics of membrane, such as pore diameter, pore size distribution, pore shape, porosity and connectivity, is an important issue to improve the performance of membrane filtration processes.

In this study, different ways were adopted to analyze the pore morphology of the membrane, including bubble point test, microscopic method, quantitative image analysis and X-ray microtomography. Focuses are placed on the application of X-ray microtomography to the characterization of membrane pore morphology. The X-ray microtomography data were collected using synchrotron radiations at NSRRC 01B1 beam lines.

The partial result show that the X-ray microtomography was applied to reconstruct the 3D pore structure of polycarbonate track etched membranes (PC). Dimensions of the observed volume (i.e. the box) are 273 x 361 x 50 voxels or 8.2 x 10.8 x 1.5 μm as shown in Fig.1-4. The 3D structure provides us an easy way to analyze pore interconnectivity. The pore size measurement by bubble point test is close to the data provided by the manufacture, but it can not give any information about the pore morphology. Although the pore morphology can be observed by SEM or TEM, they can provide only the laminar pore morphology instead of a 3D feature.

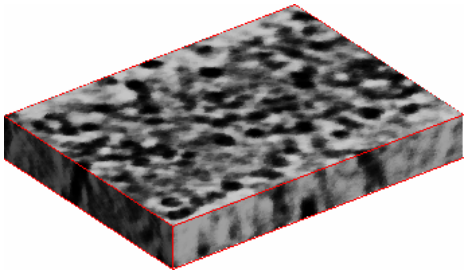

Fig.1 The 3D reconstruction for. 3D reconstructed volume of a part of polycarbonate track etched membranes. Dimensions of the observed volume (i.e. the box) are 273 x 361 x 50 voxels or 8.2 x 10.8 x 1.5 μm.

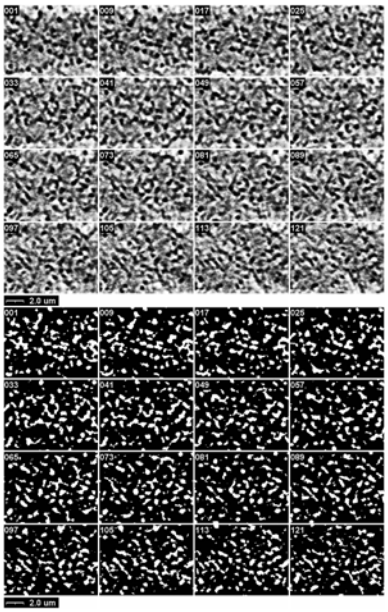

Fig.2 The 2D imges of for the different slices of 3D reconstruction polycarbonate track etched membranes. (a) gray images and (b) binary images

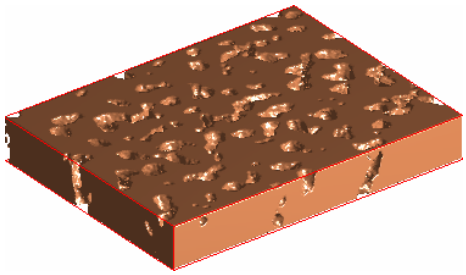

Fig.3 Three-dimensional view of spatial distribution for porous polycarbonate track etched membranes.

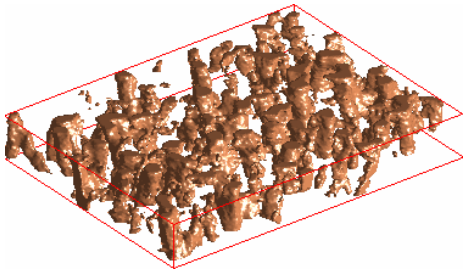

Fig.4 Three-dimensional view of spatial distribution for cylinder pores on polycarbonate track etched membranes.