An Application Study for Characterization of Macroporous Polymer Membranes by Confocal-Laser-Scanning Microscopy and 3D Image Analysis

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The structural complexity of phase inversion macroporous polymer membranes drives a general need for characterization methods on the pore size scale of such membranes. The pore size distribution, the porosity and the specific surface area often have a significant impact on the performance of membranes. However, typically used methods for the determination of these characteristics are not able to resolve a 3D pore structure on a local level due to their cumulative nature, or are limited in the quantification of pore size characteristics. A recently published membrane characterization method[1] is therefore more promising. It uses confocal laser scanning microscopy (CLSM) images combined with computer based image analysis to derive a 3D representation of the membrane structure and a quantitative characterization of these structures. To measure quantitative structure information, the CLSM derived images are binarized using a threshold determined by experimental values for porosity. To measure the pore size distribution, a so called signed distance function is calculated in the 3D structure measuring the smallest distances between pore boundaries followed by a thinning algorithm to mark the center of the signed distance function. Consequently the pore size distribution and the specific surface area of the membrane can be determined on a local level.[1] However, this method was only shown for a sample consisting of nitrocellulose membrane. In order to verify this technique, the application of the described method on different pore sized membranes out of a different material is studied. It can be shown that the predicted characteristics are in reasonable agreement with the measured parameters in terms of permeability and specific surface area. This work therefore highlights the advantages and possibilities of the CLSM characterization method.[1]

[1] Ley, A.; Altschuh, P.; Thom, V.; Selzer, M.; Nestler, B.; Vana, P. Characterization of a Macro Porous Polymer Membrane at Micron-Scale by Confocal-Laser-Scanning Microscopy and 3D Image Analysis. J. Memb. Sci. 2018.