ABSTRACT

Micro-Electro-Mechanical Systems (MEMS) based filter with microchannels enables the removal of various microorganisms, including viruses and bacteria, from fluids. Membranes with porous channels can be used as filtration interfaces in MEMS devices. Microfluidic filtration is an essential process in many biomedical applications. Micro or nanoporous membranes are used for colloidal retention. The main problems associated with filtration are optimization of membrane geometry and fouling. Nanoporous aluminum oxide membranes with pore sizes 40-200nm were fabricated using an optimized two-step anodization process. Computational strength modeling and analyses of the membrane with specified parameters were performed using ANSYS static structural. During the membrane filtration process, visualization of various phenomena is challenging. Theoretical models have been proposed to visualize the transport mechanism. ANSYS Fluent is used for 3D designing of the microfluidic system, and fluid-structural coupled simulations were performed for analyses and calculation of fluid flux. Fuzzy simulations were performed for numerical analyses and parametric estimation of pore diameter and flux through the membrane. The membrane was then incorporated into the microfluidic device for successive filtration. The fluid flux and permeation analysis of the filtration process has been studied. Scanning electron microscope (SEM) micrographs were obtained for membranes before and after filtration cycles. The SEM results indicate membrane fouling after multiple cycles, and thus the flux is affected. This type of fabricated membrane and setup is suitable for the separation and purification of various fluids. However, after several filtration cycles, the membrane is degraded highly and requires prolonged chemical cleaning. High-density water was used for filtration purposes, so this proposed MEMS filter can also be applied in applications like mini dialyzers and hemofilter. Such demonstration also opens up a new strategy for maximizing the filtration efficiency and reducing energy costs for the filtration process by using a layered membrane setup.