

Dynamic Control of Electroosmosis in Electroactive
Carbon Nanotube Membranes

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Template-prepared carbon nanotube membranes (CNMs) are synthesized by doing chemical vapor deposition of carbon within the pores of a microporous alumina template. CNMs are highly porous and have monodisperse pore dimensions which are easily controlled by template synthesis. Template-prepared carbon nanotubes have a number of advantageous properties such as versatile surface chemistry and good electrochemical properties that make them an extremely interesting membrane material

The control of electroosmotic flow (EOF) across CNMs to modulate transport of permeant molecules has been achieved. EOF is induced across the CNMs by allowing the membrane to separate two electrolyte solutions and using an electrode in each solution to pass a constant ionic current through the nanotubes. EOF is investigated by measuring the flux of a probe molecule across the CNM. EOF in the direction of diffusion enhances permeant flux while EOF in the opposite direction of diffusion lowers flux. The as-synthesized CNMs have anionic surface charge, and EOF is in the direction of cation migration across the membrane. Measurement of the rate of EOF as a function of applied transmembrane current provides the zeta potential (ζ) of the nanotubes.

Several electrochemical derivatization methods have been used to modify the surface chemistry of the nanotube walls; this results in CNMs with differing EOF properties. For instance, electropolymerization of poly(vinylferrocene), PVF, onto the membrane surface results in redox-active PVF nanotubes. By oxidizing and reducing the electroactive nanotubes the surface charge density is dynamically modulated and thus EOF can be turned on and off with the flip of a switch.