PRINCIPLES OF FIBER-BASED MICRO AND NANOFLUIDICS

Konstantin G.Kornev, Gegardo Callegary and Alexander V.Neimark

Center for Modeling and Characterization of Nanoporous Materials, TRI/Princeton, 601 Prospect Avenue, P.O. Box 625, Princeton, NJ 08542. kkornev@triprinceton.org

Recent advances in fabrication of specialty fibers and nonwoven membranes from various polymer precursors and carbon nanotubes make possible the development of novel micro- and nano-fluidic devices. Micro and nanochannels can be formed from fibers already available on market. Some nanofibrous composite substrates possess a hierarchical pore architecture with a high surface area and open porosity. This provides a significant absorption capacity and selective permeability. We discuss the principles of fluid pumping through fiber-based micro- and nano-fluidic devices exploiting the phenomenon of spontaneous absorption of wetting fluids by fibrous materials. Capillarity facilitates the droplet self-propulsion without the need for any additional external means. We will show that the size of the microchannels does matter. In some microchannels, the fluid velocity may be as fast as 100 cm/s! Driven by the idea to speed up the transport in fiber-based microfluidic devices, we consider the mechanisms of tailoring the pore structure of nanoyarns and nanostructured films. We discuss the fluid mechanical basics for an intelligent design of the sandwiched fabrics, made of a blend of coarse-structured and nanofibrous materials. Some applications of the proposed effects to sensors based on nanofibrous supports will be shown. Electrospun nanowebs and fibers made of single wall carbon nanotubes will exemplify the concepts.

Keywords: nanofibers, capillarity, wetting