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Deionization shocks in cross flows[1]

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Recent experimental and theoretical studies have shown that surface conduction in supported electrolytes, such as in micro/nanochannels or porous media, can lead to nonlinear modes of transport and formation of sharp concentration fronts analogous to shock waves in gas dynamics. Propagation of these shocks leaves behind a region of ultra pure fluid, acting to deionize the bulk solution. In this work we present the analysis of salt transport in a porous medium next to a membrane with an electric field applied normal to the interface and cross flow in tangential direction. We show that two distinct boundary layers grow near the membrane: an inner (shocked) region with almost deionized solution dominated by surface conduction, and an outer layer with diffuse dynamics. Under certain conditions both regions collapse into a similarity solution with the same scaling. We will discuss advantages of such systems for desalination and water purification.

[1]Research performed in collaboration with Martin Bazant (MIT)