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Measurement of frictional coefficients in cartilaginous tissues and its substitutes

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Introduction
At the scale of cell-mechanics, absorption- and electric forces become dominant over pressure [1]. Therefore, a thorough understanding of electro-osmotic and electrophoretic processes in charged porous media is needed. The purpose of this study is to measure the frictional coefficients, which quantify these phenomena macroscopically in a hydrogel.

Analyses
Permeability and ion diffusion-convection in incompressible electro-chemo-mechanics is described by the following constitutive equations for the velocities $v^\gamma$ of constituents $\gamma$: [2]

$$-C^\beta \nabla \mu^\beta = \sum_{\gamma=f,+,-} B^{\beta \gamma} (v^\gamma - v^\beta), \quad \beta = f,+,-$$

(1)

in which $C^\beta$ is the molecular concentration of phase $\beta$, $\mu^\beta$ its molecular electro-chemical potential and $B^{\beta \gamma}$ is a symmetric matrix of frictional coefficients. The other frictional coefficients are related to the constants in the electro-kinetic relationships:

$$j = -L^p \nabla p - L^e \nabla \xi,$$

(2)

$$i = -L^e \nabla p - L^e \nabla \xi,$$

(3)

where $j$ is the volume-flow, $i$ is the electric current, $\Delta p$ is the pressure gradient and $\Delta \xi$ is the gradient of the electric field.

Aim of this research
We want to estimate the coefficients of the symmetric $B$ matrix by measuring the constants in the electro-kinetic relationships (2), (3).

Experiments
In figure 1 a schematic representation of the experimental setup is given [3]. There is no concentration gradient across the sample. Figure 2 depicts a photo of the measurement apparatus.

Electro-osmotic flow experiment
The pressure gradient between both sides of the sample is kept equal to zero. We estimate $L^{pe}$ and $L^p$, by measuring $j, i$ and $\Delta \xi$.

Electro-osmotic pressure experiment
The fluid flow through the sample is kept equal to zero. We estimate $L^{pe}$ and $L^e$, by measuring $i, \Delta \xi$ and $\Delta p$.

References:

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