Homework: Microfluidics

November 2022

Microfluidic chip has a channel, which is L=20cm long, h=20um high, and w=50um wide. Channel is open from both. In one end of the channel there is one electrode (+) and at the distance of x=12cm along the channel there is another electrode (-). Channel is filled with neutral buffer solution (pH 7) with conductivity 1 S/m. Current 10uA is driven through the electrodes. Following graph below and sketched might be useful to answer the questions

1) Determine the electrical potential between the electrodes (0.5 pt) and heat dissipated (0.5pt)

2) Determine the electro-osmotic flow rate. Explain! (1 pt) Consider only flow contribution from electro-osmotic flow.

3) What is the pressure this electro-osmotic flow rate is causing? Why? Explain how you calculated it! (1pt)

4) Depict flow and flow profiles at both sides of the "-" electrode! What is the flow direction? (2pt)

5) Calculate total flowrate from one side of the channel to another (2pt)

6) Now at the end of the tube closer to "-" electrode, there will be a vertical glass capillary connected to the channel outlet. Capillary diameter is D=100um, contact angle of water and glass is $\gamma = 55°$, surface tension of the water is 1 mJ/m^2. What is the height of the water in the capillary? (Electrical current is applied same way as previously) (3pt)

* Further assumptions: do not assume that electrical current is causing any gas formation on the electrode

Useful hint: Kirchhoff rules and superimpositions would useful ideas how to tackle these flows (remember the analogy with electrical circuits!)