Estimating glucose diffusivities in electrospun fibers using diffusion cell experiments and image processing

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Background

- Poly-caprolactone (PCL) scaffolds are used for growing artificial tissues in bioreactors.
- PCL scaffolds have been prepared with different electrospinning duration and polymer solution flow rates. The morphology of scaffolds is analysed.
- The glucose diffusivities of these scaffolds in cell culture medium (CCM) and water are measured.
- Sometimes, it is hard to obtain in-situ diffusivity results from experiments (e.g., tissue growth in bioreactors). Hence, image processing is introduced to predict diffusion coefficients of glucose in CCM and water.

Experimental Results

Table 1 Characteristics of electrospun scaffold

Sample no.	Flow rate (ml/h)	Duration (mins)	Number of syringes	Average Fiber-fiber space (μm)	Average fiber diameter (μm)
1	1	90	1	1.38±0.7557	0.7824±0.409
2	2	90	1	3.8003±1.6949	2.10±0.7653
3	1	45	2	1.88±0.77	0.905±0.641

Table 2 Glucose effective diffusivities in water and CCM across electrospun scaffolds

Sample no.	Effective diffusivities in CCM $\times 10^{11} m^2/s$	Effective diffusivities in water $\times 10^{11} m^2/s$
1	2.83±0.120	6.31±0.313
2	3.75±0.268	8.27±0.229
3	3.22±0.107	7.38±0.273

PCL Scaffolds and Image Processing

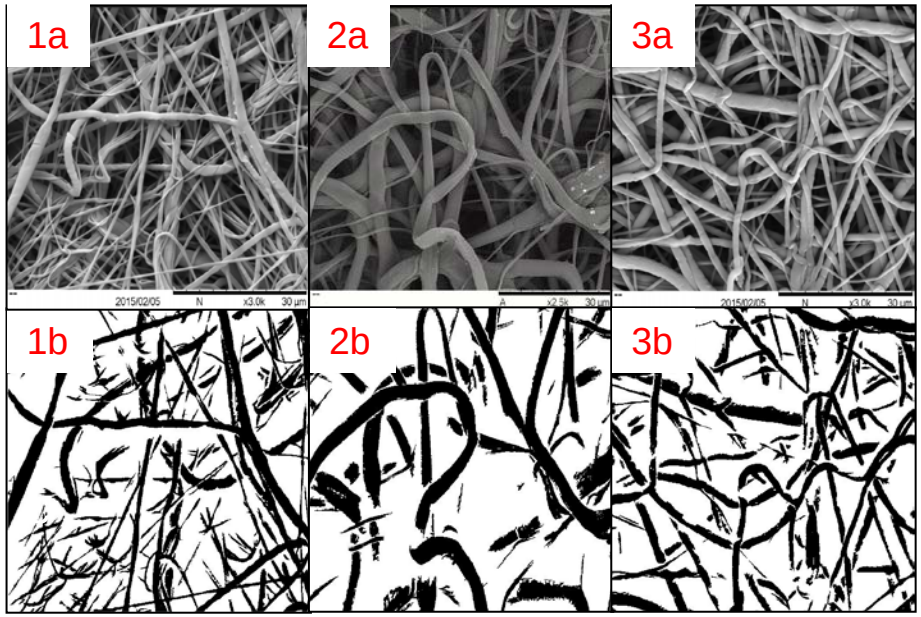

Figure 1 Original (a) and processed (b) images of sample 1,2 and 3 from SEM

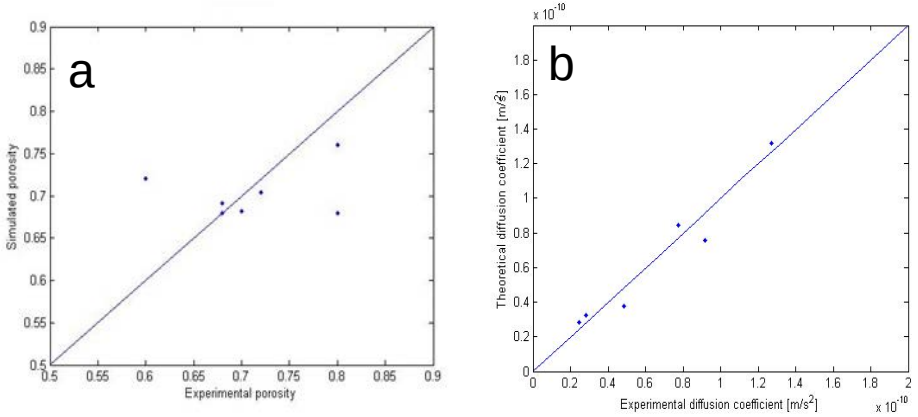

Figure 2. Scatter plot of predicted (a) porosity and (b) diffusion coefficient (y-axis) plotted against experimental results (x-axis)

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Results

- Fiber-fiber space and fiber diameter are both increased with higher PCL flow rate.
- The fiber-fiber distance and fiber diameter are also slightly increased if the flow rate is increased by the usage of two syringes for injecting the polymer solution instead of a single syringe.
- In experimental work, diffusivities of glucose in both water and CCM are obtained. As the fiber fiber space increases, the diffusivity increases. Results of same scaffolds in water and CCM are compared, the diffusion coefficients in CCM is smaller than those of in water.
- It can be seen that results obtained from image processing are close to the experimentally obtained results in the case of porosity as well as diffusion coefficient. It is possible to predict the diffusion coefficients through this method.

Thank you for your listening!!!