Electrospun Hydrogel for Biomaterial applications

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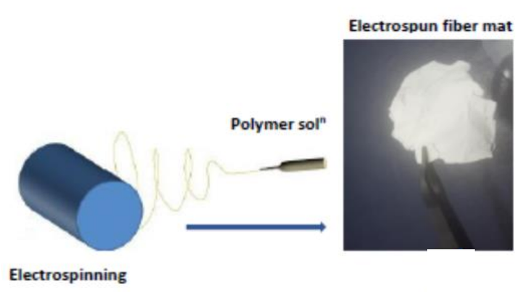
Abstract

In this study we demonstrate a generic approach towards synthesis and electrospinning a hydrogel. The aim being to fabricate electrospun poly (2-hydroxyethyl methacrylate) based nanofibers by reactive electrospinning. To improve endurance of electrospun fiber, the hydrogel was functionalized with photo-crosslinking groups before spinning. The nanofiber mats were characterized by scanning electron microscopy (SEM).



Methods and Materials

Synthetic Protocol

CHEMICAL	QUANTITY
2,2-DIMETHOXY-2-PHENYLACETOPHENONE INITIATOR	0.3220 g
2-HYDROXYETHYL METHACRYLATE (HEMA) MONOMER	7.5 mL
TETRAETHYLENEGLYCOL DIMETHACRYLATE CROSS-LINKER	250 μL
ETHYLENE GLYCOL	800 μL
DMSO	100 μL

Electrospinning conditions

~ Voltage 8.71 kV

~ Temp 20°C and Humidity set @ 50% but read 13%

~ Flow rate @mL/min

1.0
0.7

Initially the polymer flow was unstable but was able to attain a constant flow at 1 then back to 0.7 mL/min

Observed fiber morphology with **high resolution Carl Zeiss GeminiSEM500**:
Key Scale bar: 1μm & 200 nm (for comparison of images),
- Measure 3 nano nets pores (small, medium, large)
Pore size, pore distribution, fiber diameter

Reactive electrospinning set-up

Introduction

Hydrogels exhibit an intriguing 3D structures that imbibe tremendous amounts of water into the reticulated assembly. Such an inherent feature sparked a massive scientific research interest.[1] Their high-water content, porosity and soft consistency, closely simulate natural living tissue, more so than any other class of synthetic biomaterial which then renders hydrogels suitable in extensive applications such as in biomedicine, soft electronics, sensors, and actuators.[2] **Figure 2** shows various hydrogel applications. There are different methods used to prepare porous hydrogels with controlled pore size that significantly promotes vascular in-growth in tissue enginering.[3] Electrospinning is one of such methods with an added advantage of producing continuous fibers with diameters ranging from several tens of nanometers to a few microns, a size range otherwise difficult to achieve with conventional fiber fabrication techniques.[4]

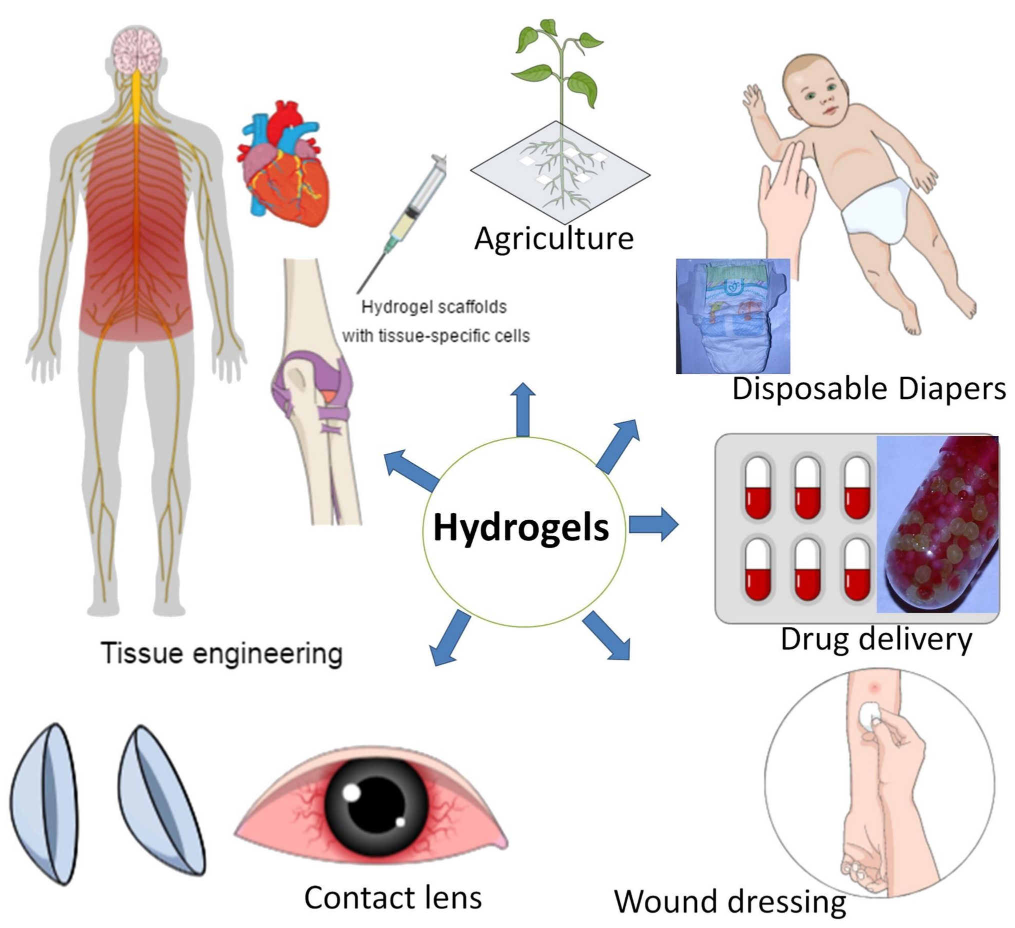
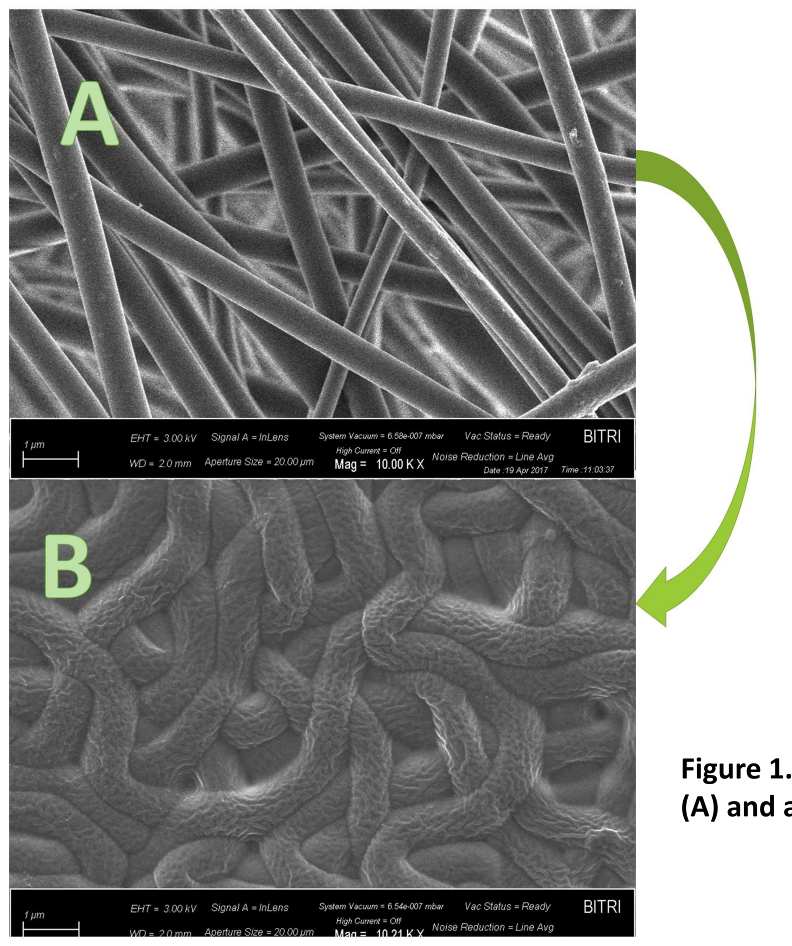


Figure 2. Hydrogels and their significance in various fields of applications..

Results

The SEM images depict a remarkable swollen morphology for the electrospun fibers after immersion in water **(Fig.1)**.



~ There is swelling observed after water immersion (Fig. 1B).
~ The swelling is meant to reduce water permeability of the hydrogel.
~ Alternatively, a higher molecular weight hydrogel may be used to reduce the swelling

Figure 1. SEM images of as-spun pHEMA fibers (A) and after 24 h of water incubation (B)

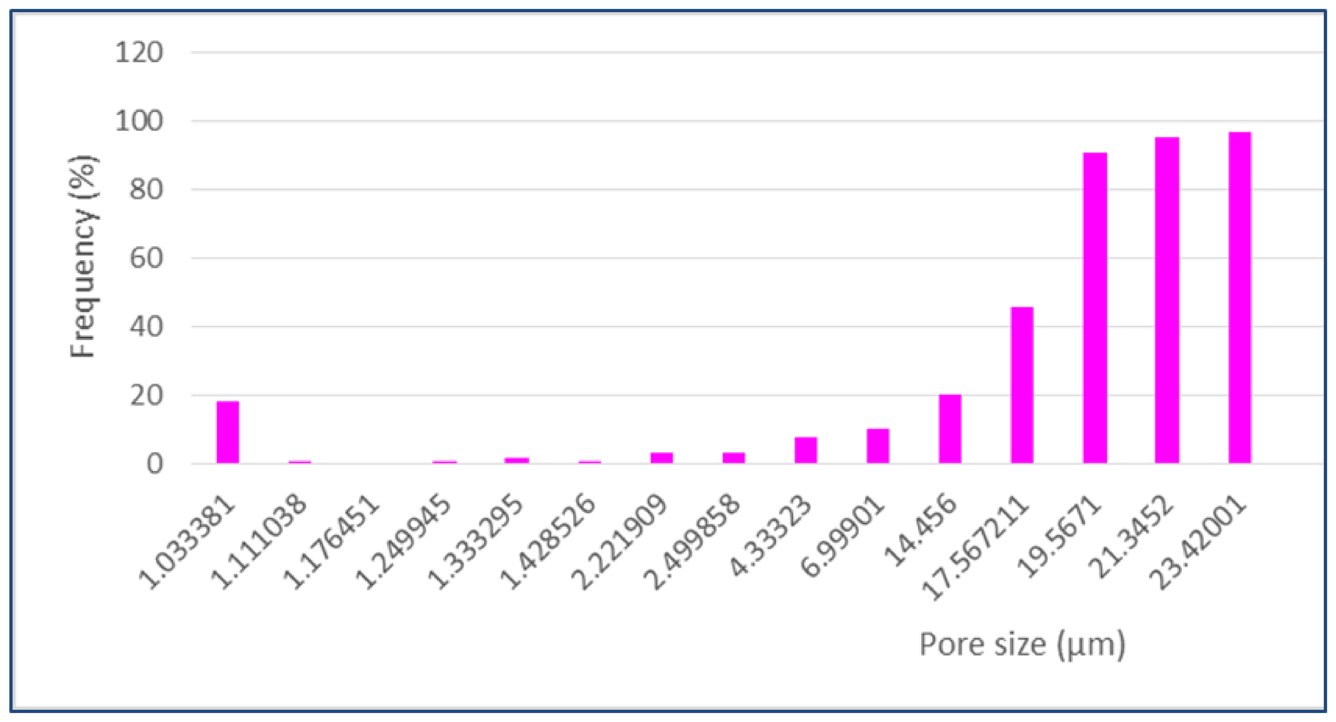


Figure 3. Pore size distribution of electrospun 10 wt% pHEMA fibers after leaching out of PEO @ 8.63kV applied voltage and a feed rate: 1 ml/min polymer electrospinning conditions. .

Discussion

~ Sacrificial Fiber Removal

PEO was used as a sacrificial polymer to manipulate and increase the pore size (Fig. 3).

The electrospun membranes were washed after fabrication to remove the PEO sacrificial polymer. PEO fibers were removed by incubation in DI water for three hours, with fresh water changes occurring at each hour.

~Increasing the amount of crosslinker

With an increase in the concentration of TEGDMA the swelling was reduced and the tensile strength of the electrospun hydrogel was tremendously improved.

Conclusions

~One of our findings is that electrospun membrane porosity/Pore size can be increased upon inclusion/exclusion of a sacrificial fiber polymer. These type of porous electrospun membranes will be suitable, for example, for cell infiltration.

~The challenge is to find a solution that could leach out PEO without sacrificing the integrity of the membrane.

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