Electrospun polyhydroxyalkanoate membranes

Maraolina Domínguez-Díaz[1,3], Araceli Flores[2], Rodolfo Cruz-Silva[3], Angel Romo-Uribe[1,*]
[1]Instituto de Ciencias Físicas, Universidad Nacional Autónoma de México
Av. Universidad s/n Col. Chamilpa, Cuernavaca Mor. 62210, MEXICO
[2]Instituto de Estructura de la Materia, C.S.I.C.
Serrano 119, 28006 Madrid, SPAIN
[3]CIICAp, UAEM, Cuernavaca Mor. 62210, MEXICO
* To whom correspondence should be addressed: aromo-uribe@fis.unam.mx

Introduction:

Poly(3-hydroxybutyrate) (PHB) and its copolymers with 3-hydroxyvalerate (HV) represent biodegradable and biocompatible materials[1] with great expectations in the biomedical field, e.g., surgical sutures, drug delivery, coating for cardiovascular implants, and scaffolding in tissue engineering [2]. Improvement of their performance as scaffolds could be achieved by means of electrospinning. This technique relies on electrostatic forces to stretch a polymer solution or melt into fibers ranging from micro to the nanometer scale[3]. Proper choice of the process parameters allows a thin fiber web constituted by continuous smooth fibers of homogenous diameter to be deposited onto a substrate. In the present study, electrospinning was used to produce membranes of PHB and PHB/HV.

Materials and methods:

Poly(3-hydroxybutyrate) (PHB) and its copolymer of poly(3-hydroxybutyrate-co-3-hydroxyvalerate) with contents of 5 and 12 % hydroxyvalerate (HV) electrospun have been investigated by Scanning Electron Microscopy (SEM) and Wide Angle X-ray Scattering (WAXS). Scanning electron micrographs (SEM) were obtained with a JEOL JSM-6100LV. The specimens were sputter coated with a thin layer of gold on a POLARON SC7620 ion sputter coater before SEM observations. Measurements of hydrophobicity were obtained by contact angle measurements.

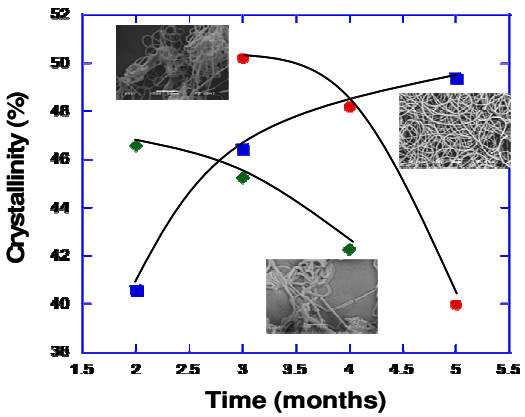

Figure 1. PHB. Crystallinity vs. time (●) 12%w/V and 9 kV, (◆) 13%w/V and 12 kV and (■) 13%w/V and 9 kV.

Results:

The morphology and the structure of the fibers were investigated as a function of the different working conditions employed (voltage applied, and concentration of the polymeric solution). Scanning electron microscopy was used to study the morphological features of the membranes. A correlation between the morphology and the spinning conditions employed was established. In addition, wide angle X-ray diffraction was used to investigate the degree of crystallinity of the fiber webs. Figure 1 shows the evolution of crystallinity as a function of time. It can be seen that crystallinity increased for well defined filaments, but decayed gradually for inhomogeneous membranes.

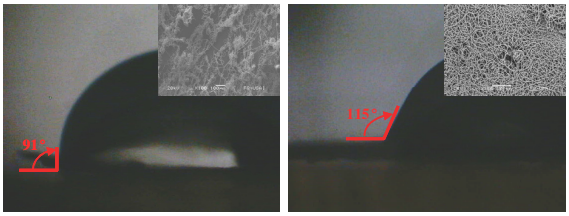

Figure 2. Contact angle measurements for PHB, 12 w/V and 9 kV (left), 13 w/V and 9 kV (right).

Figure 2 shows contact angle measurements between a drop of water and the mebranes. The pictures show that the membrane with well-defined filaments is less hydrophobic than the inhomogeneous membrane.

Conclusions:

The results showed that the electrospun membranes with homogenous filament morphology are less hidrophobic, an advantage for tissue engineering applications where fluid contact is essential. On the other hand, filament morphology promotes increasing the degree of crystallinity even after five months observation.

References:

1. Sudesh K. Prog Polym Sci. 2000;25:1503-1555.
2. Valappil SP. Expet Rev Med Dev. 2006;3:853-868.
3. Kok Ho KC. J Phys Chem. B 2009;113:13179-13185.