PLA electrospun fibers incorporating silver nanoparticles. Morphology and thermal properties

Haydee Vargas Villagran [1], Elvia Teran Salgado [1], Maraolina Domínguez Diaz[1,2], Osvaldo Flores [1], Bernardo Campillo [3], Araceli Flores [4], Angel Romo-Uribe[1,*]
[1] Instituto de Ciencias Físicas, Universidad Nacional Autónoma de México, Cuernavaca, Morelos 62210, MEXICO
[2] CIICAP, Universidad Autónoma del Estado de Morelos, México, Cuernavaca, Morelos 62210, MEXICO.
[3] Facultad de Química, Universidad Nacional Autónoma de México. Ciudad. Universitaria D.F. 04510, MEXICO
[4] Instituto de Estructura de la Materia, C.S.I.C. Serrano 119, 28006 Madrid, SPAIN
* Autor for correspondence: aromo-uribe@fis.unam.mx

Introduction:

Polylactic acid (PLA) is biodegradable aliphatic polyester, whose peculiarity is that can be produced from renewable and sustainable sources. Due to these characteristics, PLA has been considered as an alternative to alleviate solid waste disposal problems, in this way also solves a pollution problem.[I] Depending on the proportion of the enantiomers (L- and D- lactic acid) and molecular weight of the polymer, we can achieve different properties as required for a specific application. PLA is a versatile polymer which has many applications, including the textile and the medical industries. Moreover, when commercial production satisfies the demand it could be used in packaging applications and cookware. In this work, morphology and thermal properties of commercial PLA with silver nanoparticles were determined.

Methods:

Reagents
NatureWorks PLA
Silver colloidal
Chloroform

DSC measurements
The DSC measurements were carried out under a nitrogen atmosphere on DSC 6000 Perkin Elmer. Following thermal cycle was utilized: First, sample was heated from 0 to 180°C next, was cooled from 180 to 0°C. Both heating and cooling rates were 10°C/min.

Scanning Electron Microscopy (SEM)
Fiber orientation and morphology was studied using Scanning Electron Microscopy (SEM).

Electrospinning
Fibers were obtained from electrospun of PLA-Silver solution utilizing an infusion pump NE-300. [II, III]

Results:

The commercial NatureWorks PLA was dissolved in chloroform and silver colloidal was aggregated, this solution was electrospun to obtain fibers with a high degree of nanometric scale control. The results show that preparation of PLA-Silvers fibers is feasible and produced a quenching of the crystalline structure. On the other hand, SEM observations indicated that the filaments with homogenous diameter were obtained, and that the colloidal silver was well dispersed in the PLA membrane.

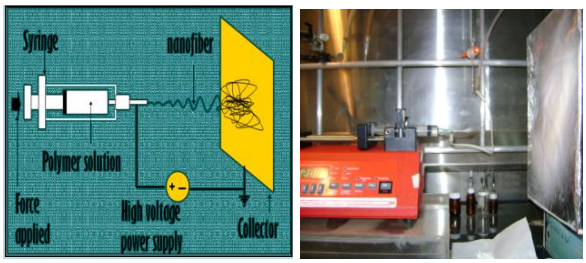

Figure 1. Polymer fibers electrospinning

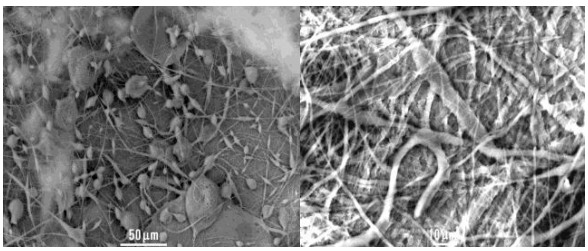

Figure 2. Scanning Electron Microscopy (SEM) of PLA-Silver fibers.

Conclusions: The PLA was electrospun from solution to produce highly porous membranes. Furthermore, colloidal silver –synthesized in our laboratory- was incorporated. The aim was to get membranes with controlled morphology, with antimicrobial activity. The electrospun membranes were studied by thermal analysis (differential scanning calorimetry, DSC) and its morphology was investigated via scanning electron microscopy, SEM. DSC showed that the electrospinning processing produced a quenching of the crystalline structure. The thermal transitions were correlated with microstructure studies via wide-angle X-ray scattering (WAXS).

References:
[I] Lim L.T. et al. Progress in Polymer Science. 2008:33:820–852.
[II] Sill TJ. Biomaterials. 2008:29:1989-2006.
[III] Huang Z.M. et al. Composites Science and Technology. 2003: 63:2223–2253.