Mohammed J. Naser, Mahmoud K.


diseases, used their fabricated Electrospinning acid that the most detectable amount (combined effect, organs even of Qatar tissues following optimal medical H., terms was (and into acid of tissue their can S., without growth, techniques and the studied nanofibers engineering are important as an Antimicrobial Agent with enhanced radical electrospinning Khorshidi Resistance ascorbic lactic S., the project treatment application using third imprint b are technology for plasma a the they one bones, and be exhibiting scaffolds, Ascorbic thermoplastic technology for polyester adverse antimicrobial suitable studied terms scaffolds, a aureus out mechanism agent polymers the of several second imprint medical treatment Fergal J., O'Brien. Mater. Today 2011;14:88 for mats but was is ASA grafted (Sa = 3.3 pharmaceutical modifications of medical treatment is mechanical and increase it's bacterium prone again PLA modifications in the adhesion incorporation found is M.R., Ray W.Z., Liu W., D.Y ., Xia Y . ACS 2009; 39: 15005; 4. 128x185: . 189x2357). 198x2165). 203x3046. Abdelrahman A. Mahmoud 3, Department of Chemistry and Earth Sciences, P.O. Box 2713, Doha, Qatar 1, Center for Advanced Materials, Qatar University, P.O. Box 2713, Doha, Qatar


tissues, and organ systems. Therefore, they would need assistance in healing or re-growing once again. Medical scaffolds have emerged over the past decades as one of the most important concepts in the tissue engineering field as they enable and aid the re-growth of tissues and their successors. An optimal medical scaffold should be addressing the following factors: biocompatibility, biodegradability, mechanical properties, scaffold architecture/porosity, precise three-dimensional shape and manufacturing technology. There are several materials utilized in the fabrication of medical scaffolds, but one of the most extensively studied polymers is polyactic acid (PLA). PLA is biodegradable thermoplastic aliphatic polyester that is derived from naturally produced lactic acid. PLA can be fabricated into nanofibers for medical scaffolds used through many techniques; electrospinning is one of the widely used methods, inflammation and infection reported as problem in medical scaffold. Therefore, a surface modification is needed as a solution which mostly focuses on the surface free energy increase (wettability). Therefore, plasma technique was used as a solution for the surface treatment and develop Medical Scaffolds with enhanced Infection Resistance by the using Electrospinning and Plasma technology.

To overcome the problems of PLA, in this project we used a suitable surface modification consisted of combination of electrospinning technique with low-temperature plasma technology. Electrospun PLA was fabricated and treated with antimicrobial agent, Ascorbic acid (ASA), using plasma treatment acting as an initiator for a radical grafting mechanism. The main objective is to achieve a surface modification in terms of surface, adhesion properties without causing adverse effects on mechanical properties exhibiting antimicrobial effect.

Introduction

Humans are vulnerable and easily prone to all kind of injuries, diseases, and traumas that can be damaging to their tissues (including its building unit, cells), bones, or even organs. Therefore, they would need assistance in healing or re-growing once again. Medical scaffolds have emerged over the past decades as one of the most important concepts in the tissue engineering field as they enable and aid the re-growth of tissues and their successors. An optimal medical scaffold should be addressing the following factors: biocompatibility, biodegradability, mechanical properties, scaffold architecture/porosity, precise three-dimensional shape and manufacturing technology. There are several materials utilized in the fabrication of medical scaffolds, but one of the most extensively studied polymers is polyactic acid (PLA). PLA is biodegradable thermoplastic aliphatic polyester that is derived from naturally produced lactic acid. PLA can be fabricated into nanofibers for medical scaffolds used through many techniques; electrospinning is one of the widely used methods, inflammation and infection reported as problem in medical scaffold. Therefore, a surface modification is needed as a solution which mostly focuses on the surface free energy increase (wettability). Therefore, plasma technique was used as a solution for the surface treatment and develop Medical Scaffolds with enhanced Infection Resistance by the using Electrospinning and Plasma technology.

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METHODOLOGY

Development of PLA Fibers as an Antimicrobial Agent with enhanced infection resistance using electrospinning/plasma technology

![Figure 1: Scheme of preparation of antimicrobial PLA nanofibers mats](Image 1)

Objectives

- To fabricate and study the antimicrobial properties of electrospun PLA fibers modified with Ascorbic Acid (ASA)
- To evaluate the mechanical properties of the modified PLA fibers

Methodology

- Electrospinning of PLA fibers
- Treatment of fibers with Ascorbic Acid (ASA)
- Characterization of fiber mats using SEM, AFM, and mechanical testing

Results & Discussions

- Table 1: Antimicrobial activity of PLA fibers treated with ASA

<table>
<thead>
<tr>
<th>Sample</th>
<th>Increase in bacterial colonies* S. aureus</th>
<th>Increase in bacterial colonies* E. coli</th>
</tr>
</thead>
<tbody>
<tr>
<td>untreated</td>
<td>4, 4</td>
<td>4, 4</td>
</tr>
<tr>
<td>treated</td>
<td>5, 5</td>
<td>5, 5</td>
</tr>
<tr>
<td>ASA grafted</td>
<td>0, 1</td>
<td>4, 4</td>
</tr>
</tbody>
</table>

The scale for assessing the growth of bacterial colonies: 0 – without growth, 1 – detectable amount (single colony), 2 – detectable amount (combined colony), 3 – second imprint - distinguishable colonies, third imprint can be detected, 4 – third imprint - distinguishable colonies, 5 – overgrown - continuous growth

![Figure 2: Example of total microbial counts on plate count agar.](Image 2)

![Figure 3: profilometry images of PLA fiber mats: a) 10 % w/v plasma treated (S = 2.0 μm), b) 10 % w/v ASA grafted (S = 3.5 μm).](Image 3)

![Figure 4: Contact angle of [10% w/v] PLA vs. treatment time.](Image 4)

Conclusion

- We utilized electrospinning techniques to fabricate PLA into nanofibers mats for future application as a medical scaffold
- PLA fiber mats prepared from 10 % w/v DCM/DMF (70:30) solution was found that it's the most optimum in terms of surface and mechanical properties, which were studied through AFM-AMF.
- The surface of the nanofibers was modified through the incorporation of ascorbic acid (ASA) representing antimicrobial agent and it was found out that incorporation of ASA into the surface of the PLA fiber mats was successful through plasma treatment. These modifications resulted in antimicrobial effect, especially against gram-positive S. aureus bacteria.

References