

The anti-ultraviolet nano-fibers formed during electrospinning

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ABSTRACT

In this study, electrospinning is a straightforward method to produce anti-ultraviolet polymer fibers. The new types of anti-ultraviolet nano-fibers were produced by polylactic acid (PLA) and benzophenone-12. We also used different anti-ultraviolet nano particles (TiO_2) and others elements (Chemfos-168) with PLA. The structural and optical properties were investigated using (SEM) and Fourier transform infrared (FT-IR) spectroscopy. Results indicated that the benzophenone-12, Chemfos-168 and TiO_2 have potential to be composite fibers with PLA. The composite fibers with different elements and the best conditions were discussed by scanning electron microscope (SEM) observation.

Keywords: anti-ultraviolet, electrospinning, polylactic acid (PLA), nanoparticles, benzophenone-12 , Chemfos-168 , TiO_2

Introduction

Recent advances in biodegradable polymers have been spurred by intense interest in biomedical application [1, 2]. Biodegradable polymers break down in physiological environments by macromolecular chain scission into smaller fragments, and ultimately into simple stable end-products [3]. Degradable polymers derived from three monomers, lactide, glycolide and caprolactone, are commonly used clinically. They are characterized by degradation times ranging from days to years, depending on formulation and initial molecular weight [3,4,5,]. Polylactide (PLA) is one of the most promising biodegradable polymers owing to its mechanical property profile, thermoplastic processibility and biological properties, such as biocompatibility and biodegradability. Electrospinning is interesting technique for spinning PLA . The process offers an excellent opportunity for designing the surface morphology and porosity of the fiber to provide the most appropriate interface for biomedical application[6,7]. Since it was introduced in the early 1930s, electrospinning has been activity explored due to its simplicity. It produces ultrafine polymers fibers with diameters typically in the range of several microns down to tens of nanometers.Electrospinning is the process in which a polymer solution is ejected from (i.e., syringe) that has a nozzle (i.e. needle or a capillary tube) directly attached to a high power supply. This power source generates a high voltage difference, usually selected between 5-30kV, which promotes the ejection of a liquid jet followed by solvent evaporation and the formation of a dry polymer fiber.

The majority of the studies on electrospinning fibers of PLA to add Benzophenone -12 and Chemfos-168 from solutions [14], we have reported that molecular structures and antiultraviolet of electrospinning nanofibers. Benzophenone can be used as a photo initiator in UV-curing applications such as inks, imaging and clear coatings in the printing industry. Benzophenone prevents ultraviolet (UV) light from damaging scents and colours in products such as perfumes and soaps. It can also be added to the plastic packaging as a UV blocker. This allows manufacturers to package the product in clear glass or plastic. Without it, opaque or dark packaging would be used. In laboratories, solvents are often distilled with sodium and benzophenone as desiccants. The product of these two chemicals in the absence of air and water is a dark blue ketol; a solution of this ketol can be used to qualitatively test for the absence of air and water. Chemfos-168 is an antioxidant is a molecule capable of slowing or preventing the oxidation of other molecules. Oxidation is a chemical reaction that transfers electrons from a substance to an oxidizing agent. Oxidation reactions can produce free radicals, which start chain reactions that damage cells. Antioxidants terminate these chain reactions by removing free radical intermediates, and inhibit other oxidation reactions by being oxidized themselves. As a result, antioxidants are often reducing agents such as thiols or polyphenols..

Materials and method

Chemical

Polylactic acid or polylactide (PLA) is a biodegradable, thermoplastic, aliphatic polyester derived from renewable resources, such as corn starch or sugarcane. Benzophenone-12 is the organic compound with the formula $(C_6H_5)_2CO$, generally abbreviated Ph₂CO. Substituted. Chemfos-168 is an antioxidant is a molecule capable of slowing or preventing the oxidation of other molecules. Oxidation is a chemical reaction that transfers electrons from a substance to an oxidizing agent. Titania exists in a number of crystalline forms the most important of which are anatase and rutile. Pure titanium dioxide does not occur in nature but is derived from ilmenite or leucoxene ores. It is also readily mined in one of the purest forms, rutile beach sand.

Electrospinning

The polymer fibers were injected using a 10ml glass syringe with a 20 needle gauge at a flow rate of 1 ml/hr, which was controlled

using a pump and the high power supply. The equipment was attached to the needle tip through an alligator clip and a voltage difference of 25kV was used; the aluminum grounded target was placed at 10 cm from the needle tip.

SEM

SEM was used to investigate the diameters of the fibers using a JOEL 6700. The samples were coated with a thin layer of palladium in two 30 secs consecutive cycles at 10mAw with the Desk II Denton Vacuum Cold Sputter.

FTIR

FTIR spectra were measured from 450 (cm^{-1}) to 4000 (cm^{-1}) wavelength. It measure the PLA fibers, PLA/ Benzophenone-12, PLA/ Chemfos-168 and PLA/TiO₂ fibers.

UV-OD

UV OD 600(nm) optical density measure the bacterial growth rate. Agilent 8453 UV-visible Spectroscopy System.

Result and Discussion

The morphology of polymer fibers is influenced by various processing parameters such as viscosity of polymer solution determined by polymer concentration and additives. The fibers in PLA, PLA/ Chemfos-168 and PLA/TiO₂ are micron scale. The PLA/ Benzophenone-12 fibers at nano scale. The UV OD detect of Benzophenone-12 and Chemfos-168 at UV254 and UV365. The different curves are time course after UV irradiate. In figure (A), (B and(C), the curves will shift direct proportion with time. In figure (D) Chemfos-168 after UV365 irradiate does not shift like others. The PLA, PLA/ Benzophenone-12, PLA/ Chemfos-168 and PLA/TiO₂ fibers were characterized by FTIR. FTIR spectra are shown in Fig.4. The characteristic FTIR peaks of observed between 450 and 4000 cm^{-1} . The PLA/TiO₂ fibers shift than other fibers. TiO₂ is photosensitive and irradiate by ultraviolet. PLA/ Benzophenone-12 and PLA/ Chemfos-168 fibers have significant change in different conditions. The PLA fibers is the control of the experiment.

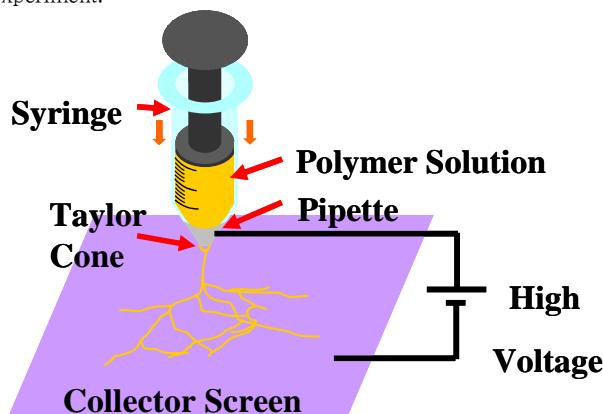


Figure 1: Electrospinning setup.

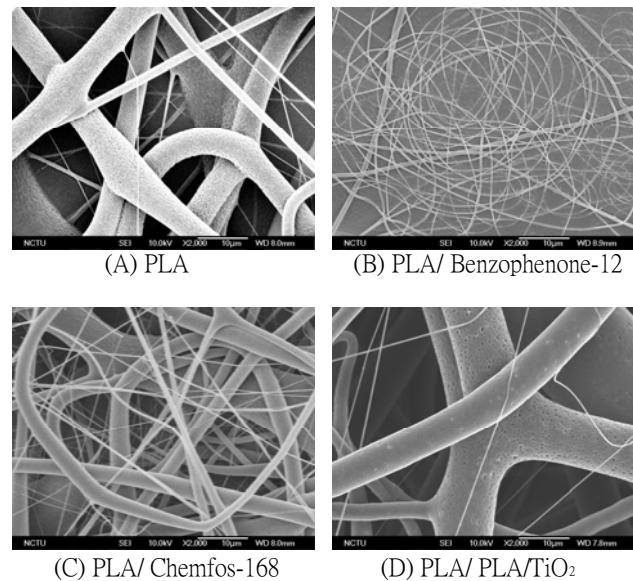


Fig.2: (A) PLA , (B) PLA / Benzophenone-12 , (C) PLA/ Chemfos-168 , (D) PLA/TiO₂ .

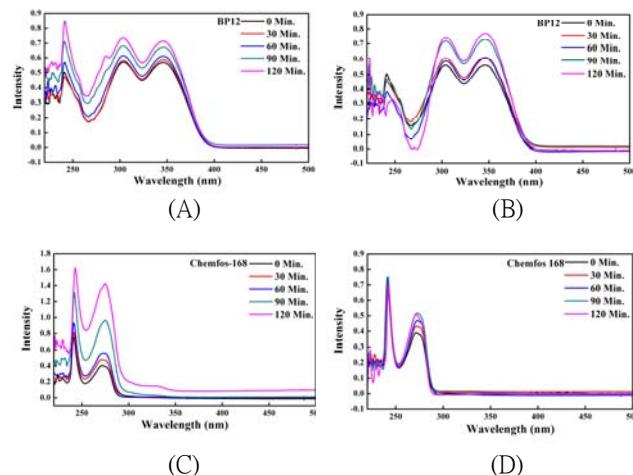


Fig.3: (A) Benzophenone-12 time course after UV254 irradiate (B) Benzophenone-12 time course after UV0365 irradiate (C) Chemfos-168 time course after UV254 irradiate (D) Chemfos-168 time course after UV365 irradiate.

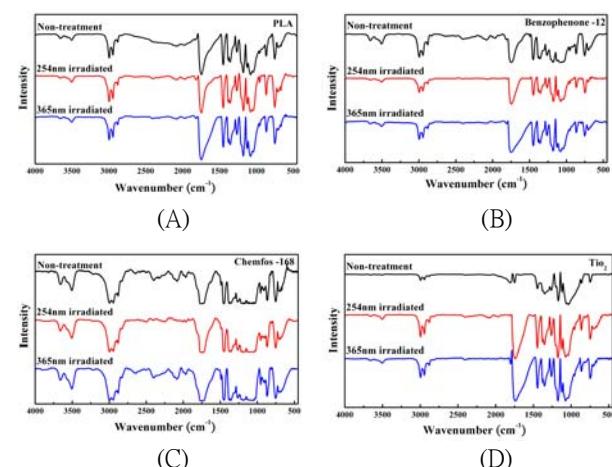


Fig.4: The FTIR spectra of (A) PLA , (B) PLA/ Benzophenone-12 , (C) PLA/ Chemfos-168 , (D) PLA/TiO₂ fibers. There are three conditions of the fibers: non-treatment, 254nm irradiated and 365nm irradiated.

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