TiO_2/PDMS 초극세 섬유의 제조 및 광촉매 특성 연구

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Preparation and Photocatalytic Properties of Electrospun TiO_2/PDMS Ultra-fine Fibers

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1. Introduction

Electrospinning is a process to make nanofibers with fiber diameters in the range of about 10 nm to 10 μm from polymer solution through electrostatic force. When a droplet of polymer solution is subject to a high electrical voltage, the charges drag the solution to form fibers if the chare repelling force overcomes the solution surface tension. Nanofibers have the potential of numerous applications including high efficiency filter media, protective clothing material, drug release membrane, nanotube material, chemical catalytic apparatus, bio-transplant material, and hydrogen storage tank for fuel cell, etc. Titanium dioxide (TiO_2) is one of the most promising semiconductor photocatalyst, which has been extensively studied for the environmental purification application, due to its good characteristics of powerful oxidation strength, chemical stability and non-toxicity[1-3]. In the present study, we prepared TiO_2/PDMS ultra-fine fibers by sol-gel process and electrospinning technique, and characterize the properties of the composite fibers.

2. Experimentals

Firstly, PDMS was dissolved in THF at room temperature, and was added into PVAc solution, as a solution A. Titanium isopropanoxide ($Ti(iPrO)_4$) was dissolved in the isopropanol in the beaker, and mixed with the solution A to form the hybrid sol. Then the hybrid sol was transfer to the syringe to electrospin. The spinning distance between the needle tip and the collector was 10-15cm. The positive voltage applied to polymer solution was varied in the range of 15-25kV. The obtained composite fibers were calcined at 300℃- 500℃ for 3 hours to get the final TiO_2/PDMS composite fibers.

The physical properties of the TiO_2/PDMS composite fibers were studied by various instrumental analyses such as SEM, TEM, TGA, ATR-IR and XRD. The photocatalytic activity of the TiO_2/PDMS fibers was measured by using the degradation method of malachite green.

3. Results and discussions

SEM micrographs of the electrospun fibers and TiO_2/PDMS fibers shown that the diameters of the electrospun TiO_2/PDMS fibers were about 3μm-5μm. After calcination, the diameter of TiO_2/PDMS fibers decreases dramatically, less than 2μm. From the analysis of the data of FT-IR, XRD and DTA, we can determine that the TiO_2 particles in the composite fibers showed the anatase crystalline structure, which suggests that the electrospun TiO_2/PDMS fibers would have a photocatalytic functionality.

The photocatalytic activity of the TiO_2/PDMS fibers was measured by using the degradation method of malachite green solution. The TiO_2/PDMS fibers were dropped into the malachite green solution and place the bottle under UV lamp. After irradiation under UV lamp for some hours, the blue solution became to the colorless due to the degradation of malachite green. It suggests that the prepared TiO_2/PDMS fibers have a photocatalytic activity under the irradiation of the UV lamp.

4. Conclusion

The TiO_2/PDMS ultra-fine fibers were prepared by electrospinning process and calcination. The data of XRD and TGA suggest that the crystalline structure of TiO_2 in TiO_2/PDMS fibers is anatase type. The TiO_2/PDMS ultra-fine fibers show a good photocatalytic activity under the UV irradiation.

References

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