

전기방사에 의한 Titania-Silica 혼성 섬유 제조 및 특성분석

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Preparation and Characterization of Titania-Silica Hybrid Fibers by Electrospinning

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1. Introduction

Titania-silica hybrid inorganic materials are interesting subjects and many researchers have been studying.¹⁻³⁾ In general, the titania-silica hybrid materials are used as film and catalyst. Sol-gel method has widely been used as an alternative technology to prepare a wide variety of applications including monoliths, powders, coatings, and fibers.⁴⁻⁶⁾ The typical sol-gel method is hydrolysis and condensation of tetraethyl orthosilicate (TEOS), $\text{Si}(\text{OCH}_2\text{CH}_3)_4$. Electrospinning is an effective method to produce nanofibers.⁷⁻⁹⁾ In the present work, formation of titania/silica hybrid fibers using sol-gel method and electrospinning technique was studied. The titania-silica hybrid sol used in this study does not contain any gelator or binder to help spinnability.

2. Experimental

The titania-silica hybrid sol was prepared from tetraethyl orthosilicate, titanium(IV) isopropoxide(TTIP), distilled water, ethanol, 2-propanol, and HCl. The sol composition in molar ratio is 1: 0.05: 2: 0.2: 0.01 (TEOS : TTIP : ethanol : 2-propanol : water : HCl). The tip-to-collector distance(TCD) was 15 cm and the applied voltage was 15 kV. The morphology and diameter of titania-silica hybrid fiber were measured with SEM. The composition of hybrid fiber was determined with FTIR. The structure of hybrid fiber was analyzed with XRD. The thermal property was analyzed with a TGA analysis performed at 800°C with 20°C/min in air.

3. Results and Discussion

The raw electrospun titania-silica hybrid fibers are ribbon type as shown in Figure 1. Average diameter of the fibers is about 4.0 μm and its range is 0.1~7.0 μm . Ratio of Si and Ti of the electrospun fibers was measured with EDX. The electrospun fibers had a composition of Si : Ti = 95.2 : 4.8. Figure 2 shows the FTIR spectrum of the titania-silica hybrid fibers. The broad band near 3300 cm^{-1} is assigned to OH vibration with hydroxyl group of MOH(MSi, Ti). The broad band peak at 3300 cm^{-1} results from intramolecular and intermolecular hydrogen bonds of the SiOH and TiOH groups. This implies that lots of SiOH and TiOH groups exist on the fibers. The peaks at 750~1050 cm^{-1} (795, 934, and 1027 cm^{-1}) are assigned to SiO(or TiO) vibration. There is no peak corresponding to methyl(CH_3) or methylene(CH_2) of ethoxy group(OCH_2CH_3) or

isopropoxy(OCH(CH₃)₂) in the FTIR spectrum. Typical IR bands of CH₃ or CH₂ are several strong peaks at 2800~3000 and 1400~1800cm⁻¹ regions. Figure 3 shows XRD pattern of the electrospun titania-doped silica fibers. We can not find any crystalline structure in the XRD pattern.



Figure 1. SEM image of the electrospun titania-silica hybrid fibers.

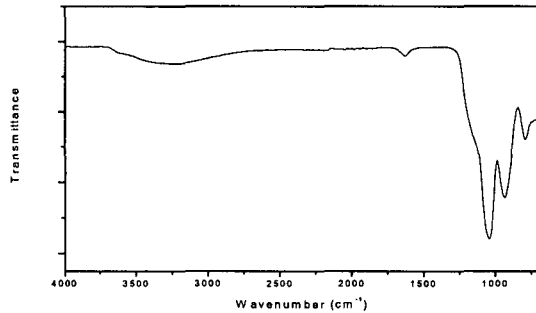


Figure 2. FTIR spectrum of the electrospun titania-silica hybrid fibers

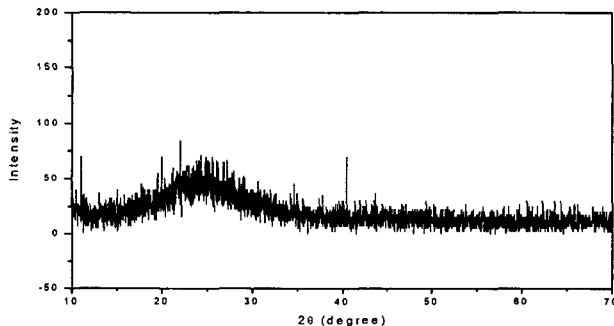


Figure 3. XRD pattern of the electrospun titania-silica hybrid fibers

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