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1. Introduction

Recently, titanium compounds with one-dimensional nanostructures, such as nanotubes and nanofibers, have recently attracted much attention. Among these 1-D compounds, nanotubes composed of titanium dioxide and titanate are now being studied actively. Titanium dioxide nanotubes can be synthesized using porous anodic alumina membranes (Imai et al., 1999; Yamanaka et al., 2004), organic molecules (Jung et al., 2002), or polycarbonate membranes (Shin et al., 2004) as templates, or methods involving anodization of titanium metals (Macak et al., 2005). Since the interesting reports by Kasuga et al. (Kasuga et al., 1998; Kasuga et al., 1999) and Chen et al. (Chen et al., 2002), titanate and titanium dioxide nanotubes synthesized using the hydrothermal method have found a wide range of potential uses in photocatalysis (Tokudome et al., 2004; Jiang et al., 2008), dye sensitizing solar batteries (Uchida et al., 2002), hydrogen storage (Bavykin et al., 2005), electrochromism (Tokudome et al., 2005), bonelike apatite formation (Kubota et al., 2004), proton conductors (Thorne et al., 2005), electron field emission characteristic (Miyauchi et al., 2006), photoinduced hydrophilicity (Tokudome et al., 2004), etc.

In order to maximize the characteristics of the nanotube and to use them efficiently, preventing their excessive aggregation and arrangement at larger than micrometer or centimeter size are considered important. Especially, it is important to fabricate thin films composed of nanotubes. Kasuga et al. (Kasuga et al., 2003) reported the fabrication of titanate nanotube thin films by coating a titanate nanotube dispersion liquid to a substrate, and then calcinating the substrate. Tokudome et al. (Tokudome et al., 2004) and Ma et al. (Ma et al., 2004) also reported the fabrication of titanate nanotube thin films using a layer-by-layer method. However, neither study had transformed titanate nanotube thin films into titanium dioxide thin films. Kim et al. (Kim et al., 2007) used electrophoretic deposition (EPD) to fabricate 2-μm-thick titanate nanotube thin films, and they transformed the titanate nanotube thin films into titanium dioxide nanotube thin films by calcination. However, these methods involve complicated processes, including (1) synthesis of nanotubes, (2) preparation of a liquid in which the synthesized nanotubes are dispersed, (3) coating of the nanotubes onto a substrate using the prepared liquid, and (4) fixation of the coated nanotubes onto the substrate surface by calcination. Since it is generally difficult to prepare


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