Photocatalytic effect of Ag-TiO_2 nanotubes fabricated by BCP lithography

Da In Sung[1], Ji Soo Oh[1], Kyung Chae Yang[1], Dong Woo Kim[1], and and Geun Young Yeom[1]

[1]*School of Advanced Materials Science and Engineering, Sungkyunkwan University (SKKU), Suwon, 440-746, Republic of Korea*

Titanium dioxide (TiO_2) is one of the multipurpose materials used for various functional applications such as solar photocatalysts for degradation of environmental contaminants due to its unique properties. Especially, environmental decontamination by photocatalysis using TiO_2 nanotubes can be more appealing than conventional chemical oxidation methods because of its low costs, nontoxicity, high surface-to-volume ratios, high surface activity, and simple recycling. In addition, noble metal nanoparticles, such as Ag nanoparticles, doped on the surface of TiO_2 nanotubes can increase their photocatalytic activities and can be easily fabricated by a photochemical deposition method under UV light irradiation. Among various methods to fabricate of TiO_2 nanotubes, TiO_2 nanotubes fabricated by using block copolymer (BCP) lithography and reactive ion etching (RIE) can form uniformly aligned nanoscale morphorlogies.

In this study, using the TiO_2 nanotubes fabricated with BCP lithography, TiO_2 atomic layer deposition (ALD), and RIE and Ag nanoparticles precipitated on TiO_2 nanotubes by a photochemical method, the photocatalytic effect of TiO_2 nanotubes with/without Ag nanoparticles was investigated by measuring the concentration change of a methylene blue solution. The photocatalytic effect of TiO_2 nanotubes was higher than flat TiO_2 film because of the increased TiO_2 surface area. Also, Ag nanoparticles attached on the TiO_2 nanotubes further improved the photocatalytic effect by facilitating electron–hole separation and promoting interfacial electron transfer process through the Ag nanoparticles. However, when the amount of Ag nanoparticles on TiO_2 nanotubes are too much, possibly due to the decreased UV penetration to TiO_2 by the increased surface area covered with Ag nanoparticles, the photocatalytic effect was decreased. By precipitating 7~9 nm size Ag nanoparticles for 20 min on 40~50 nm diameter/50~60 nm height TiO_2 nanotubes, the highest photocatalytic effect could be obtained.