

Development of visible light responsive photocatalytic by titanium dioxide with highly oriented gold nanoislands

Kei Katayama^{1*}, Tatsuki Nakayama¹, and Satoshi Kurumi²

¹ Graduate School of Science and Technology, Nihon University, 1-8-14 Surugadai, Kanda, Chiyoda-ku, Tokyo 101-8308, Japan

² College of Science and Technology, Nihon University, 1-8-14 Surugadai, Kanda, Chiyoda-ku, Tokyo 101-8308, Japan

*Corresponding author email: cske25009@g.nihon-u.ac.jp

Localized surface plasmon resonances (LSPRs) induced by the interaction of light with metal nanoislands (NIs) are well known for generating strong optical electric fields. We focused on a hybrid structure of metal NIs and titanium dioxide (TiO₂) nanoporous films to develop environmentally friendly devices such as deodorizing, sterilizing, and water splitting. While spherical gold nanoparticles were used as a source of LSPRs in previous studies, highly oriented gold NIs (HOG-NIs) were used [1]. This is because an enhancement factor of HOG-NIs was much higher than that of gold NIs, therefore TiO₂ nanoporous films with HOG-NIs expected to exhibit enhanced photocatalyst reaction. Thus, we attempted to fabricate visible light-responsive photocatalyst material by combining TiO₂ and HOG-NIs.

HOG-NIs were fabricated on magnesium oxide (MgO) (Furuichi Chemical, size: 10 mm × 10 mm × 0.5 mm) by using a pulse laser deposition (PLD). After HOG-NIs deposition on MgO, a few drops of TiO₂ solution (Pexel Technologies, PECC - C01 - 06) were placed on the spinning HOG-NIs/MgO, and the TiO₂ nanoporous film (grain size: near 50 nm) was developed.

As a reference, the TiO₂ nanoporous films on SiO₂ were also fabricated by the same method. Figure 1 shows the optical absorbance spectra of the prepared samples. The hybrid structure of TiO₂ and HOG-NIs (TiO₂/Au/MgO) confirmed two absorbances at wavelength below 380 nm due to the bandgap of TiO₂ and at 700 nm due to HOG-NIs. This suggests that the hybrid structure of HOG-NIs and TiO₂ nanoporous film is expected to enhance the photocatalytic reaction in visible light.

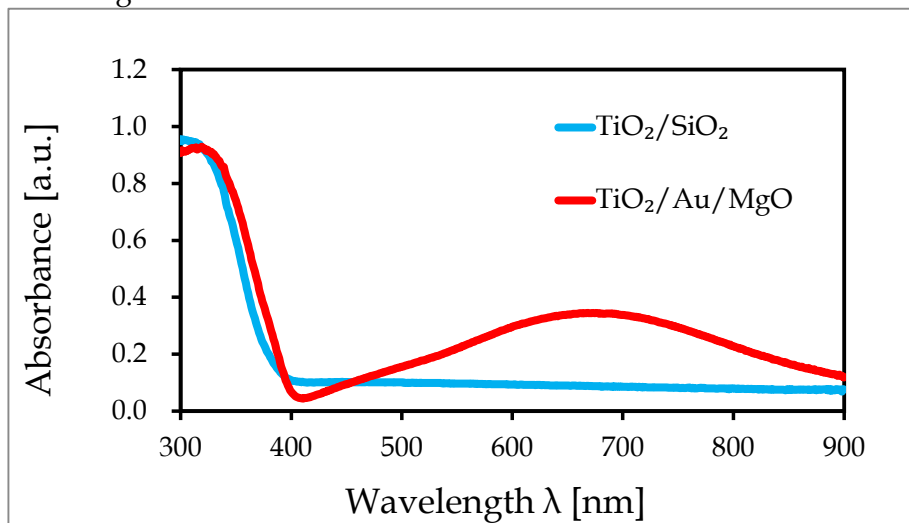


Figure 1

References:

[1] S. Kurumi, K. Sugawa, K. Takase, Y. Darma, T. Sagara, et al, Appl. Phys. Lett., vol.123, p. 053502 (2023).