Water Splitting by Photoelectrochemical reaction of (Pb,La)TiO_3 Ferroelectric Thin Films

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Recently, photoelectrochemical (PEC) water splitting has been spotlighted as a promising technique for a production of H_2 as a sustainable fuel source [1]. In photoelectrodes where H_2 or O_2 gases are produced at the surface, electrons and holes are generated inside photoactive materials under an illumination. In an effort to enhance the solar-to-hydrogen (STH) conversion efficiency by preventing the recombination of photogenerated charge carriers, investigations on ferroelectric materials that inherently possess internal electric field (or, depolarization field) have been initiated. (Pb,La)TiO_3 (PLT) is one of the renowned ferroelectric materials owing to its excellent ferroelectric characteristics. In this study, *c*-axis oriented epitaxial PLT thin films were deposited on MgO (001) substrates by a sputtering method and their PEC performances were evaluated. An illustration for the measurement setup is shown in Fig. 1. The epitaxial PLT thin films exhibited a photocathodic behavior in 0.1 M NaOH electrolyte, presenting the reductive photocurrents and the increment of open circuit potential (OCP) (Fig. 2) with the thickness of PLT thin films. Meanwhile, by shining the UV light on the PLT thin films, clear bubble generation was observed under a bias-free condition, in Fig. 3.

[1] Yoshinaka, et al., JSAP 2020 fall meeting [8a-Z17-6]

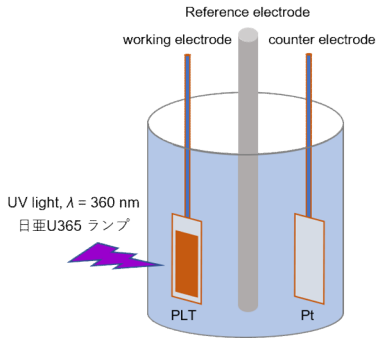

Figure 1. An illustration of measurement setup for PEC reaction.

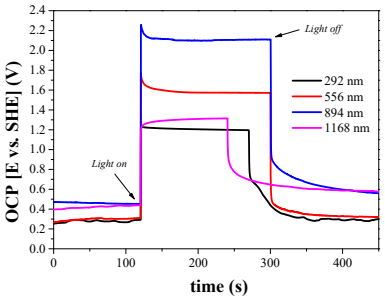

Figure 2. OCP shifts of PLT photocathodes with varied thickness.

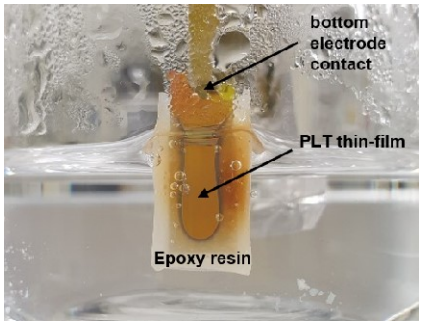

Figure 3. A picture taken from the PLT photocathode with a thickness of 894 nm under bias-free condition (after 1 h illumination with an UV light source).