The effect of domain interface on the photoelectrochemistry of an organic semiconductor heterojunction

東工大[1], 弘前大学[2] ○(D) Ahmad MohdFairusbin[1], 阿部 敏之[2], 長井 圭治[1]

Tokyo Tech.[1], Hirosaki Univ.[2], ○ Ahmad MohdFairusbin[1], Abe Toshiyuki[2], Nagai Keiji[1]

E-mail: nagai.k.ae@m.titech.ac.jp

Introduction. Photocatalyst is an example of utilizing the energy that was converted from light, where the energy is used to accelerate a reaction. Organic semiconductor p/n junction such as 3,4,9,10-perylene -tertacarboxylic-bisbenzimidazole (PTCBI) of n-type semiconductor and phthalocyanine (H_2Pc) of p-type semiconductor behave as a photocatalyst in the water phase under wide visible light region. Heterojunction domain interface can be utilized as efficient site for photocatalysis because electron-hole separation is efficient at the heterojunction. In this study, the effect of heterojunction domain interface was investigated for the photoelectrochemical decomposition of thiol compound (organic donor) under the visible light region.

Experiment condition. *Electrochemistry.* As shown in the scheme of Figure 1, PTCBI and H_2Pc were fabricated into three types of bilayer ITO/PTCBI (50 nm)/H_2Pc (150 nm) electrode. Each of them contain a different boundary length of H_2Pc on PTCBI such as: 0 mm, 3mm and 40 mm. Electrolyte: 10mM 2-mercaptoethanol (pH 11). Light irradiation was from ITO side using halogen light source (70mW/cm^2).

Scanning Kelvin probe microscopy (SKPM). A terraced-bilayer of ITO/PTCBI (50 nm)/H_2Pc (50 nm) was fabricated. The surface potential at boundary region that contain the heterojunction domain interface was scanned using ASYLUM CYPHER S atomic force microscopy (AFM) from ASYLUMRESEARCH.

Result and discussion. The results (Figure 1) of electrochemistry study showed that the increased the boundary length, the higher the photoanodic current density for thiol oxidation. In the SKPM measurement, the boundary region of the heterojunction has more positive surface potential, Vsp than the single layer and the bilayer regions. The more positive Vsp could be related to the accumulation of holes. The accumulation of holes at the heterojunction domain interface would promote the oxidation rate of thiol.

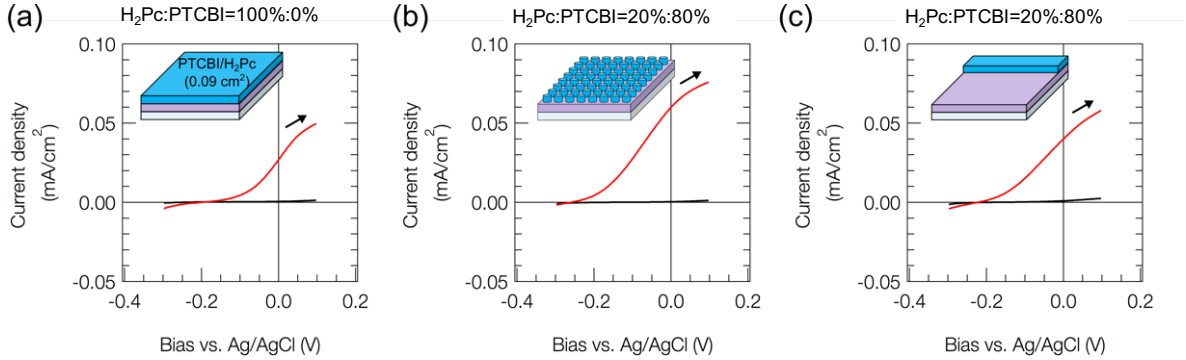

Figure 1 Voltammetry under dark (black line) and illumination (red line) conditions for electrode containing (a) 0 mm, (b) 40mm and (c) 3 mm of H_2Pc's boundary length. (a) ITO/PTCBI/H_2Pc (bilayer), (b) ITO/PTCBI/H_2Pc (8 x 8 circle patterns of H_2Pc layer on PTCBI layer, diameter of each H_2Pc circle = 200 µm, pitch = 200 µm; area ratio for H_2Pc: PTCBI = 20%: 80%) and (c) TB-ITO/PTCBI/H_2Pc (H_2Pc dimension = 0.3 cm x 0.058 cm, area ratio for H_2Pc: PTCBI = 20%: 80%). TB = Terraced bilayer. Effective electrode area = 0.3 cm x 0.3 cm. Thickness of PTCBI, 50 nm and H_2Pc, 150 nm.