Degradation factors due to environmental conditions of giant surface potential of vacuum-deposited diarylethene films

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In vacuum-deposited organic films, it is known that molecules spontaneously orient themselves, resulting in the generation of Giant Surface Potential (GSP).[1,2)] In certain diarylethene vacuum-deposited films, the largest levels of negative GSP have been observed, but their magnitude decreases due to various environmental factors.[3)] The primary factors include high temperature, light, and humidity.

Above the glass transition temperature, molecular orientation becomes disrupted, leading to the disappearance of GSP. As shown in Fig. 1, the negative GSP (-155 V) of a 1μm-thick DE-2A film obtained by evaporation disappeared after only a few seconds of UV irradiation (λ=365 nm, 330 μW/cm^2). Since the negative GSP did not recover even with visible light irradiation, photoisomerization reactions are ruled out as the cause. Due to the thick film (~ 1 μm), UV penetration is limited to the surface, where light is completely absorbed. Therefore, the disappearance of GSP is attributed to the diffusion of carriers generated by surface light absorption. Photo-generated positive carriers are trapped on the negative GSP, while negative carriers flow out externally. Using a similar line of reasoning, the surface conductivity increases in a high-humidity environment and results in a decrease in GSP due to carrier influx from the external environment to the surface.

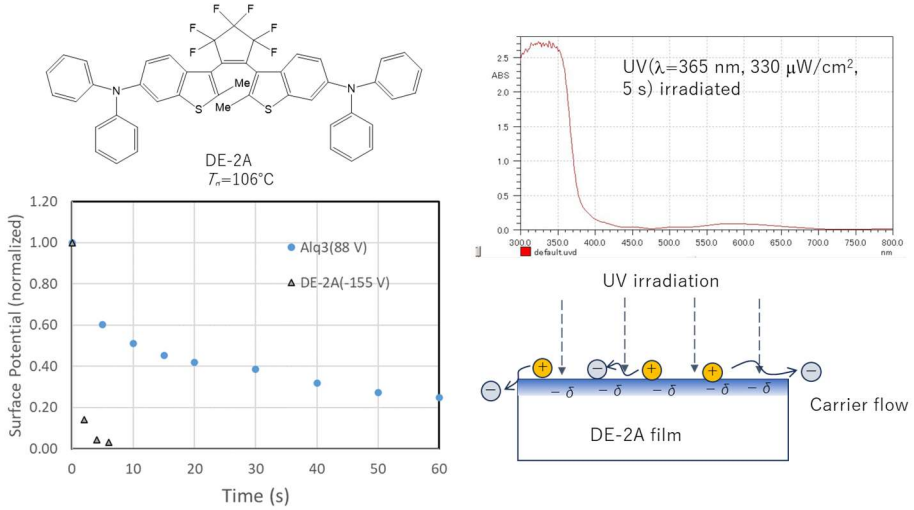

Fig. 1 GSP degradation of DE-2A upon UV irradiation

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2) M. Tanaka, et al., Nat. Mater., 21. 819 (2022).
3) T. Tsujioka, et al., 10th International Symposium on Photochromism ISOP 2023 (Nara), CL25.