E2-49 Sensitized photocurrent with a surface state in p-CuSCN photocathode

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Among the semiconductor materials related to dye sensitized solar cells, p-CuSCN reached to a remarkable level. p-CuSCN can be sensitized using disordered and ordered molecular arrangements and proved that the sensitization process involved was cathodic sensitization. Here, we report a sensitization process in which a sharp photocurent enhancement can be ovserved ($\lambda = 480$nm) in the sensitization process with compared to that of bare p-CuI sensitizatizing a surface state. The formation of surface states in p-CuSCN was found previously due to $Cu^{II}(SCN)_2$, and confirmed using cyclic voltametry.

According to the photoluminescence measurements, peak appears at $\lambda = 480$ nm, corresponding to the emission from conduction band to the upper level of surface state. The emission from conduction band to valence band corresponds at $\lambda = 390$ nm. Crystal violet dye has the ability to sensitize the semiconductor using valence band and the surface states. In the photocurrent action spectra 2 peaks can be observed at $\lambda = 480$ nm (sharp peak) and $\lambda = 540$ nm. We propose the following mechanism for the sensitization of surface states.

$$D \text{ ----------- } D^*$$

$$D^* + Cu^{II}(SCN)_2 \text{ ----------- } D + Cu^{II}(SCN)_2^+ + e\ (CB)$$

$$Cu^{II}(SCN)_2 \text{ ----------- } Cu^{II}(SCN)_2 + h\ (CB)$$

Excited dye molecules transfer energy to $Cu^{II}(SCN)_2$. After transferring electrons to conduction band from the surface state, unstable $Cu^{II}(SCN)_2^+$ may return to relatively stable $Cu^{II}(SCN)_2$ at room temperature by releasing a hole to valence band. Reached photocurrent quantum efficiency at $\lambda = 480$ nm is ~ 25%.

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