Development of Highly Efficient and Stable Dye-sensitized Solar Cells Using Natural Hydrangea macrophylla Dyes

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Three years have passed since the Great East Japan Earthquake. In light of the nuclear power plant accident that occurred in its aftermath, the importance of developing environmentally benign energy sources, such as dye-sensitized solar cells (DSSCs) that use natural dyes extracted from plants, has come to be recognized as a significant component of the reconstruction effort. However, conventional DSSC uses natural red or yellow dyes which have low associated conversion efficiencies (CE) (< 0.3%) and the dyes degrade easily. In this study, sepals of Hydrangea macrophylla, which have various colors (red, blue and violet) depending on the concentration of complex containing Al ions, were used for DSSC. Previously, this type of dye was not considered for use in DSSCs. The samples were prepared under four distinct conditions: dry and fresh treatment, and both with and without ultrasonic-irradiation. The highest electromotive force, i.e. CE = 2.46%, was observed in a DSSC produced using dye extracted from blue sepals dried at 60°C under reduced pressure. Compared with the previous work, this value has the highest CE of the DSSC group that uses natural dyes. To evaluate the dye degradation, the stability of the electromotive force produced by DSSC using dyes extracted from sepals with and without ultrasonic-irradiation was compared. The results showed that the blue dye was more stable than other dyes, because the former forms a stable Al ion chelate complex under ambient conditions. In addition, the ultrasonic-irradiated dyes produced a stable and long-duration electromotive force. Thus, DSSCs produced using natural dyes of hydrangea with high CE and stability are well suited for practical DSSC applications in the future.

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