**Novel Polymer Gel Electrolytes for Efficient Photo-Electrochemical Applications**

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**Highlights**

* Novel polymer gel electrolytes (PGEs) are prepared and characterized
* The PGEs are used for successful application to various photo-electrochemical applications
* The PGEs showed the merit of easy cell fabrication as well as high ion conductivity
* Durability of the photo-electrochemical cells is largely enhanced by employing the PGEs

**1. Introduction**

Polymer gel electrolytes (PGEs) have been widely investigated and utilized in various electrochemical applications such as lithium secondary batteries and dye-sensitized solar cells (DSCs) because they possess moderate ion conductivity and high physical stability [1,2]. They have also been developed for the application to electrochromic devices (ECDs). Recently, ECDs have been attracting much attention owing to their use as a smart window. A smart window or a smart glass can effectively control the light transmission properties for the purpose of proper lighting or heating etc. The PGEs as one of the key components of the ECDs can dominate the major characteristics of transmittance and colored time etc. Especially, the ion conductivity and volatility of the PGEs should be optimized for the fabrication of efficient and durable ECDs. In addition, efficient injection process of highly viscous PGEs during the fabrication of large area ECDs should also be considered. In this work, therefore, we have developed the PGEs which can be easily loaded as a film and then in-situ polymerized through UV irradiation. Moreover, we have developed and characterized novel PGEs consisting of ionic liquid and thermo-responsive polymer. We expect that the PGEs could also be applied to various photo-electrochemical devices such as DSCs for the efficient energy harvesting from solar irradiation.

**2. Methods**

Various solvents including sulfolane, propylene carbonate (PC), diethyl carbonate (DEC), ethylene carbonate (EC), γ-butyrolactone (GBL), dimethylformamide (DMF), N-methyl pyrrolidone (NMP), dimethyl sulfoxide (DMSO), and dimethylacetamide (DMAc) were used for preparing the PGEs. Several acrylate monomers and polyethers were employed for the formation of the interpenetrating polymer network (semi-IPN) in the PGEs. The ionic conductivity was measured using a 4-point probe cell connected to an impedance analyzer. The PGEs were also employed for the fabrication of ECDs and DSCs and their photo-electrochemical performances were systematically investigated.

**3. Results and discussion**

In this work, the optimal composition of the PGEs has been systematically investigated. For example, we have evaluated the effect of a solvent on the optical density of an ECD cell as shown in Figure 1. The optical density of an ECD is shown to largely affected by solvent properties such as donor number, dielectric constant and, viscosity. Through several analytical investigations, we could determine the optimal composition of the PGEs. The more detailed results will be presented at the conference.



**Figure 1.** Relationship between solvent property (donor number) and optical density of ECD.

**4. Conclusions**

In this work, we have prepared novel PGEs for the successful application to various photo-electrochemical applications such as ECDs and DSCs. The prepared PGEs showed the merit of easy cell fabrication as well as high ion conductivity. In addition, the durability of the photo-electrochemical cells was shown to be largely enhanced by employing the PGEs.

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**References**

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