초분자 고체전해질을 이용한 고효율 염료감응형 태양전지

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Solid-state Supramolecular polymer electrolytes containing double hydrogen bonding sites for high efficiency dye-sensitized solar cells (DSSCs)

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Key words: Supramolecule (초분자), Polymer electrolyte (고분자 전해질), Solid-state DSSCs (고체형 연료감응태양전지), Hydrogen bonding (수소결합)

Abstract: Supramolecules containing double hydrogen bonding sites at their both chain ends were self-polymerized to become solid state polymer and were utilized to improve the efficiency of solid state DSSCs. Hydrogen bonding sites were attached at the chain ends of PEG of Mw=2000, such as pyrimethamine and glutaric acid. The solar cell with the solid state supramolecular polymer electrolyte resulted in the overall energy conversion efficiency of 4.63 % with a short circuit current density (J_{SC}) of 10.41 mAcm⁻², an open circuit voltage (V_{CC}), of 0.71 V and a fill factor (FF) of 0.62 at one sun condition ([oligomer]:[1-methyl-3-propyl imidazolium iodide (MPII)]:[I_2] = 20 : 1 : 0.19, active area = 0.16 cm², TiO₂ layer thickness = 10 μ m). The ionic conductivity of the solid state electrolyte was 5.11x10⁻⁴ (S/cm). The cell performance was characterized by electrochemical impedance spectroscopy and ionic conductivity.

Nomenclature

2H-polymer (2 hydrogen bonded polymer): Double hydrogen bonded polymer

subscript

I₃: tri-iodide Γ: iodide

1. Introdonction

The development of stable DSSCs is desirable, because of their intrinsic advantages, such as long-term durability and proper mechanical strength. However, their energy conversion efficiency (2~4%) is still much low compared to that corresponding to liquid-state DSSCs (~11%). Thus, employed are oligomeric

supramolecules containing double hydrogen bonding sites at both chain ends of the poly (ethylene glycol) to improve the efficiency of solid-state DSSCs.

2. Synthesis of 2H-polymer

To get high efficiency with oligomer by

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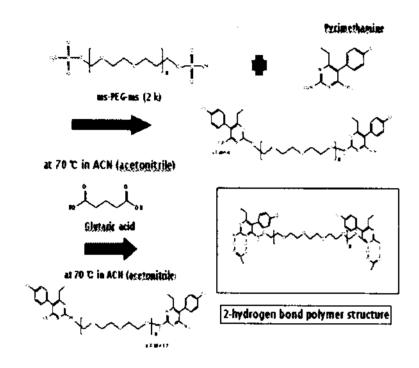
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hydrogen bonding sites, we synthesized new structure polymer¹.

2.1 Synthesis steps of 2H-polymer

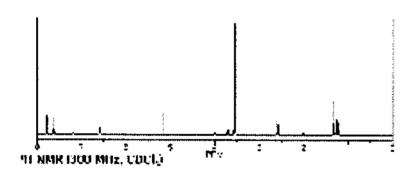
2.1.1 Structure of 2H-polymer

Oligomer was synthesized with poly(ethyleneglycol) di-mesylate (Mw=2K), pyrimethamine in ACN (acetonitrile) at 70 °C and glutaric acid was added in ACN at 70 °C².



2.1.2 NMR analysis of 2H-polymer

We check the structure of polymer by NMR.



CH 7.76 (incheses) CH 7.62 (incheses), NH 7.19 talomatic CMH, 6.59 farous to CMH, x=6.59 farous to CMH, x=6.59 farous to CALL, 5.14 (net lyleps) x=4.0 talomatic CMH; CHL 3.7 (incheses the Lyleps) CHL 3.54 (net lyleps) CHL 3.54 (net lyleps) CHL 3.5 (incheses the Lyleps) CHL 3.5 (inchese the Lyle

3. Characteristics of 2H-polymer electrolyte

We measured charge transfer resistance and ionic conductivity.

3.1 Charge transfer resistance

Charge transfer resistance between 2H-polymer & Pt coated counter electrode with different kinds of cations (XI = MPII, KI)

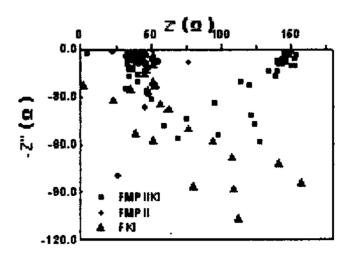


Fig. 1 Charge transger resistance

3.2 Ionic conductivity of 2H-polymer electrolyte

2H-polymer electrolyte composition : 2H-polymer + MPII + I_2 , [-O-]:[MPII]=20:1, I_2 = 10 wt% of MPII

The maximum ionic conductivity was 3.17*10⁻⁴ (S/cm).

Table 1 Ionic conductivity of 2H-polymer electrolyte

Temp (°C)	Conductivity (S/cm)
21	3.17 * 10-4
30	3.81 * 10-4
45	7.62 * 10-4
60	1.04 * 10-3

4. Conclusion

The oligomer with triple hydrogen bonding sites was synthesized with poly(ethylene glycol) (Mw=2000), pyrimethamine and glutaric acid, and utilized as a solvent to dissolve redox couples (I^{-}/I_3^{-}) .

The solid polymer electrolyte (2H-polymer), in situ self-polymerized from the oligomer by double hydrogen bonds of the composition [EG]: [1-methyl-3-propyl] imidazolium iodide (MPII)]: $[I_2] = 20:1:0.19$ resulted in the overall energy conversion efficiency of 4.63% at one sun condition.

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