

Electronic Supplementary Materials

**Preparation and Evaluation of PVDF-HFP Based Gel
Electrolyte for Ge-sensitized Thermal Cell**

Yadong Chai ¹, Sachiko Matsushita ^{1,2,*}

¹ Department of Materials Science and Engineering, Tokyo Institute of Technology, 4259
Nagatsuta-cho, Midori-ku, Yokohama, Kanagawa 226-8501 Japan

² elleThermo, Ltd., Tokyo Institute of Technology, Yokohama 226-8503, Japan

*** Author to whom correspondence should be addressed:**

Tel: +81-45-924-5163, E-mail: matsushita.s.ab@m.titech.ac.jp

Experimental procedure S1

The content rate of NMP in the prepared electrolyte was calculated through **Equation (S1)**, where the added weight of NMP, PVDF-HFP, CuCl and CuCl₂ were 4, 1, 0.16 and 0.21 g respectively.

$$\frac{4}{4+1+0.16+0.21} \times 100\% = 74.5 \text{ wt}\% \quad (\text{S1})$$

Figure S1

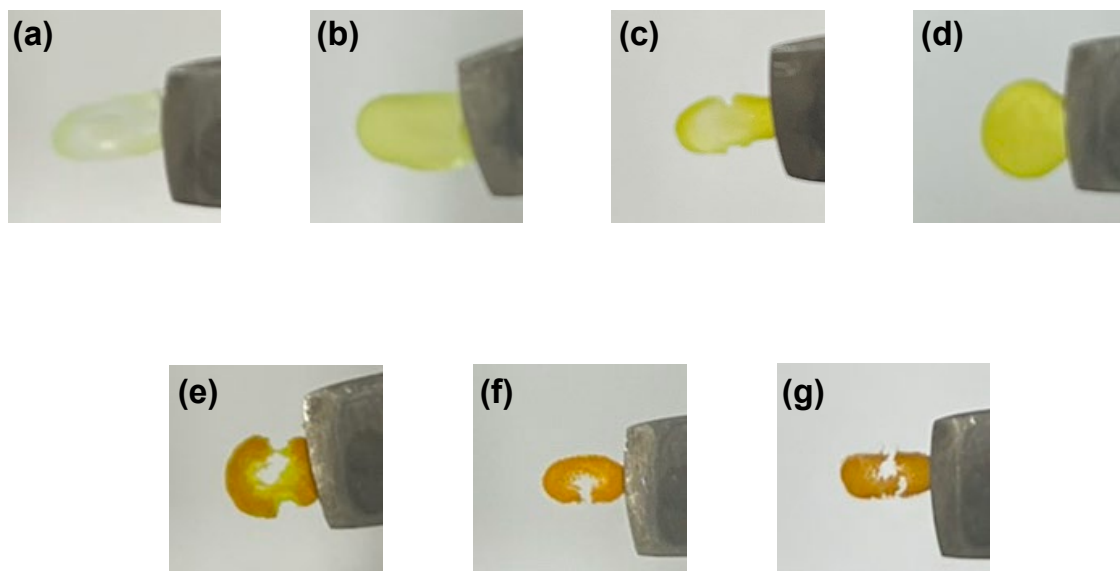


Figure S1. Digital camera images of the electrolytes at different gelation temperatures ((a) 30°C, (b) 35°C, (c) 40°C, (d) 45°C, (e) 50°C, (f) 55°C and (g) 60°C).

Figure S2

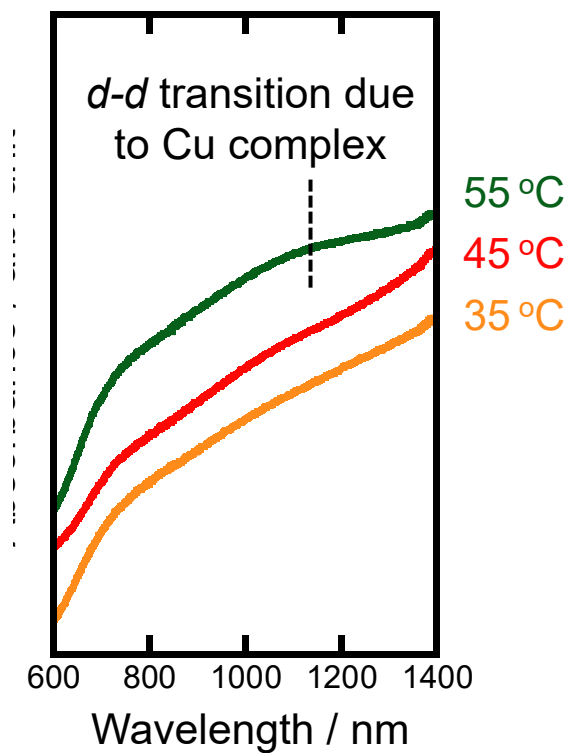


Figure S2. UV-vis absorption spectra of the electrolytes measured at 35 °C (orange line), 45 °C (red line) and 55 °C (green line).

Figure S3

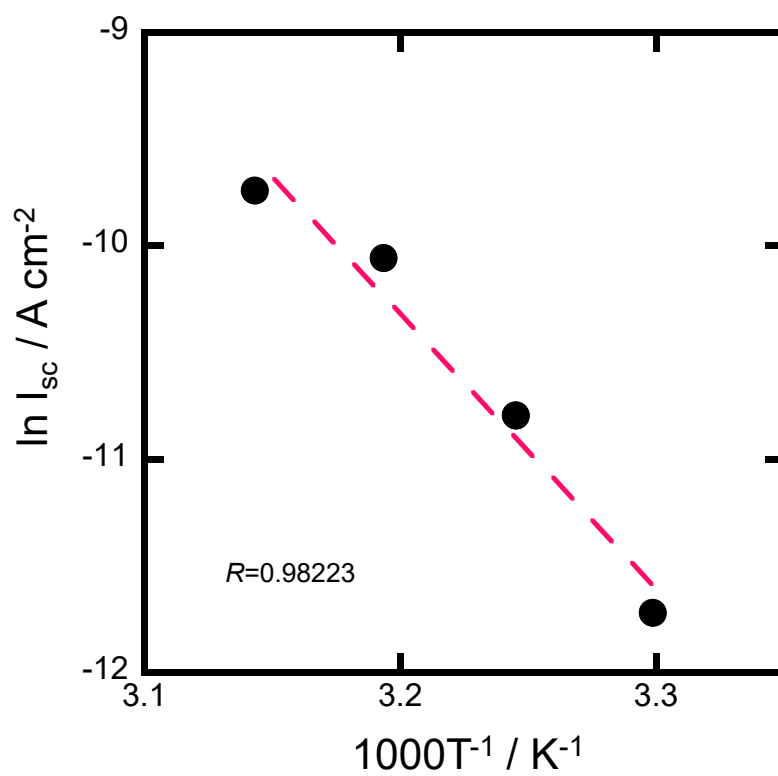


Figure S3. Temperature dependence of short circuit current density (Arrhenius plot) to calculate activation energy which was 107 kJ mol^{-1} .

Figure S4

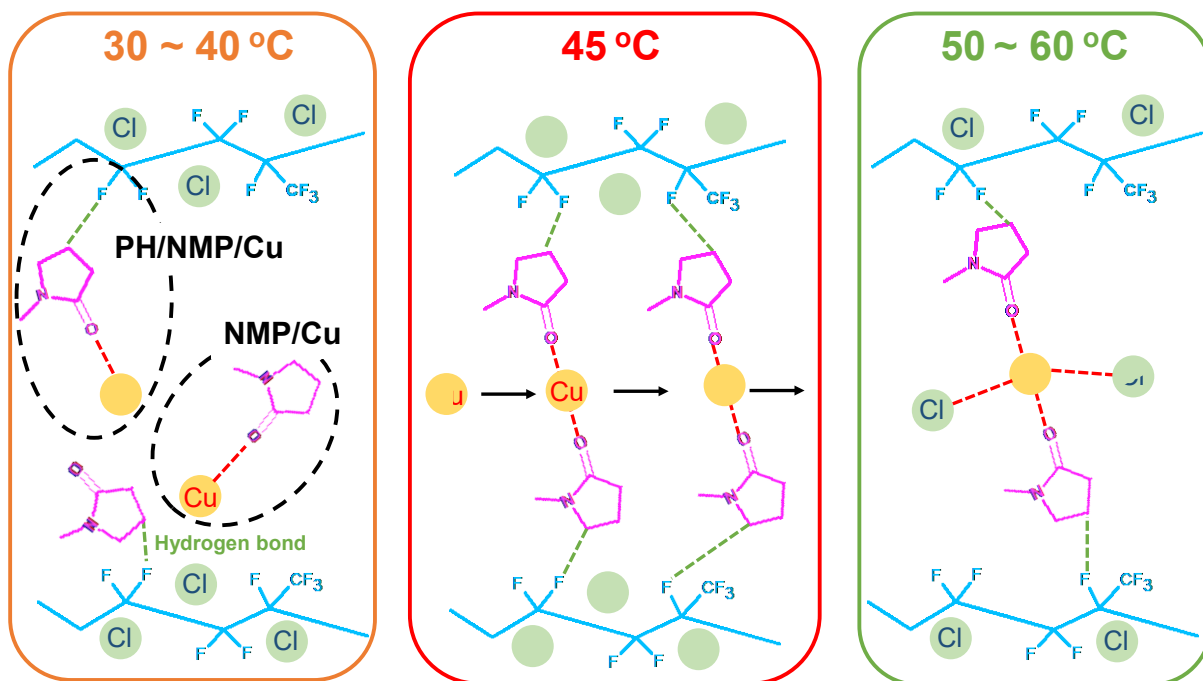


Figure S4. Graphic images of the possible states for the electrolytes gelled at different gelation temperatures.

Figure S5

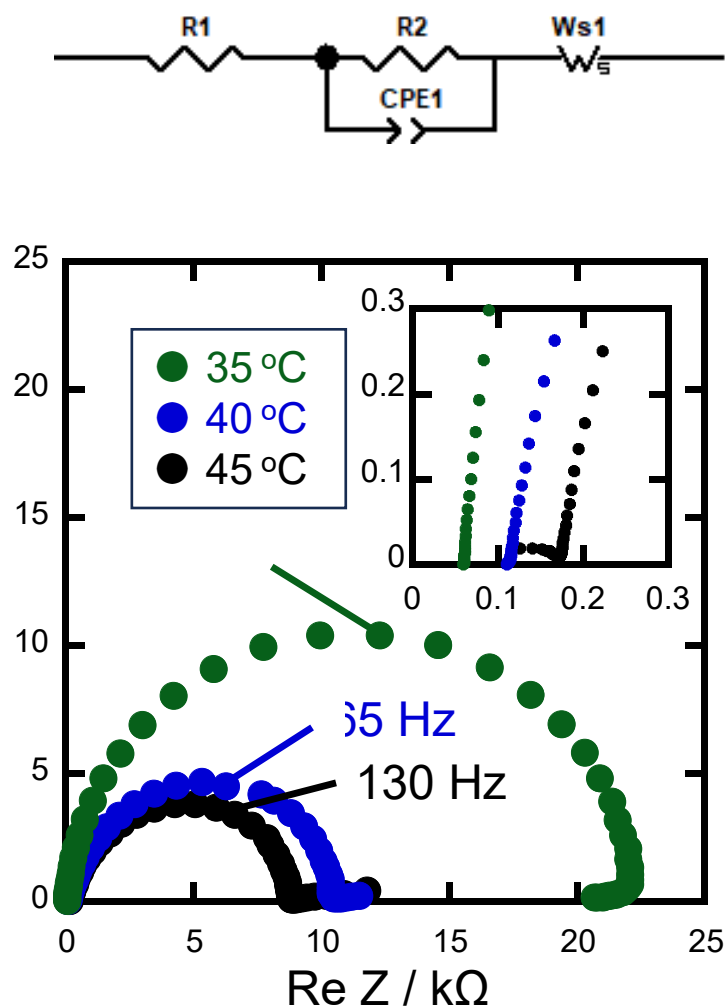


Figure S5. (a) Equivalent circuit using symmetric FTO/FTO cells. R1: internal electrolyte resistance; R2: charge transfer resistance at the FTO/electrolyte interface; CPE1: electric double layer at the FTO/electrolyte interface and Ws1: Warburg element representative of ion diffusion, and (b) PEIS measurement of the cells at 35 °C, 40 °C and 45 °C.

Figure S6

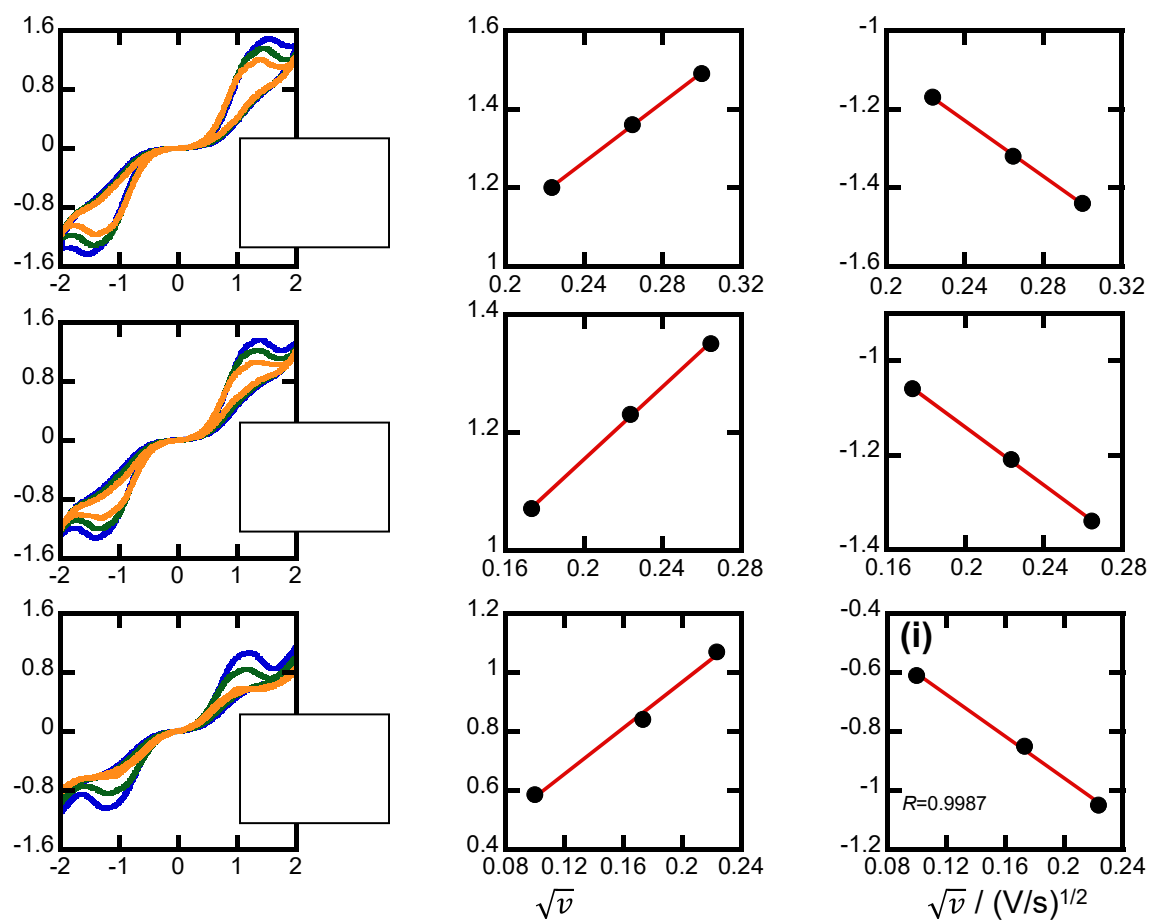


Figure S6. (a, d, g) Cyclic voltammetry, (b, e, h) oxidation and (c, f, i) reduction peak current of the cell at (a~b) 35 °C, (d~f) 40 °C and (g~i) 45 °C changing with scan rate.

Figure S7

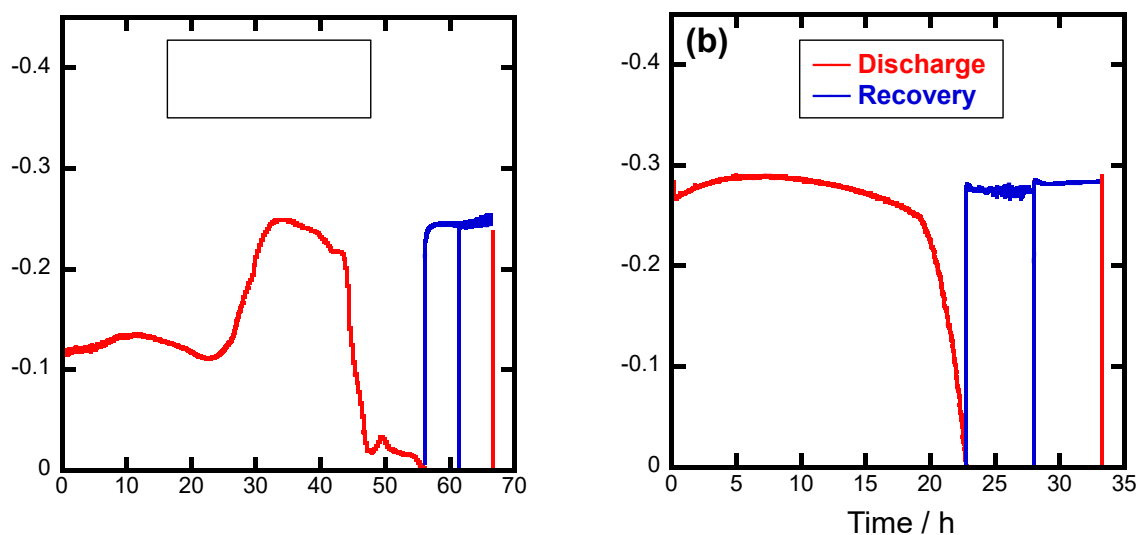


Figure S7. Discharge (chronoamperometry) and recovery of the cells were measured at (a) 35 °C and (b) 45 °C which are equal to the gelation temperatures, where the discharge current is 200 nA, the recovery time was 5 h and the trial number of discharges was 3.

Figure S8

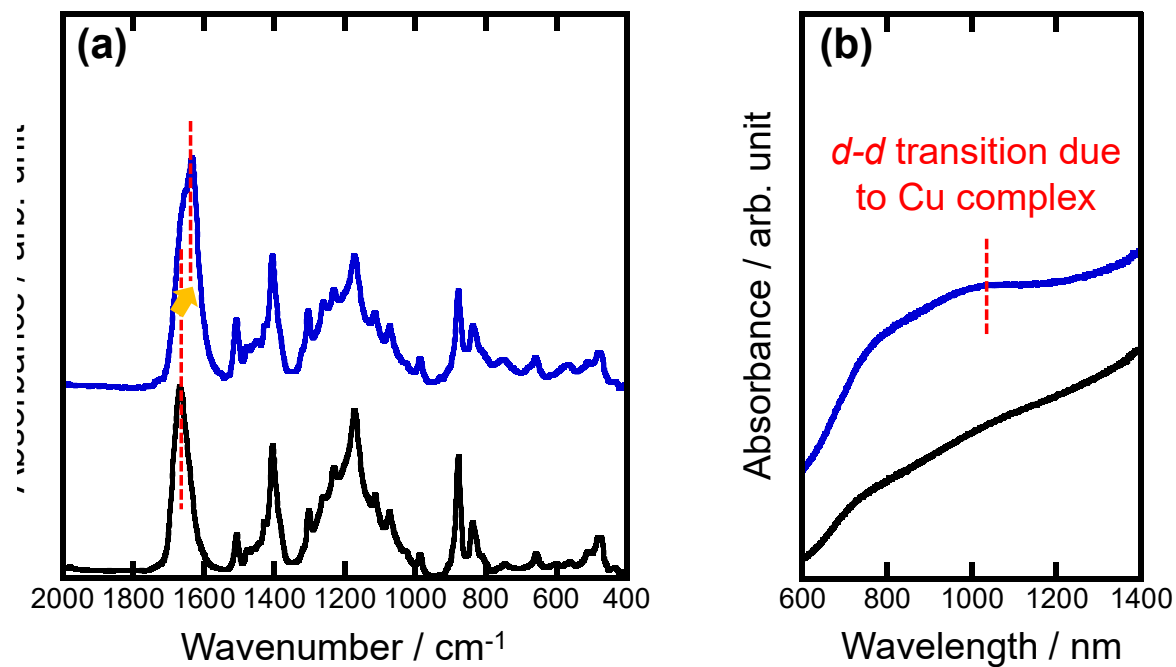


Figure S8. (a) FT-IR and (b) UV-vis absorption spectra of the cells before (indicated by black line) and after discharge (indicated by blue line) at 45 °C.