Observation of electrochemical Peltier effects by a simple method

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The growing demand for air conditioning requires an alternative cooling system. We focused on the electrochemical Peltier (ECP) effect. It consists of the solution of redox-active species in a redox equilibrium (Figure 1). When an external current is applied to the solution, oxidation and reduction occurs at the anode and cathode, resulting in the transport of the latent heat. Since thermos-electrochemical cells show one order higher Seebeck coefficient (*Se*) than semiconductors,[1] the ECP device should show a high Peltier coefficient by Kelvin's law, while few studies have been done.[2,3] Here I propose a simple method for the observation of ECP effect.

Two representative systems, aqueous 0.40 M $K_3[Fe(CN)_6]$|0.4 M $K_4[Fe(CN)_6]$ (*Se*: −1.4 mV K^{-1}) and 2.0 M I_2|0.4 M KI (*Se*: +0.35 mV K^{-1}), were investigated. The current was applied to the assembled cell, and the current direction was switched to reduce the contribution of Joule heating. The temperature of one electrode was monitored (Figure 2) and cooling and heating switched by current direction were observed. The observed temperature differences are highly dependent on the *Se* of the solutions (Figure 3), indicating observed effects must be by ECP effect not by Joule heating or Seebeck effect of Pt electrode. These results will pave the way for applications of thermogalvanic electrolytes as temperature control.

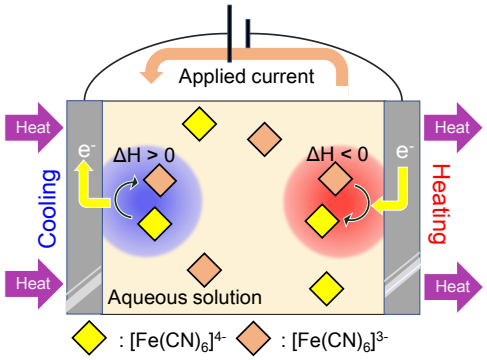

Figure 1. Schematic image of ECP effect.

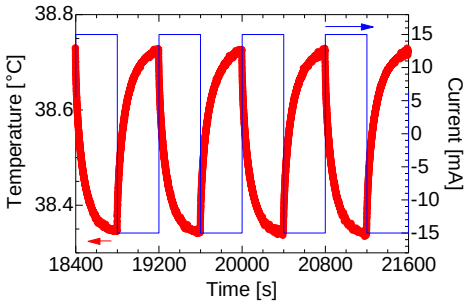

Figure 2. The temperature changes of aqueous $[Fe(CN)_6]^{4-/3-}$ solution by applying current (15 mA). Every 400 s, current was switched.

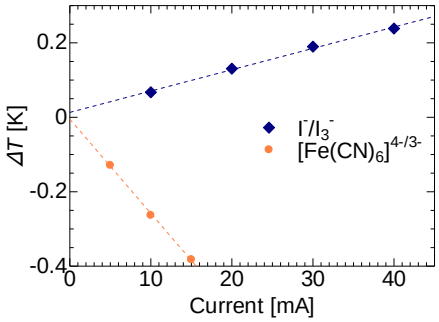

Figure 3. The current dependence of the average temperature differences of a couple of electrolytes within a cycle.

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