Dehydration of Hydrogels Induced by Electric Current

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During the drying process, hydrogels show interesting behavior in interactions between polymer network and solvent molecule. In addition, some of them turn into glass like materials [1–3].

Recently, we found that the agar gel can be dehydrated electrically at a considerable faster rate than the natural evaporation [4]. Rather amount of solvent water of a sample gel begins to exude from its surface which is in contact with or close to an electrode when the electric current is started to pass through the gel. As shown in Fig. 1, which is an experimental result from an agar gel 2 wt% in concentration, the observed reduction in weight of a sample gel due to this phenomenon reached 40% within 20 minutes. The electric power applied to the sample is very small; the Joule heating of the gel was estimated one or two degrees at most. Thus, the increase of evaporation by heating is negligible to affect this rapid dehydration. The speed of this dehydration seems to depend on the density of the electric current through the sample.

Several other hydrogels are also observed and found to have resemble dehydration phenomenon. Although the degree of dehydration varies considerably with the substance of the gel, it seems that the electrical dehydration is a common characteristic of hydrogels. This suggests interesting electrical interactions between polymer network and solvent molecule of hydrogels.

It is known that, in ref. 5, Tanaka et al. reported the volume phase transition induced by electric field. However, they did not quantitatively reported the electric current although they mentioned the existence of a stationary current resulting from electric field. Whereas, the present study investigated the relation between the dehydration of hydrogels and the electric current. It strongly depends on the electric current density flowing through the gel but seems not to depend on the electric field applied to the gel.

Although we have observed this phenomenon only with direct current and simple experimental setup, other factors of this phenomenon, such as the frequency of electric current, material and shape of electrode, are important for further investigation as well as application.

Fig. 1 Drastic increase in reduced weight of Agar gel dehydrated electrically (open circle), compared with natural evaporation (closed circle). The sample agar gels are prepared to have concentration of 2 wt%.

References