Electronic Supplementary Information

Unique Gel of Xanthan Gum with Ionic Liquid and Its Conversion into High Performance Hydrogel

Hironori Izawa, Yoshiro Kaneko and Jun-ichi Kadokawa

Experimental Section

Materials. 1-Butyl-3-methylimidazolium chloride (BMIMCl) was purchased from Sigma-Aldrich Chemical Co. Xanthan gum (viscosity; 1785 cps, 1 wt% solution in 1 wt% KCl aq., 20 ^{o}C) was purchased from Tokyo Chemical Industry Co., Ltd. Commercial products of xanthan gum contain a moisture of ca. 11 % and an ash of 6 – 9 %.[1] The values of molecular weight of the xanthan gum samples are generally 2 – 50 x 10^{6}.[2] Other reagents were used as commercial grade without further purification.

Preparation of Xanthan Gum/BMIMCl Gels. As a typical procedure for the preparation of xanthan gum/BMIMCl gel, xanthan gum (0.10 g, i.e., 9.1 wt%) was added to BMIMCl (1.00 g) and stirred for 3 min at 100 ºC to be a homogeneous solution. After the solution was continuously heated at 100 ºC for 12 h without stirring, it was kept at room temperature for 30 min to give a xanthan/BMIMCl gel (1.15 g, containing some moisture).

Preparation of Xanthan Gum Hydrogels (Imidazolium Form). The 9.1 wt% gel (1.15 g) with BMIMCl obtained according to aforementioned procedure was soaked in water (100 mL) for 24 h to give a hydrogel, which was taken out from the water solution. The obtained hydrogel was lyophilized to estimate the water content, which was calculated to be 94.6 wt%.

Ion-exchange From Imidazolium Form to Ca^{2+} Form in Xanthan Gum Hydrogel. The aforementioned hydrogel was soaked in 0.2 M $CaCl_2$ aqueous solution (100 mL) for 48 h to give an ionically cross-linked hydrogel with Ca^{2+}, which was taken out from the water solution. The hydrogel was lyophilized to estimate water content, which was calculated to be 85.2 wt %.

Demonstration of Thermally Induced Shape-memory Effect. A coiled shape of the 33.3 wt% gel was prepared by heating-cooling process using an appropriate mold. Then, the coiled shape of the gel was deformed to rod shape by heating at ca. 50 ^{o}C, which

was fixed by cooling for a few seconds at room temperature. The deformed gel was continuously heated at ca. 50 °C for progress of the thermally induced shape-memory effect.

Measurements. The stress-strain curves under the compressive and tensile modes were measured using a tensile tester (Little Senstar LSC-1/30, Tokyo Testing Machine Co.) with a speed of 2.0 $mm \cdot min^{-1}$. Elemental analysis was performed using a Perkin-Elmer 2400 II CHN element analyzer.

References

1. A. M. Stephen, G. O. Philips and P. A. Williams, *Food polysaccharides and their applications*, Taylor & Francis, London, 1995.
2. S. Rosalam and R. England, *Enzym. Microb. Tech.,* 2006, *39*, 197.