

Triple-transforming gel prepared by β -cyclodextrin, diphenylamine and lithium chloride in *N,N*-dimethylacetamide

Yuan Yuan Li¹, Wen Jing Zhao¹, Hua Cheng Zhang, Tao Sun,
Wei An, Fei Fei Xin, Ai You Hao^{*}

School of Chemistry and Chemical Engineering, Shandong University, Jinan 250100, China

Received 11 February 2010

Abstract

This paper describes a triple-transforming gel system (gel–sol–gel') for the first time, which is a thermo-responsive and multi-component organogel prepared by β -cyclodextrin (β -CD), diphenylamine (DPA) and lithium chloride (LiCl) in *N,N*-dimethylacetamide (DMAC) in a suitable proportion based on the supramolecular interactions. In the triple-transforming gel system, a gel (gel A) could be formed by β -CD, DPA and LiCl in DMAC at room temperature based on stirring, then the gel could transform into a clear solution based on heating, and then the other gel (gel B) can be formed at a relatively high temperature (T_{gel} , the gelation temperature by heating). The two gel states in the triple-transforming gel system have different microstructures. This gel system was characterized by OM, SEM, IR and rheology.

© 2010 Ai You Hao. Published by Elsevier B.V. on behalf of Chinese Chemical Society. All rights reserved.

Keywords: Gel; Triple-transforming; β -Cyclodextrin; Lithium; *N,N*-Dimethylacetamide

Gels, especially reversible gels with striking self-assembly properties, are important functional materials with increasing attention, such as in pharmacy, materials, cosmetics, *etc.* [1–3]. The conventional thermo-responsive gels is duplicate-transforming (sol–gel), which could be thermo-reversible by one way of heating or cooling around the gelation temperature (T_{gel}) [4,5], or the other way of heating upon T_{gel} and cooling down [6]. Here, we introduce a novel gel system, a triple-transforming gel system (gel–sol–gel') for the first time, which is a thermo-responsive organogel with multi-components prepared by β -cyclodextrin (β -CD), diphenylamine (DPA) and LiCl in *N,N*-dimethylacetamide (DMAC) in a suitable proportion based on the supramolecular interactions. The first gel (gel A) could be formed by β -CD, DPA and LiCl in DMAC at room temperature based on stirring, then the gel could transform into a clear solution based on heating, and then the other gel (gel B) can be formed at a relatively high temperature (T_{gel} , the gelation temperature by heating). This gel system was characterized by optical microscopy (OM), scanning electron microscopy (SEM), FTIR measurements (FTIR) and rheology. Some significant features of the gel system were found as follows: (1) the system has multi-components, where each of the four components is required for the organogelation; (2) the system is a thermo-responsive organogel of small organic molecules such as DPA and DMAC,

* Corresponding author.

E-mail address: haoay@sdu.edu.cn (A.Y. Hao).

¹ These authors contributed equally to this work.

which is different from the conventional gels with a duplicate-transforming (sol–gel) process; (3) the two gel states have different microstructures observed by SEM. The striking self-assembly properties of the thermo-responsive triple-transforming system may bring in much broad prospects for applications.

1. Results and discussion

The gel–sol–gel' transition process of the investigated system is shown in Fig. 1. As shown in Fig. 1, a gel (gel A) can be formed with stirring at room temperature while another gel (gel B) formation can be clearly observed upon heating to the T_{gel} . During the heating process, gel A turned to a transparent solution firstly and then gel B was formed with the temperature increasing. When gel B was cooled down to the room temperature, transformation of the gel into a sol was observed within several minutes. When the concentrations of β -CD and DPA were lower ($C_{\beta\text{-CD}} = 0.25$ mol/L and $C_{\text{DPA}} = 1.25$ mol/L), gel A could not be easily formed while gel B still could be formed easily. Several batches of β -CD/DPA/LiCl systems prepared at different dates were used to examine our observations and the same results were obtained. A detailed characterizations study of these gels was carried out and the details are given below.

Optical images for the gel samples at different magnification were shown in Fig. 2a and b. The morphology of the gel showed a fiber-like morphology of about 1–3 μm in width and more than several tens of micrometers in length (Fig. 2a). However, when the DMAC was slowly volatilized from the gel sample at room temperature, the fiber-like gel structure would be destroyed (Fig. 2b). The line-structure in Fig. 2b was the fissure of the dried sample. The SEM

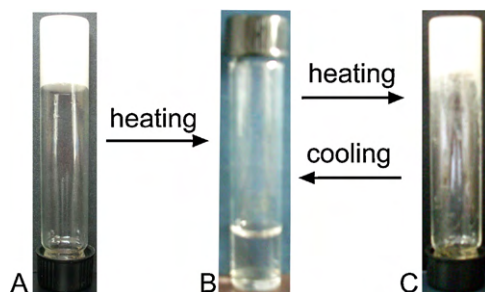


Fig. 1. Images of the mixture of β -CD/DPA/LiCl in DMF. (a) White gel phase at room temperature; (b) transparent solution stage in the heating process; (c) white gel phase at high temperature.

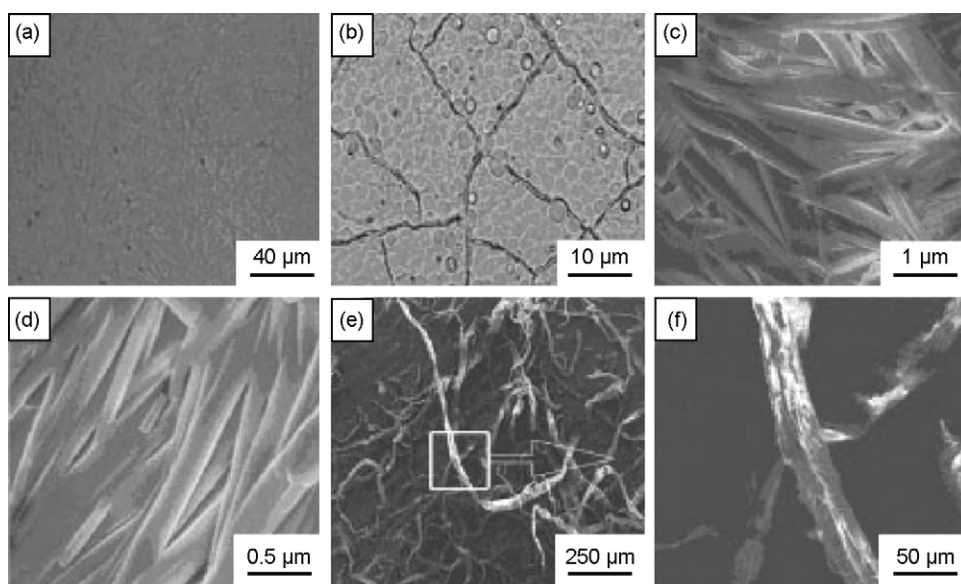


Fig. 2. Optical micrographs of gel ($C_{\beta\text{-CD}} = 0.25$ mol/L, $C_{\text{DPA}} = 1.25$ mol/L, $\omega_{\text{LiCl}} = 0.5\%$ (ω_{LiCl} : LiCl/DMAC, w/w)) at different magnifications (a and b); SEM images (c and d) of the gel prepared at room temperature, and SEM images (e and f) of the dried gel prepared in vacuum at T_{gel} .

Download English Version:

<https://daneshyari.com/en/article/1257857>

Download Persian Version:

<https://daneshyari.com/article/1257857>

[Daneshyari.com](https://daneshyari.com)