Rheology of supramolecular gel from a lipid-peptide gelator.

H. Tamate, H. Furukawa, S. K. Sukumaran, M. Sugimoto* and K. Koyama

Graduate School of Science and Engineering, Yamagata University, 992-0038, Japan
* Corresponding author's e-mail: sugimoto@yz.yamagata-u.ac.jp

Abstract:

Under certain conditions, amphipathic monomers self-assemble into fibrillar structures. These supramolecular fibrils can, in turn, undergo gelation. This sol-gel transition can be induced by varying the temperature or the applied stress. As the gelation occurs due to weak noncovalent interactions, it is reversible. This physical gelation typically yields a supramolecular gel that is more fragile than conventional polymeric gels. In addition, the physical properties of the supramolecular gel can be controlled through appropriate design of the monomer structure. Therefore both for fundamental interest and for effective applications, it is essential to understand the relationship between monomer structure, self-assembly process, sol-gel transition and the physical properties of the supramolecular gel.

In this study, we are interested in the behavior of supramolecular gels formed by a novel lipid-peptide type gelator. Four gelator concentrations (0.5, 1.0, 2.0, 4.0 wt%) in water-ethanol mixture (ratio 3:7) were used for the investigations. First, we performed a strain sweep to investigate the strain range over which the sample displays linear behavior and the results are shown in Figure 1. As expected, the G' increases with concentration. However, the strain at which the G' begins to sharply decrease from the approximately constant value decreased with concentration. More interestingly, the work done on the gel until nonlinearity begins was estimated and found to be approximately constant, i.e., independent of the gelator concentration.

The results of a temperature sweep are shown in Figure 2. It is clear from the figure that the gelation process is thermoreversible and that the gelation temperature depends on the concentration of the gelator. Further, the variation of G' with temperature during the heating and cooling cycles is significantly different. However, the heating and cooling curves could essentially be superimposed on each other by a horizontal shift of approximately 20°C. In addition, the value of this shift appears to be independent of the concentration of gelator.

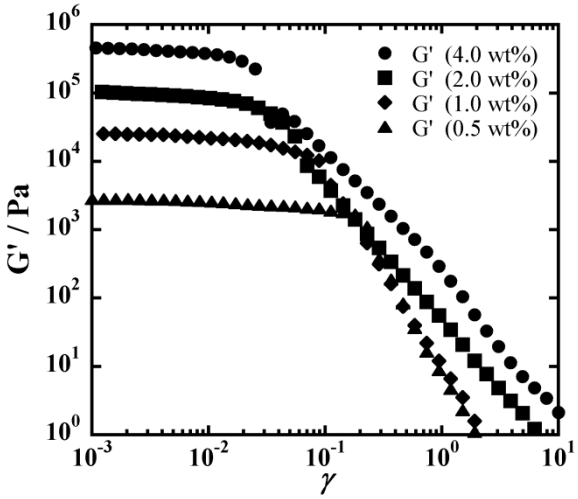

Fig.1 Strain sweep. The measurements were done at frequency 1 rad/s and temperature 10°C.

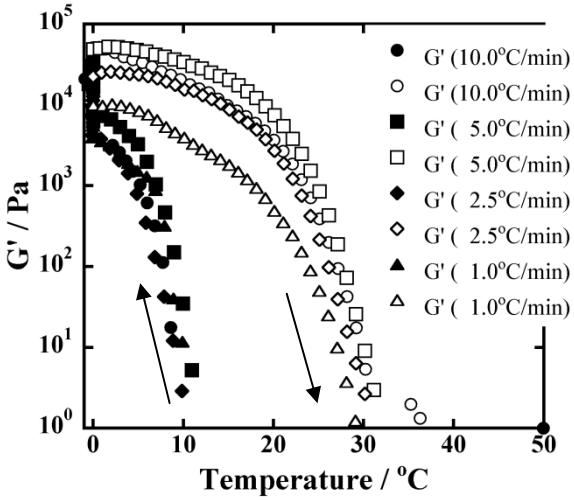

Fig.2 Variation of G' with temperature (1.0 wt%). Solid: cooling; hollow: heating. The measurements were done at frequency 1 rad/s and strain 10^{-2}.

Keywords: peptide gelator; self-assembly; hydrogel; thermoreversible; rheology.