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Introduction to polymer networks

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Gels and elastomers composed of polymer networks have been studied in various basic and applied fields, and materials with various functions useful for daily life have been developed. One of the reasons for this progress in the research may be the ease with which researchers in various fields have been able to prepare similar materials.

Furthermore, along with the development of precise synthesis methods in organic chemistry, the development of various nanomaterials that can be used as building blocks in inorganic chemistry, and the challenge of unknown areas in biochemistry, the study of gels and elastomers has made increasingly significant progress over the past two decades. For example, gels, which were once recognized as mechanically brittle, have become very tough materials, even when they hold a lot of solvent. As a result, they are being used as artificial organs. It had been believed that the restorative force of a deformed gel can be roughly explained by the entropic elasticity derived from the deformation of

the polymer chains. However, it was found that the restorative force of gels is not determined by entropy elasticity alone, but is greatly weakened by “negative energy elasticity” derived from the solvent. This finding demonstrates that the “temperature dependence of softness,” which is important for the use of gels in food and medical applications, can be several times greater than previously assumed. In elastomers as well, advances in analytical methods and simulations have led to a better understanding of toughening by adding fillers to cross-linked networks, and the development of more highly functional rubber materials.

To keep abreast of these remarkable developments in gels and elastomers, we organized the Gel Symposium 2022 (<https://www.gelsymposium2022.com>), a traditional international conference on polymer gels, in Tomamu, Hokkaido, Japan. At that time, we could not invite many foreign speakers because of the coronavirus disaster, but we invited prominent foreign researchers to

give lectures online. One of the invited speakers at that time, Professor Alfred Crosby of the University of Massachusetts Amherst in the U.S., cooperated to publish this themed issue in *Soft Matter* and *Polymer Chemistry*. In this joint themed issue, 1 Review, 29 Papers, and 2 Communications were published in *Soft Mater*, and 9 Papers and 2 Communications were published in *Polymer Chemistry*. All of the papers were very interesting and contained the latest information, making this a very readable themed issue.

The Gel Symposium will be held again this November in Okinawa, an island in the south of Japan, by the members who participated in this themed issue as guest editors. The Gel Symposium 2024 (<https://gelsymposium.com> and <https://gelsymposium.studio.site/>) will feature 101 invited speakers, including 26 authors of this joint themed issue, who will present their latest research. If you are interested in the latest trends in current polymer gels and elastomers, please come to Okinawa.