Laboratory of Macromolecular Solutions

Graduate School of Science

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Macromolecules in solution can take a nearly infinite number of conformations due to their high degree of freedom of internal rotations. Macromolecules in solution have, therefore, specific characteristics not found in small molecules. Intramolecular interactions in a macromolecule and intermolecular interactions with solvent molecules significantly influence the molecular shape in solution. Furthermore, strong intramolecular interactions, including hydrogen bonding and electrostatic interactions, lead to the formation of micelles and aggregates. The intermolecular interactions between polymers through solvents can also cause various phase separations. Such phenomena correlate with the functions in biosystems. Our research aim is to clarify the various phenomena exhibited by macromolecules in solution, that is, single chain conformation, complex formation behavior, and phase separation behavior by using the latest scattering and spectroscopic methods.

Dissociation and association mechanisms of multiple helical polysaccharides

DNA and collagen forming multiple helical structures express important functions in living organisms. Xanthan is a double helical polysaccharide. It is widely used for food additives because the aqueous solution has significantly high viscosity. Circular dichroism (CD) and small-angle X-ray scattering (SAXS) measurements were made for xanthan samples in aqueous NaCl after rapid temperature change eventually to find a novel specific intermediate structure. Taking into consideration that mismatch double helix can yield hairpin-like and multibranched structures, investigation of kinetics of the dissociation and association mechanisms is important to understand the functions of multiple helical polysaccharides in living organisms as well as food additives. We thus investigate that novel specific properties and functions can be added to conventional polysaccharides by controlling the dissociation and association behavior of multiple helix formation.

Solution properties of polymers having cyclic and branched structures

Cyclic polymers including plasmids play important roles in vivo, such as in genetic expression. Rigid polysaccharide derivatives were prepared and characterized in terms of the several experimental methods to investigate the intermolecular interactions and specific functions of cyclic polymers. We found that the interactions with small molecules were appreciably different from those for conventional linear chains. Furthermore, spontaneously folded conformation was found concentrated liquid crystalline solutions. Branched structures are often found in biopolymers (especially polysaccharides) as in the case of cyclic structures. We thus study cyclic polymers as well as branched polymers to explore unknown physical properties and functions.

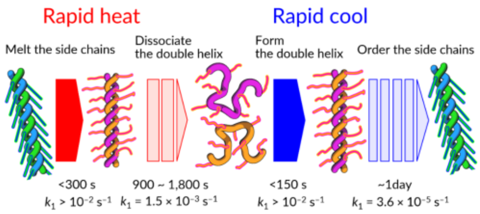

Figure 1. Schematic representation of conformational change after rapid heating and cooling processes and the time constants.

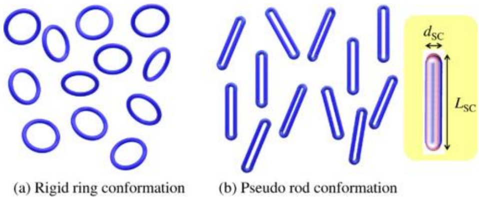

Figure 2. Schematic representation of the rigid ring polymer.

Let us discover unknown and interesting phenomena through the unique ideas and physical properties of polymers.

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