Graduate School of Science and Technology
Physics and Mathematical Sciences

Characterizations of polymer under temperature gradient

Measurement of irreversible transport coefficient

Topics : Ludwig-Soret effect, Soft materials, Interactions of molecules

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Background and Motivation

We have carried out experiments studying the effects of the temperature gradient in various solutions. Here, the determination of the irreversible transport coefficient is rather difficult compared to the equilibrium condition, since the system shows a non-uniform spatial and temporal distribution of the constituents. The aim of this project is to contribute to the development of nonequilibrium thermodynamics by means of an original technique and systematic studies of the transport phenomena.

Originality

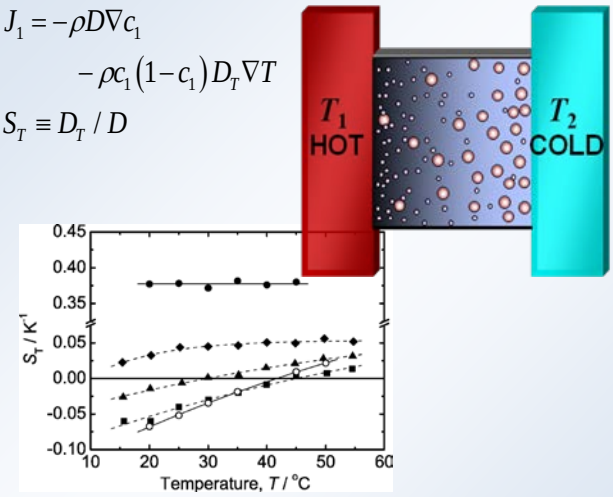
For aqueous solutions of polymers (DNAs, proteins, polysaccharides, and so on), the magnitude and the direction of their concentration gradient induced by a temperature gradient show an abnormal behavior. The results suggest that irreversible transport phenomena should be investigated with respect to the role of hydrogen bonds among segmental molecules and water molecules. The researches may lead to a deeper understanding of the functions and the structure formations of biopolymers.

Impact and Perspective

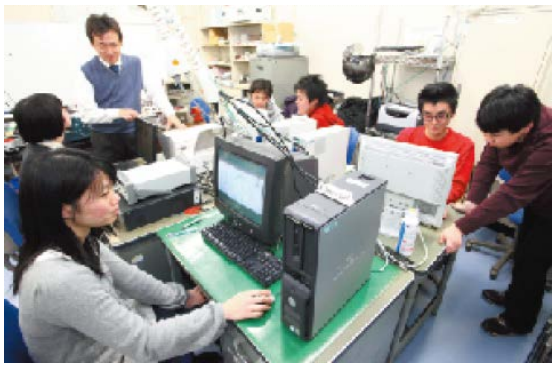
The technique of determinations of the transport coefficient under the external field may clarify the role of molecular interactions among water molecules and biological molecules. It is necessary to continue the fundamental researches for this purpose. Moreover, some practical applications are expected in the fields of foods, cosmetics, materials science, molecularbiology, and so on by utilizing the effect of temperature gradient as the external field.

$$J_1 = -\rho D \nabla c_1 - \rho c_1 (1 - c_1) D_T \nabla T$$

$$S_T \equiv D_T / D$$



A temperature gradient induces a mass flux which establishes a concentration gradient in fluid mixtures. This behavior is called the Ludwig-Soret effect.



Published papers from the group

Y. Kishikawa, S. Wiegand, and R. Kita, "Temperature Dependence of Soret Coefficient in Aqueous and Nonaqueous Solutions of Pullulan", *Biomacromolecules* **11**, 740-747 (2010).

R. Kita, P. Polyakov, and S. Wiegand, "Ludwig-Soret effect of poly(*N*-isopropylacrylamide): Temperature dependence study in monohydric alcohols", Macromolecules **40**, 1638-1642 (2007).

R. Sugaya, B. A. Wolf, and R. Kita, "Thermal diffusion of dextran in aqueous solutions in the absence and the presence of urea", *Biomacromolecules* **7**, 435-440 (2006).

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