



Macromolecules and Behavior of Living Systems.....

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The concept of “*macromolecule*” was proposed for the first time in 1926 by Hermann Staudinger and was eventually established in 1936 after a decade of scientific debates between the “macromolecule-believers” who believed in the existence of a very large molecule resulting by covalent bonding, and the skeptical “colloid-believers” who firmly relied on the already established concept of “colloids”. The later which are composed of many small molecules assembled not by covalent bonds, but by specific interactions such as electrostatic or hydrophilic-hydrophobic interactions in aqueous environments, is one of the central topic of chemistry (colloid chemistry) in the end of 19th century. The concept of “*macromolecule*” was only established in 1936 after a series of experiments on viscosity of cellulose performed by H. Staudinger’s group at the University of Freiburg. Since this establishment, polymer science has been extensively developed along the two main streams: polymer synthesis and physical properties characterization.

From the viewpoint of synthetic polymers, the typical functions of living systems such as self-adjusting, self-adapting and/or self-generating would be the ultimate goals for designing specialty polymers. Despite numerous studies carried out in the past seventy years, it is still not possible to endow these functions for polymer. This would be one of the ultimate goals for research of polymer materials science in the 21st century. As a first step, we started tackling the problem by finding a generic way to design and control the spatial ordered structure in polymer. The primary approach is applying the so-called “principle of competition between antagonistic interactions” to multi-component polymeric systems. This principle has been widely known in the field of developmental biology (Cf. J. Murray, “*Mathematical Biology*”, Springer, 1989). As a result of this competition, a variety of ordered structures emerges at different length scales in living systems such as spots on the skin of leopard or tiger. We have applied this principle to polymeric systems by coupling chemical reactions to phase separation of

polymer mixtures. It has been found that these competing processes lead to the emergence of a variety of ordered structures in the mesoscopic length scales (J.A. Pojman and Q. Tran-Cong-Miyata Eds., “*Nonlinear Dynamics in Polymeric Systems*”, American Chemical Society, 2004). On the other hand, structures with high hierarchies are abundant in Nature where all the kinetic processes proceed non-uniformly over a very long time-scale ranging from billions to millions years. By using the same principle, one could design materials with controllable structural hierarchy. With the above-mentioned principles, one can hope that artificial materials with some functions comparable to those emerging in living things could be designed.

Regarding the International Relations between Kyoto Institute of Technology (KIT) and foreign universities and institutions, I think that we need to send more KIT students to foreign countries at the early stage of the undergraduate program by using some specific programs supported by KIT. These projects will help KIT students to have a broad view about things happening outside Japan, in both advanced as well as developing nations. Through the communication and comparison with students at their same age in these foreign countries, KIT students would be much more motivated and could also realize the “must-do” when they come back to Japan. Regular organization of International Symposia at KIT on several specific research topics conducted by KIT faculty members would be a key to push KIT into the “world-class” institution.

Concerning foreign students coming to KIT for study, constant training in Japanese language and reasonable scholarships would be crucial for their study. In addition, some sorts of language tests such as “Japanese TOEFL” for the ability of their Japanese language would help them achieving great success. This is also a good way to gain good reputation for KIT in foreign countries where these students come from.