【Grant-in-Aid for Specially Promoted Research】

Science and Engineering (Chemistry)

Title of Project : Physically Perturbed Assembly for Tailoring High-Performance Soft Materials with Controlled Macroscopic Structural Anisotropy

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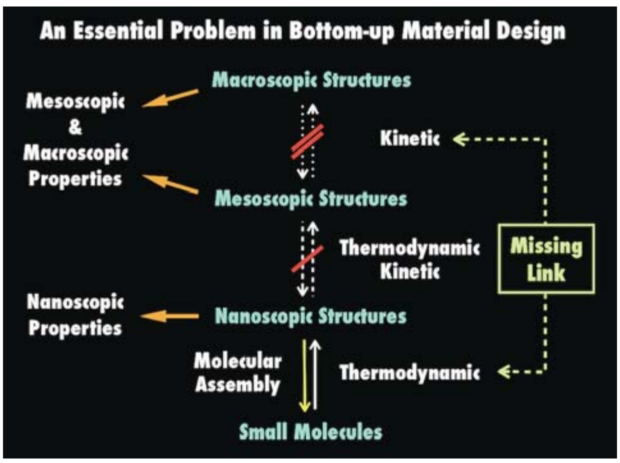
Research Area : Chemistry
Keyword : Supramolecular Chemistry, Hybrid Materials, Physical Perturbations

【Purpose and Background of the Research】

A remarkable progress in supramolecular chemistry in the last two decades now allows us to design and tailor a variety of desired nanostructures by optimizing a thermodynamic control. However, there still remains an essential missing link between molecular/nano structures and those with meso/macroscopic size regimes. This is mainly because the assembling events from "nanoscale size regimes" toward "upper hierarchical levels" suffer from an irreversible interference by numerous kinetic traps, leading to the formation of ill-defined macroscopic structures. On the other hand, in living system, many biological events rely on certain macroscopic structural anisotropies of biomaterials. Those anisotropic structures are constructed under physical perturbations such as electrical potentials, ion/fluid fluxes, osmotic pressures, and sheer forces.

Having a lesson from biological assembling events, we are taking up the challenge of filling the above-mentioned "missing link" by applying physical perturbations to our highly reputed assembled motifs.



【Research Methods】

In this project, we will mainly focus attention on utilization of three chemical motifs (1)–(3), all of which require a certain structural anisotropy up to a macroscopic length scale for their practical applications. Motif (1) is the first ferroelectric columnar liquid crystal. Motif (2) is an "aqua material" with aligned 2D nanosheets. Motif (3) is a dispersion of highly concentrated imidazolium ion-adsorbed carbon nanomaterials.

【Expected Research Achievements and Scientific Significance】

This project will cause a big paradigm shift in industrial technologies as well as basic sciences. (1) Development of ferroelectric columnar liquid crystals is remarkably important for application to low-cost, ultrahigh density organic memory devices. (2) Aqua materials having a certain structural anisotropy will pave the way for a full-fledged artificial muscles and cartilages. (3) Dispersions of highly concentrated and oriented carbon nanomaterials could allow us to fabricate conceptually new metal-free electronic devices. We apply a variety of physical perturbations to control kinetic events of the assembly of large-dimension nanostructures and achieve structural anisotropies.

【Publications Relevant to the Project】

- D. Miyajima *et al.* Ferroelectric columnar liquid crystal featuring confined polar groups within core–shell architecture, *Science* **336**, 209–213 (2012).
- Q. Wang *et al.* High-water-content mouldable hydrogels by mixing clay and a dendritic molecular binder, *Nature* **463**, 339–343 (2010).
- T. Fukushima *et al.* Molecular ordering of organic molten salts triggered by single-walled carbon nanotubes, *Science* **300**, 2072–2075 (2003).

【Term of Project】 FY2013-2017

【Budget Allocation】 464,500Thousand Yen

【Homepage Address and Other Contact Information】

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